



SRI VENKATESWARA COLLEGE
(University of Delhi)

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NAAC Accredited "A+" Grade (2022)

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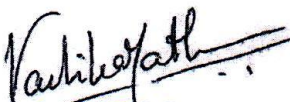
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CRITERIA 1

Supporting Document

1.3.2 Number of courses that include experiential learning through project work/field work/internship during the year


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Sri Venkateswara College
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धौला कुआँ, नई दिल्ली / Dhaura Kuan, New Delhi-21

UNIVERSITY OF DELHI
DEPARTMENT- Biochemistry
COURSE NAME: Bachelor of Science (Hons) Biochemistry
(SEMESTER - III)

based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)



Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite	Contents of the course and reference in Annexure/ Page no.
			Lecture	Tutorial	Practical		
Metabolism of Lipids	DSC	4	2L		2P	Class XII with Science	
Bioenergetics	DSC	4	2L		2P	Class XII with Science	
Membrane Biology	DSC	4	2L		2P	Class XII with Science	
Environmental Biochemistry	DSE	4	2L		2P	Class XII with Science	
Biochemical Applications in Forensic Sciences	DSE	4	2L		2P	Class XII with Science	
Microbiology	DSE	4	2L		2P	Class XII with Science	
Protein and Enzymes	GE	4	2L		2P	Class XII with Science	
Nutrition and Food Science	GE	4	2L		2P	Class XII with Science	
Physiology of Sports and Exercise	GE	4	2L		2P	Class XII with Science	

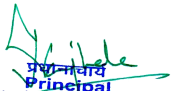
Based on Undergraduate Curriculum Framework 2022

UNIVERSITY OF DELHI

UNDERGRADUATE PROGRAMMES OF STUDY

STRUCTURE, COURSES & SYLLABI OF SEMESTER -III




प्रधानाचार्य
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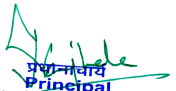


BIOCHEMISTRY

COURSES OFFERED BY DEPARTMENT OF BIOCHEMISTRY

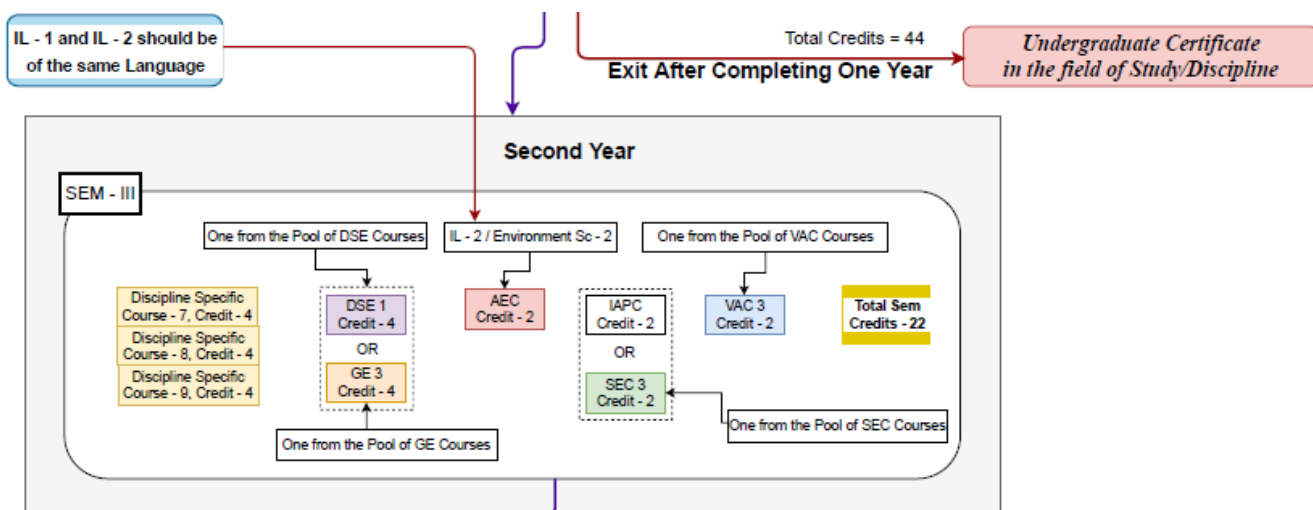
Category I

**Biochemistry Courses for Undergraduate Programme of study with
Biochemistry as a Single Core Discipline
(B.Sc. Honours in Biochemistry in four years)**


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STRUCTURE OF THIRD SEMESTER

A student who pursues undergraduate programme with Biochemistry as single core discipline is offered the following courses:



CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Metabolism of Lipids	04	02	-	02	Class XII with Science	-

Learning Objectives

The aim of this course is to give students an exhaustive understanding of lipid metabolism, enzymes involved in various catabolic and anabolic pathways of lipids, and their regulation. The course will also discuss the significance of such pathways in the context of metabolic disorders.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the concepts of metabolism of lipids, characteristics of metabolic pathways and strategies used to study these pathways.
- Apply the knowledge of various catabolic and anabolic pathways in lipid metabolism and their regulation.
- Describe the diseases caused by defects in metabolism with emphasis on metabolic control.

SYLLABUS OF DSC-7

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE) BCH-DSC-301: METABOLISM OF LIPIDS Semester – III

2.2 Course Contents

Theory

Credits: 2

Total weeks : 15

Unit 1. Digestion absorption and transport of lipids (2 weeks)

Digestion and absorption of lipids, Structure, classification and biogenesis of lipoproteins, Endogenous and exogenous pathways, Lipoprotein cycle.

Unit 2. Degradation of lipids (5 weeks)

Fatty acid oxidation: Activation of fatty acids, transport to mitochondria, β oxidation of saturated, unsaturated, odd and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal β oxidation, ω oxidation and α oxidation. Ketone-body synthesis and utilization and its regulation. Ketone body metabolism in diabetes and starvation.

Unit 3. Synthesis of lipids (6 weeks)

Transport of mitochondrial Acetyl groups to cytosol, Fatty acyl synthase complex, Synthesis of saturated and unsaturated fatty acids, Regulation of fatty acid metabolism. Fatty acid elongation systems, role of mixed function oxidases in fatty acid desaturation. Synthesis of triacylglycerol, glycerophospholipids and sphingolipids.

Unit 4. Cholesterol metabolism (2 weeks)

Biosynthesis of cholesterol and its regulation. Fates of cholesterol, cholesterol transport. Familial Hypercholesterolemia, Dyslipidemia, and atherosclerosis.

2.3 Practical:

Credit: 2

Total weeks: 15

1. Isolation of lipids and determination of phospholipid/ cholesterol ratio from egg yolk
2. Separation of Phospholipids by TLC
3. Estimation of Ketone bodies in blood/urine
4. Total Cholesterol estimation and HDL-Cholesterol estimation
5. Triglyceride estimation and lipid profile
6. Case studies: Obesity, Dyslipidaemia, Metabolic syndrome, Fasting, Ketosis

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). *Lehninger: Principles of Biochemistry* (8th ed.). New York, WH: Freeman and Company. ISBN-10: : 1319381499 ISBN-1319381493-978
2. Devlin, T.M. (2011). *Textbook of Biochemistry with Clinical Correlations* (7th ed.). New York, John Wiley & Sons, Inc. ISBN:978-0-470-28173-4.
3. Voet, D., Voet. J. G. (2013). *Biochemistry* (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN:978-1-11809244-6.

Suggested readings:

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671
2. Denise R Ferrier (2018) Lippincott Illustrated Reviews Biochemistry, 7th Edition Publisher. Wolter Kluwer; ISBN-10. 8184739141.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be introduced to digestion absorption. They will gain conceptual clarity on functions of lipoproteins and transport of lipids	Teaching will be conducted both through black board mode and power point presentations.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
II	Students will gain insight into the mechanism of breakdown of fats to derive energy. They will be able to appreciate the importance of ketone bodies as alternate fuel.	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. They will practically isolate lipids from egg yolk and analyze the components by TLC	Students will be asked to analyse case studies. Practical related oral questions will be asked.
III	The pathway of synthesis of fatty acid and the concept of multienzyme complex will be introduced to the students.	Teaching will be conducted both through black board mode and power point presentation mode. Analysis of blood samples will be performed to assess the lipid profile.	Regular class question-answer sessions. Internal assessment tests will be conducted. Discussions using case studies will be conducted.

IV	Gain understanding regarding the importance of cholesterol, its biosynthesis and transport. Students will be able to appreciate the regulation of cholesterol metabolism by studying diseases arising from dysregulation	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted
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(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Lipids, Lipoproteins, triacylglycerol, Fatty acid oxidation, multienzyme complex, desaturases, ketone bodies, cholesterol

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Bioenergetics	04	02	-	02	Class XII with Science	-

Learning Objectives

The objective of the course is to provide students with the basic understanding of thermodynamic principles, bioenergetics and the roles of high energy compounds in metabolism. The course will also provide an understanding of the biological oxidation reduction reactions. The course will introduce students to the detailed molecular mechanisms of oxidative phosphorylation and structural as well as functional aspects of ATP synthase. The course will provide an in-depth knowledge of photophosphorylation.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the basic tenets of thermodynamics and energy transformations that are taking place in the cell
- Explain the biological oxidation-reduction reactions and the mechanisms of electron transfer by electron carriers.
- Appreciate the concept of chemiosmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis.
- Elaborate the basic mechanisms photophosphorylation in plants and microbes.

SYLLABUS OF DSC-8

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE) BCH-DSC-302: BIOENERGETICS Semester – III

2.2 Course contents

Theory

Credits: 2

Total weeks : 15

Unit I: Principles of Thermodynamics

(3 weeks)

Laws of thermodynamics, Thermodynamic quantities: Gibbs free energy, enthalpy, entropy, Free energy change. Standard free energy change, equilibrium constant, actual free energy change, coupled reactions, energy charge, phosphorylation potential, ATP cycle. Chemical basis of high standard free energy change of hydrolysis of ATP, phosphoenolpyruvate, 1,3 bisphosphoglycerate, phosphocreatine and thioesters. Bioluminescence.

Unit II: Biological Oxidation-reductions

(2 weeks)

Redox reactions, reduction potentials, standard reduction potential and its relationship with standard free energy change, Nernst equation. Universal electron carriers-NADH and FADH₂.

Unit III: Oxidative phosphorylation

(5 weeks)

Mitochondria as the site of oxidative phosphorylation, electron carriers in mitochondria, structural and functional organization of the mitochondrial respiratory chain, proton motive force, chemiosmotic hypothesis, inhibitors and uncouplers of mitochondrial electron transport chain. Structure of FoF₁ ATP synthase and mechanism of ATP synthesis. Shuttle systems in mitochondria: Malate-aspartate and Glycerol 3-phosphate. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratory pathways in plants.

Unit VI: Photophosphorylation

(5 weeks)

Harvesting light energy. General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Photophosphorylation in purple and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Oxygen evolving complex, cyclic photophosphorylation and its significance, ATP synthesis by photophosphorylation, efficiency of photophosphorylation, Bacteriorhodopsin.

2.3 Practical:

Credits: 2

Total weeks : 15

1. Study the photosynthetic O_2 evolution in hydrilla plant.
2. Isolation of chloroplast from spinach leaves.
3. Estimation of chlorophyll content.
3. Study the Hill reaction by using artificial electron acceptor.
4. Estimation of the activity of PS-II.
5. Separation of photosynthetic pigments by TLC.
6. Isolation of mitochondria from liver and assay of mitochondrial marker enzyme SDH.

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
2. Berg, J.M., Tymoczko, J.L., Gatto G.J., Stryer L. (2019) *W.H.*: Freeman and Company, ISBN:10: 1319114679, ISBN:13:978-1319114671
3. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

Suggested readings:

1. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will understand the basic principles of thermodynamics, meaning of standard free energy changes of reactions	Traditional chalk & board method with powerpoint presentations. Numerical problems relating to free energy change, entropy, etc., to be done in class	Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts. Prelecture quiz to evaluate students understanding of previous lecture.

II	Students will learn about redox reactions, reduction potentials, standard reduction potential and its relationship with standard free energy change	Powerpoint presentations; Teaching using chalk and board; Oral discussion sessions in the class	Students will be given home assignments to enhance their learning and for assimilation of concepts
III	Understand the concept of chemiosmotic theory and the mechanism of oxidative phosphorylation and ATP synthesis	Numerical problems relating to standard redox potential, proton motive force done in class	Students will be given home assignments to enhance their learning and for assimilation of concepts.
IV	Understand the basic mechanisms of photo phosphorylation in plants and microbes	Traditional chalk & board method with powerpoint presentations. Numerical problems relating to photo phosphorylation efficiency	Post lecture students will be given home assignments to enhance their learning and for assimilation of concepts

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Thermodynamics, free energy, oxidative phosphorylation, ATP synthase, photophosphorylation

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Membrane Biology	04	02	-	02	Class XII with Science	-

Learning Objectives

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. This course also provides understanding of molecular mechanisms involved in vesicular transport processes and membrane fusion.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the general composition and structure of biomembranes.
- Describe the basic properties of membranes such as membrane fluidity.
- Elaborate various types of membrane transport mechanisms.
- Apply the knowledge gained about the molecular mechanism of vesicular transport and membrane fusion to understand the functioning of cells.

SYLLABUS OF DSC-9

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)

BCH-DSC-303: MEMBRANE BIOLOGY

Semester – III

2.2 Course Contents

Theory

Credits: 2

Total weeks : 15

Unit I: Membrane composition and structure

(5 weeks)

Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols; Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates.

Historical background and various membrane models. Overview of membrane functions.

Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase.

Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter.

Unit II: Membrane dynamics

(2.5 weeks)

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions, microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

Unit III: Membrane transport

(4.5 weeks)

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport glucose transporter and anion transporter. Primary active transporters- P-type ATPases, V-type ATPases, F-type ATPases. Secondary active transporters - lactose permease, Na⁺ - glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na⁺ and K⁺ channel) and ligand-gated ion channels (acetylcholine receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

Unit IV: Vesicular transport and membrane fusion

(3 weeks)

Vesicular transport. Vesicles, Clathrin-Coated Vesicles and COP-Coated Vesicles (COPI and COPII). Molecular Mechanism of Vesicular Transport. Membrane Fusion (dynamin protein, Rab proteins, NSF/ SNAP complex, SNARE proteins). Receptor Mediated Endocytosis: LDL, Transferrin

2.3 Practical:

Credit: 2

Total weeks : 15

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Isolation of membrane phospholipids and separation by TLC.
3. Effect of temperature, pH, detergents, and ionic strength on Tonoplast membrane of beetroot.
4. Determination of CMC of detergents, neutral and ionic
5. Preparation of RBC ghost cell.
6. Separation of RBC membrane proteins by SDS-PAGE.
7. Demonstration of Histidine uptake from the intestinal membrane.

2.4 Essential readings:

1. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
3. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
4. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
5. Wardhan, R., Mudgal, P. (2017). Text Book on Membrane Biology (1st ed.). Singapore, Springer. ISBN-10: 9811071004, ISBN-13: 978-9811071003

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about general composition and structure of biomembranes. They would study various membrane model systems and their application. Learn about lipid shapes and Polymorphic Lipid-Water Systems.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

II	Students would learn about membrane dynamics and various techniques used to study membrane dynamics.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would have knowledge about the various types of membrane transport mechanisms.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
IV	Learn about molecular mechanisms of vesicular transport and membrane fusion.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords:

Membrane structure composition, membrane fluidity, membrane transport, vesicles, membrane fusion

DISCIPLINE SPECIFIC ELECTIVE (DSE-1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Environmental Biochemistry	04	02	-	02	Class XII with Science	-

Learning Objectives

This course will provide understanding of environment around and which pollutants are of concern to us. It will provide knowledge of sustainability and methods which can help to improve the sustainability. It will also make students understand how toxicity can be monitored in our body and how our body copes to detoxify its internal system. It will also introduce methods which can be used to monitor the pollutants in various samples.

Learning outcomes

On successful completion of the course students will be able to:

- Describe various components of the environment.
- Evaluate the local and global scale of environmental problem.
- Explain the biological, chemical and physical processes relevant to environmental problems.
- Apply the hands on experience of some quantitative and qualitative research tools gained to assess and analyse the environmental problems

2.1 Course Contents

Theory

Credits: 2

Total weeks : 15

Unit 1: Introduction to Environment and the Pollutants

(4.5 weeks)

Components of Environment - Atmosphere, Hydrosphere, Lithosphere and Biosphere. Global Warming and Climate change. Ozone depletion. Normal Chemistry of - Air, Water, Soil. Environmental Toxins-Physical Pollutants- Noise, Light and Radiation and Air Pollutants- Carbon Monoxide, Lead, Nitrogen Oxides, Ozone, Particulate Matter, Sulphur Dioxide, Methane Volatile Organic Chemicals (VOC); Water Pollutants - Volatile Organic Chemicals (VOC), Heavy Metals, Insecticides, Herbicides/ Endocrine Disruptors; Soil Pollutants- Heavy metals, Herbicides/pesticides, Polyaromatic Carbon (PAH), Microplastics; Source, Effect and Impact on Flora, Fauna including Human Beings. Definition of Terminologies: Air Quality Index (AQI) Suspended Particulate matter (SPM), Water Quality Index (WQI), Air Pollution Tolerance Index (APTI), Anticipated Performance Index (API).

Unit 2: Environment and Xenobiotics

(3.5 weeks)

Understanding the principle of Toxicity. Concept of Dose and Response (LD50). Process of Bioaccumulation, Bioaugmentation and Biotransformation. Impact of pollutants on human health Mammalian Detoxification by Liver to Organic Chemicals (Heavy Metals, Endocrine Disruptors, Microplastics).

Unit 3: Sustainability and its Enhancement

(4 weeks)

Concept of Sustainability and Enhancement of Sustainability, Waste Management (Refuse, Reduce, Reuse and Recycle), Sewage treatment and Industrial effluents (tanning and electroplating), Bioremediation- Introduction and Types of Bioremediations- Phytoremediation, Microbial Bioremediation, In-situ Remediation, Ex-situ Remediation.

Unit 4: Techniques to Analyse Pollutants

(3 weeks)

Determination of pollutants in soil, water, air, blood by following Analytical Techniques: Flame Photometer; Atomic Absorption Spectroscopy (AAS); Inductive Coupled Plasma (ICP -OES & MS); Gas Liquid Chromatography (GC-MS); Ion Chromatography; High Performance Liquid Chromatography (HPLC); UV spectrophotometer; Biosensors and its application in pollution detection; Metagenomics.

2.3 Practical:

Credits: 2

Total weeks : 15

1. Evaluating APTI and API of Herbs/Shrubs/Trees
2. Evaluating seasonal variations of AQI and SPM
3. Evaluating C/N/P/K content of soil by Spectrophotometry/Titrimetric method
4. Detecting Microbial Contamination of water

5. Composting of waste (Leaf/Kitchen Waste/Cow dung) and Detecting Maturity by pH and Electric conductivity (EC) content changes
6. Studying Enzymatic Activity (amylase/urease) in the soil sample due to microbial activity
7. Student Environment Projects.

2.4 Essential readings:

- Basic Concepts on Environmental Chemistry by Des. W. Conwell (2005) 2nd edition, CRC press, ISBN 9781498770484
- Environmental Chemistry by Stanley E Manahan, 11th Edition, Taylor and Francis, 2022, ISBN 9780367560546
- Biodegradation and Bioremediation by Alexander Martin, 2nd Edition, Academic Press, ISBN 978-0-12-049861-8
- Fundamentals of Ecology author Eugene Odum, Cary W. Barrett, 5th edition Cengage learning India. ISBN 9788131500200
- Environment and Ecology author P.D. Sharma, 12th Edition, Rastogi Publication. ISBN 978-93-5078-068-8

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No	Learning Outcome	Teaching Methods	Assessment Method
I	Student will be introduced to various components of environment and basic composition of air, soil, water and its pollution. They will become aware of environment toxins and their effect on living communities. They will also be introduced to the standard terms used for identification of quality of air, water and plants	By chalk and board explanations, Power point presentations. Visualisation of Videos. Collecting News Paper Cuttings and Small Research Project. Getting soil and water of campus tested and discussing the results	Through assignments, MCQs, Power Point Presentation. Make report of the research projects.
II	Students will become aware of ways to protect the environment for benefit of future generation. They will understand the concept of waste management with the goal of zero discharge of waste. They will become aware of different methods used to eradicate pollution using plants and microbes.	By chalk and board explanations, Power point presentations. Visualisation of Videos. Collecting News Paper Cuttings and Small Research Project. Undertake waste management on campus. Study polluting ability of trees on campus	Through assignments, MCQs, Power Point Presentation. Make report of the research projects.

III	Student will know the concept of xenobiotics and how living systems contribute to magnification of pollutants. They will understand how toxins affect the human system and ways by which human physiology and biochemistry takes care of toxins	By chalk and board explanations, Power point presentations. Visualisation of Videos. Collecting News Paper Cuttings and Small Research Project	Through assignments, MCQs, Power Point Presentation. Make report of the research projects.
IV	Students will learn principles of various traditional and modern analytical techniques for assessment of pollutants in air, water and soil. They will understand the interdisciplinary approach of electronics and biological science for detection of pollutants through biosensors and quality of microbiome present around.	By chalk and board explanations, Power point presentations. Visualisation of Videos. Collecting News Paper Cuttings and Small Research Project. Undertaking Practicals in these areas	Through assignments, MCQs, Power Point Presentation. Make report of the research projects.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Environment, Climate Change, ozone depletion, Waste Management, Bioremediation, Toxicity, Bioaccumulation, Bioaugmentation, Biotransformation, Detoxification, Biosensors.

DISCIPLINE SPECIFIC ELECTIVE (DSE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemical Applications in Forensic Sciences	04	02	-	02	Class XII with Science	-

Learning Objectives

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidence, which will help students develop analytical and problem-solving skills for real life situations. With a background of the DSC of Biochemistry, the students get an insight into a major area of application of Modern Biology. The course will keep abreast with all recent developments and emerging trends in forensic science like DNA fingerprinting, brain mapping and facial reconstruction; thus, helping interested students take up forensic science as a future course of study.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the fundamental concepts and principles of forensic science and their significance.
- Explain how a forensic investigation is initiated through preservation of evidences, as well as chemical, physical and biological methods of their analysis
- Identify an individual by document evaluation, fingerprints, footprints and DNA analysis and identify the accurate age, sex and identity of an individual and identify time and cause of death in a forensic investigation.
- Explain the importance of precision, reproducibility and accuracy in identification of a biological sample.
- Elaborate the methods used to analyze samples for drug testing, ink and stain testing and document and handwriting verification.
- Describe the physiology and biochemistry behind tests like Narco Analysis, polygraphy, lie detection and facial reconstruction.
- Apply the knowledge gained from hands-on-experience in some of the basic biochemical processes involved in forensic investigation.

2.2 Course Contents

Theory

Credit: 2

Total weeks: 15

Unit I: Introduction to forensic science and application of biological sciences to forensic investigation (5 weeks)

History and Development of Forensic Science, Biochemical analysis of various biological evidences: blood, semen, viscera, bite marks, and hair. Establishment of identity of individuals: fingerprints, footprints, blood and DNA. Anthropology – skeletal remains, Odontology. Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death. case studies

Unit II: Application of chemical sciences to forensic investigation (3 weeks)

Detection of drugs of abuse and narcotics in biological samples, Toxicological examination of viscera, detection of petroleum products and food adulteration. Analysis of inks and their use in questioned document identification. Blood spatter analysis, Case studies

Unit III: DNA Fingerprinting (3 weeks)

Introduction to DNA-and source of DNA in Forensic case work, Techniques of DNA fingerprinting-RFLP, STR, PCR, DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, studying kinship by DNA profiling: Related individuals have similar DNA profiles, DNA profiling and the remains of the Romanovs. Sex identification by DNA analysis: PCRs directed at Y chromosome-specific sequences, Amelogenin gene typing. Case studies

Unit IV: Recent advances in forensics (4 weeks)

Narco analysis: theory, forensic significance, future prospect, *Brain mapping*: introduction, EEG, P-3000 wave, forensic applications, limitation of technique, *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test. *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification, Case studies.

2.3 Practicals

Credit: 2

Total weeks : 15

1. Definition, Identification and Mapping of Crime scene
2. Collection, Preservation, Packaging, and Labeling of biological evidence for their forensic investigation.
3. Preliminary and Confirmatory test for blood/semen/saliva
4. Examination of Micro Evidences: fiber, hair, pollen and soil
5. Fingerprint development from various surfaces and their microscopic and chemical examination

6. Handwriting identification based on class characteristic and individual characteristics
7. Identification of dyes, drugs and ink by TLC
8. Blood spatter analysis
9. DNA Fingerprinting: Sex determination through Y specific STRs and Maternal lineage identification through mitochondrial DNA comparisons.
10. Field trip to a forensic laboratory

2.4 Essential readings:

- James, S.H., Nordby, J.J. & Bell, S. (2014). *Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition*: Taylor & Francis. ISBN 9781439853832
- Jones, P., & Williams, R.E. (2009). *Crime Scene Processing and Laboratory Workbook First Edition*: CRC Press. ISBN 9780429249976
- Saferstein, R. (2018). *Criminalistics: An Introduction to Forensic Science, Twelveth edition*: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596
- Veeraraghavan, V. (2009). *Handbook of Forensic Psychology, First Edition*: Selective & Scientific Books, ISBN 13: 9788189128166.

Suggested readings:

- Lee, H., Palmbach, T. & Miller, M. (2001). *Henry Lee's crime scene handbook, First Edition*: Academic Press ISBN 9780080507989
- Parikh, C.K. (2016). *Parikh's textbook of medical jurisprudence, forensic medicine and toxicology: for classrooms and courtrooms, Seventh Edition*: CBS Publishers and Distributors. ISBN 9788123926469

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I.	Comprehend the developments in the field of forensic sciences; learn to observe a crime scene for identification of relevant evidences and samples for forensic analysis. Understand the importance of collection, packaging and preservation of samples to ensure reliability of data generated. Understand the importance of precision, reproducibility and accuracy in identification of a biological sample. Learn the methods to	Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Use models of crime scenes for practical training on sample identification and collection. Practical training on microscopic identification of various biological samples, finger print development from	Internal assessment tests. Students will be given questions that are application based and require analytical skills

	identify the accurate age, sex and identity of an individual and identify time and cause of death in a forensic investigation.	surfaces and identification of fingerprints	
II.	Gain knowledge about the methods used to analyse samples for drug testing, ink and stain testing and document and handwriting verification. Concept of blood splatter analysis	Class teaching with black board and power point presentation modes. Discussions on case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Practical analysis of urine samples for drug tests. Practical analysis of inks and stains.	Conduct of Internal assessment tests. PowerPoint presentation on the assigned topics.
III.	Learn the importance of DNA fingerprinting in forensic investigations	Power point presentation will be used to teach various methods. Use of blackboard and general discussions in the class. Practical exercises on DNA fingerprinting.	Internal assessment tests will be conducted. Analyzing case studies. Open book tests to promote self-learning.
IV	Understand the physiology and biochemistry behind tests like Narcoanalysis, polygraphy, lie detection and facial reconstruction.	Teaching using chalk and board and video tutorials. Expert lecture on course related topics and field trip to labs.	Internal assessment tests will be conducted. A PowerPoint presentation on any interesting case study and the use of forensic technology in investigation. Practical record book assessment, oral discussion and question-answer sessions on practical topics.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Forensic biology; blood spatter analysis; toxicology; narco-analysis; DNA fingerprinting; polygraph; odontology; forensic entomology.

DISCIPLINE SPECIFIC ELECTIVE (DSE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Microbiology	04	02	-	02	Class XII with Science	-

Learning Objectives

The course aims to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world and maintenance of microbes under laboratory conditions. Through this course students will be introduced to the concept of different modes of gene transfer in bacteria. Further, students will be made aware about the applications of microorganisms in food and industry.

Learning outcomes

On successful completion of the course students will be able to:

- Identify different types of microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, microbial growth etc.
- Carry out basic research using microbes
- Describe varied applications of microbes

2.2 Course Contents

Theory

Credits: 2

Total weeks: 15

Unit I: History and Diversity of Microbial world

(4 weeks)

Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa. Cell-wall: Composition and detailed structure of Gram positive and Gram-negative cell walls, mechanism of Gram staining

Unit II: Microbial Nutrition, Growth and Control

(3 weeks)

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics.

Unit III: Microbial Genetics

(3 weeks)

Conjugation, Transformation and Transduction. Gene mapping in Bacteria

Unit IV: Application of Microbes

(5 weeks)

Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as curd and cheese. Preparation of alcoholic beverages like wine and beer. Treatment of waste-water (Municipal treatment plant) and sewage. Bioremediation and biodegradation. Human microbiome: Role in health and disease. Soil Microbiome: Role in plant health

2.3 Practical:

Credits: 2

Total weeks : 15

1. To prepare and sterilize the culture media for the growth of microorganisms
2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml
3. To study growth curve of bacteria
4. To study the effect of pH/temperature on the growth of bacteria
5. To perform gram staining
6. To determine the effect of antibiotics using disc diffusion test
7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs

2.4 Essential readings:

1. Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.
2. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) Microbiology (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
3. Pierce, B.A. (2012) Genetics - A Conceptual Approach, (6th ed.), W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1
4. Cappuccin, and Sherman N., Microbiology: A Laboratory manual (10th ed.). Benjamin/Cummings. ISBN 10 J. G.3: 9780321840226. 86

Suggested readings:

1. Madigan, M. T., Martinko J. M., & Stahl D. A., (2010) Brock Biology of Microorganisms (13th ed.). Pearson Education International. ISBN 13: 9780321649638.
2. Snustad, D.P. and Simmons, M.J. (2012) Genetics (6th ed.), John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	The students will be able to learn the concept of spontaneous generation and also the development of basic microbiological techniques. They will also get to know about the diversity of the microbial world and difference between gram positive and gram-negative bacteria	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests Lab skills will be tested
II	Students will learn about the nutritional requirements of microbes for their growth. They will also study about the characteristic features of bacterial growth curve and the methods which can control microbial growth	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts Lab skills will be tested
III	The student will be able to learn about the concept of bacterial genetics and the various means by	Teaching will be conducted both through black board	Students will be assessed through the assignment and tests. MCQs will also be

	which bacteria can exchange the genetic material	mode and power point presentation mode Videos to demonstrate the gene transfer will be shown to students to understand the theoretical concept Students would also learn concepts by conducting lab practicals	given to assess the understanding of few concepts Lab skills will be tested
IV	The students will learn about the applications of microbes in food, environment and industry.	Teaching will be conducted both through black board mode, power point presentation mode as well as by demonstrating the experiment Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts Lab skills will be tested

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Microbiological Techniques, Media, Sterilization, Growth curve

GENERIC ELECTIVES (GE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Proteins and Enzymes	04	02	-	02	Class XII with Science	-

Learning Objectives

The objective of this course is to provide an overview of protein biochemistry to undergraduate students with diverse science backgrounds, since proteins are the most versatile functional entities in life with applications in various life sciences research as well as in industry and biomedicine. The biochemical, structural, functional and aspects of interaction of proteins will be introduced in this course. The course also aims to provide knowledge about enzyme kinetics, regulation of enzyme activity and diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Learning outcomes

On successful completion of the course students will be able to:

- Familiar with unique features and characteristics of proteins.
- Aware of the relationship between three-dimensional structure of proteins and their functions.
- Gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity.
- Understand the kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors.
- Also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell.
- Gain insight into the applications of enzymes in research and medicine.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-4 : PROTEINS AND ENZYMES
Semester – III

2.2 Course Contents

THEORY

CREDITS: 2

Total weeks : 15

UNIT I: Introduction to proteins

(4 weeks)

Amino acids and their properties. Peptides and their biological significance - hormones, antibiotics and growth factors. Diversity of proteins and their functions. Conjugated proteins, multimeric proteins and metalloproteins. Organization of protein structure - primary, secondary, tertiary and quaternary structures. Bonds in protein structures - covalent and non-covalent. Dihedral angles. Ramachandran map, Secondary structure - alpha-helices, beta-strands, beta-sheets and turns.

UNIT II: Three-dimensional structures and protein folding

(3.5 weeks)

Characteristics of tertiary and quaternary structures. Structure-function relationship in proteins. 3D structures of globular and fibrous proteins – myoglobin, hemoglobin, collagen and keratin. Protein folding - denaturation and renaturation (Ribonuclease A). Role of chaperones. Protein misfolding diseases - Alzheimer's and Cruetzfeldt-Jakob disease.

UNIT III: Introduction to enzymes and enzyme kinetics

(4 weeks)

General characteristics of enzymes; nature of enzymes - protein and non-protein. Cofactor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics. Michaelis-Menten equation, K_m and V_{max} , Lineweaver-Burk plot. Enzyme inhibition, reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Examples - FdUMP and penicillin.

UNIT IV: Regulation of enzyme activity and applications of enzymes

(3.5 weeks)

Control of activities of single enzymes and metabolic pathways: feedback inhibition, allosteric modulation (aspartate transcarbamoylase). Regulation by reversible covalent modification (glycogen phosphorylase). Zymogens (chymotrypsinogen). Enzymes as reagents (glucose oxidase), marker enzymes in diagnostics (SGPT, SGOT); Enzyme therapy (streptokinase); Enzymes in research (Taq polymerase, restriction endonucleases).

PRACTICALS

CREDITS: 2

Total weeks : 15

1. Estimation of proteins by Biuret method.
2. Estimation of proteins by Lowry's method.
3. Determination of isoelectric pH of casein.
4. Determination of activity of an enzyme by continuous assay.
5. Determination of activity of an enzyme by discontinuous assay.
6. To plot a progress curve for an enzyme.
7. Determination of K_m and V_{max} of an enzyme using Lineweaver-Burk plot.

2.3 Essential Readings

1. Nelson, D.L., Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
2. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671
3. Voet, D., Voet, J.G. (2013) *Biochemistry* (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.
4. 2. Nicholas, C.P., Lewis, S. (1999). *Fundamentals of Enzymology* (3rd ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X.

Suggested Readings

1. Whitford, D. (2004). *Protein Structure and function*. Southern Gate, Chichester, West Sussex: John Wiley & Sons, Inc. ISBN-13: 978-047149894 ISBN-10: 0471498947.
2. Schulz, G.E., Schirmer, R.H. (1979). *Principles of protein structure*. Springer, ISBN 978-1-4612- 6137-7.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
I	Students will gain knowledge about the building blocks of proteins i.e. amino acids and understand about the structural organization of proteins.	Students will be taught using power point presentations, chalk and board. In class oral discussion sessions will be conducted.	Oral questions will be asked in the class. Assignment and tests will be given.
II	Students will understand about the characteristics of tertiary and quaternary structures, 3D structure of Hemoglobin and Myoglobin. They will also understand the concept of protein folding (denaturation and renaturation).	They will be taught using power point presentations, chalk and board. The use of E-learning through online Web and Video courses will be included.	Internal assessment will be done on the basis of quiz and class tests.

III	Knowledge about the basic properties and characteristics of enzymes and their action; insights into the factors affecting enzyme activity. Students will learn about the kinetics of enzyme catalyzed reactions and bisubstrate reactions	Historical perspectives; Powerpoint presentations; Teaching using chalk and board method	Oral questions will be asked in the class. Assignments to classify enzymes, determine specific activity and reaction rates
IV	Students will learn how enzymes are regulated and the importance of enzyme regulation in the cellular context. Detailed knowledge of the various applications of enzymes in medicine and research	Teaching using chalk and board method along with powerpoint presentations and video tutorials	Problems will be assigned to test student's analytical ability; Students will discuss methods of regulation in groups

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Proteins, Enzymes, Protein structure, Protein folding, Enzyme kinetics, Enzyme regulation

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	04	02	-	02	Class XII with Science	-

Learning Objectives

The course aims to provide the basic knowledge of food and its importance in nutrition. The students will understand the importance of a balanced diet and the association of life style disorders with unhealthy food eating habits. They will be able to understand the concept of under and over nutrition and the deficiency diseases that result due to deficiency of micronutrients in diet.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the importance of food in our life
- Explain how food is spoiled and learn about some common food borne diseases/ food allergies
- Elaborate the functions of macro and micronutrients in our body
- Apply the knowledge gained to rationalize the diseases associated with malnutrition/ overnutrition and deficiency diseases

B.Sc. (HONORS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-5 : NUTRITION AND FOOD SCIENCE
SEMESTER – III

2.2 Course Contents

Theory

Credits: 2

Total weeks: 15

Unit 1 –Basics of Food Science and Nutrition

(2.5 weeks)

Definition of Food, Nutrition, Nutrient, Nutritional status

Energy value of foods, determination, physiological fuel values, SDA of foods, BMR & RMR, factors influencing BMR. Recommended allowance-RDA for Indians, basis for requirement, energy allowance for different growth pattern of children, energy allowance for various activities and different age groups. Balanced diet, fad diets

Unit 2– Macronutrients

(5 weeks)

Introduction to macronutrients and their function, digestion, absorption and assimilation of carbohydrates, lipids and proteins, Glycemic response and glycemic index of foods, dietary fiber- types, properties, sources and its role, importance of essential fatty acids, their requirements and deficiency, role & nutritional significance of PUFA, MUFA, SFA, omega-3/omega 6 fatty acid, essential amino acids, dietary protein quality- PER, NPU, BV, chemical score and PDCAAS. Factors affecting protein bio-availability including anti-nutritional factors, protein toxicity, amino acid complementation and Supplementation in foods

Unit 3 – Micronutrients

(5 weeks)

Fat soluble vitamins: Sources, physiological importance and deficiency diseases. Water soluble vitamins: Sources, physiological importance and deficiency diseases. Minerals: Sources, physiological importance and diseases due to excess or deficiency of Ca, P, Na, K, Fe, Zn, S, Mg, Se, Cu.

Unit 4 – Food and Health

(2.5 weeks)

Food as medicine: medicinal value of functional foods such as garlic, ginger, turmeric, tulsi, fenugreek, ajwain, aloe vera, moringa, role of Gut microbiome in maintaining health, pre and probiotics, various types of food additives: emulsifiers, preservatives and food colors, benefits and risks associated with these, food allergies, food spoilage, food poisoning, food borne diseases, Cholera, Hepatitis, Typhoid, Botulism

2.3 Practicals

Credits: 2

Total weeks : 15

1. Analysis of food labels for the presence of nutrients and other additives.
2. Estimation of carbohydrate content in food
3. Degree of unsaturation of any three different oils using Bromine test
4. Acid value / peroxide value of oil
5. Estimation of vitamin E / vitamin C in food
6. Morphological identification of important yeast and mold in foods (slides and culture)-
7. Assessment of diet chart for the presence/absence of nutrients
8. Case studies: PEM (Marasmus and Kwashiorkor), Diabetes, Obesity, Vitamin and mineral deficiency

2.4 Essential readings:

1. Mahan, L.K., Strings, S. E., Raymond, J. (2012) *Krause's Food and Nutrition Care process*. Elsevier's Publications. ISBN: 978-1-4377-2233-8.
2. Rosalind Gibson (2005). *Principles of Nutritional Assessment*. Oxford University Press. ISBN: 978019517169
3. Nelson, D.L., Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
4. Vasudevan, D.M., & Das, K.S. (2020). *Practical textbook of biochemistry for medical students* (3rd ed.). Jaypee Brothers Medical

Suggested readings:

1. Practical Biochemistry, Damodaran Geetha K, Jaypee Brothers Medical Publishers Private Limited; 1st edition (1 January 2011), ISBN: 9789350251416, 9789350251416
2. Plummer, D.T. (1998) *An Introduction to Practical Biochemistry* (3rd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.
3. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.
4. Coombs Jr. G.F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health*. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations*. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be taught the importance of food and balanced diet and the energy values associated with food	Teaching will be conducted both through black board mode and power point presentation mode. The students will be asked to make a note of their diet and the calories associated with the food intake	Students will be asked questions related to the topic and class discussion will be held
2	Students will learn about the macronutrients in diet and how they are digested and assimilated, the importance of micronutrients in health will be discussed	Teaching will be conducted both through black board mode and power point presentation mode. The students will perform some practical to determine macronutrients in food	Assignment will be given
3	Students will learn about the role of Ca, P, Fe, Zn etc in the diet	Teaching will be conducted both through black board mode and power point presentation mode. The students will perform some practical to determine micronutrients in food	Quiz and classroom discussions will be held, they will be asked to present a paper
4	They will learn about the importance of food as medicine and about food spoilage, food allergies, food poisoning, pro/prebiotics	Teaching will be conducted both through black board mode and power point presentation mode.	Mid semester test will be held and assignments will be given

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords:

Food, Nutrition, macronutrients, micronutrients, food as medicine, food spoilage, food allergies

GENERIC ELECTIVES (GE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Physiology of Sports and Exercise	04	02	-	02	Class XII with Science	-

Learning Objectives

To learn the changes in human body systems due to exercise and sporting activities in an integrated manner. To gain knowledge about sports training. Understanding the basic system physiology in sports. To understand the physiological adaptation and metabolic changes during exercise at varying intensities. To gain skill in measurement of various physiological responses.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the effect of exercise in detail and in application perspective.
- Measure the changes and interpret them in the context of sports.
- Describe the system concepts behind sports performance.
- Explain human body functioning during exercise and thus provide appropriate nutrition/fuel.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-6 : PHYSIOLOGY OF SPORTS AND EXERCISE
SEMESTER - III

2.2 Course Contents

Theory

Credits: 2

Total weeks : 15

Unit I: Introduction to Exercise Physiology

(Total weeks : 2)

Structure, types and Function of Skeletal Muscle. Fuel for Exercise: Aerobic and anaerobic muscle metabolism, Muscle Fatigue.

Unit II: Cardiovascular and Pulmonary control in Sports Performance

(Total weeks : 5)

Heart rate and Blood Pressure. Electrophysiology of Heart, Introduction and interpretation of EKG/ECG, Pacemakers and its Rhythms. Mechanics of ventilation during exercise. Cardiorespiratory Responses to physical activities. Training of cardiorespiratory responses in different types of physical activities for maximising output.

Unit III: Hormonal Effects on Physical Activities

(Total weeks : 4)

Role of epinephrine, cortisol, sex hormones, growth hormones and growth factors on physical endurance. Effect of aging on Sport performance.

Unit IV: Drugs and Doping in Sports

(Total weeks : 4)

History and evolution of Doping and Anti-doping in Sports, Prevalence of Doping in Sports, Doping Control in Sports, Role of Athlete Support Personnel in Preventing Deliberate and Inadvertent Use of Prohibited Substances, WADA Rules and Regulations.

2.3 Practical:

Credits: 2

Total weeks : 15

1. BMI Estimation with and without software - Techniques of taking various anthropometric measurements; Skinfold measurement and Body Fat Percentage calculations.
2. Aerobic Power Field Assessments; Cooper 1.5-Mile Run/Walk Test and 12-Minute Run/Walk Test/Rockport Fitness Walking Test.
3. Tests for anaerobic power; Wingate Test/Anaerobic Cycling Power
4. High-Intensity Fitness Testing/ AAHPER health related physical fitness test Léger 20 m Shuttle Run Test/ Margaria - Kalamen Stair Climb Test,
5. Pulmonary Function Testing: Ratio of Forced expiratory volume (FEV1/FEV6) by spirometry, Lung Volumes and Capacities
6. Determination of age by Radiography (Dry lab)

7. Blood Pressure Measurements: Effects of Body Position, Dynamic Exercise and Isometric Contractions on BP.
8. Determination of Physiological adaptation with training through Submaximal Exercise Testing; Submaximal Bench Step Test/Submaximal Cycle Ergometer Test

2.4 Essential readings:

1. Physiology of Sport and Exercise 6th Edition with Web Study Guide-Loose-Leaf Edition by W. Larry Kenney, Jack Wilmore, David Costill.
2. Endocrinology of Physical Activity and Sport, Second Edition Constantini, Naama, Hackney, Anthony C, 2013.
3. David R. Mottram, Neil Chester (2018) Drugs in Sports, Routledge, ISBN:1351838989. Portefield, Jason (2008) Doping: athletes and drugs, Rosenn Publishing, New York, ISBN:1-4042-1917-5.
4. Laboratory Manual for Exercise Physiology 2nd Edition. With Web Study Guide, Human Kinetics by G. Gregory Haff, Charles Dumke, 2018.
5. Physiological Tests for Elite Athletes 2nd Edition by Australian Institute of Sport Rebecca Tanner, Christopher Gore, 2012.

Suggested readings:

1. A Textbook of Sports & Exercise Physiology by Dey Swapan Kumar, Jaypee Publishers
2. Exercise Physiology: Theory and Application to Fitness and Performance 10th Edition by Scott Powers and Edward Howley 2018.
3. Exercise Physiology: Nutrition, Energy, and Human Performance 8th Edition by William D. McArdle, Frank I. Katch, Victor L. Katch
4. Practical ECG for Exercise Science and Sports Medicine by Greg Whyte, Sanjay Sharma, Human Kinetics, 2010
5. ACSM's Guidelines for Exercise Testing and Prescription, 10th Edition by American College of Sports Medicine. Wolters Kluwer, 2017.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be introduced to changes in human body systems due to exercise and sporting activities in an integrated manner. They will gain knowledge about muscle metabolism and muscle fatigue.	Teaching will be conducted both through black board mode and power point presentation mode.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.

II	Knowledge about the Cardiorespiratory Responses to physical activities	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. Practical performance to study various cardiorespiratory responses Blood Pressure Measurements w.r.t Effects of Body Position and ways to maximize exercise output.	Students will be asked to analyze case studies. Open book tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Role of various hormones and growth factors on physical endurance. Gain knowledge about the effect of aging on Sport performance.	Teaching will be conducted both through black board mode and power point presentation mode. Practical assessment of sport performance will be done.	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations on any topic of interest relating to physical endurance. Internal assessment tests will be conducted. Discussions using case studies will be conducted.
IV	Understand the role of doping and anti-doping in Sports. The students will gain insight into deliberate and inadvertent use of prohibited substances.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted. students will be asked to present Case studies of doping in sports.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Muscle metabolism, Muscle Fatigue, Cardiorespiratory Responses, Sport performance, Prohibited Substances

Category II

**Political Science Courses for Undergraduate Programme of study with
Political Science as one of the Core Disciplines
(B.A. Programmes with Political Science as Major discipline)**

N.A.

Category III

**Political Science Courses for Undergraduate Programme of study with
Political Science as one of the Core Disciplines
(B.A. Programmes with Political Science as non-Major or Minor discipline)**

N.A.

DISCIPLINE SPECIFIC ELECTIVE (DSE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemical Applications in Forensic Sciences	04	02	-	02	Class XII with Science	-

Learning Objectives

The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidence, which will help students develop analytical and problem-solving skills for real life situations. With a background of the DSC of Biochemistry, the students get an insight into a major area of application of Modern Biology. The course will keep abreast with all recent developments and emerging trends in forensic science like DNA fingerprinting, brain mapping and facial reconstruction; thus, helping interested students take up forensic science as a future course of study.

Learning outcomes

On successful completion of the course students will be able to:

- Describe the fundamental concepts and principles of forensic science and their significance.
- Explain how a forensic investigation is initiated through preservation of evidences, as well as chemical, physical and biological methods of their analysis
- Identify an individual by document evaluation, fingerprints, footprints and DNA analysis and identify the accurate age, sex and identity of an individual and identify time and cause of death in a forensic investigation.
- Explain the importance of precision, reproducibility and accuracy in identification of a biological sample.
- Elaborate the methods used to analyze samples for drug testing, ink and stain testing and document and handwriting verification.
- Describe the physiology and biochemistry behind tests like Narco Analysis, polygraphy, lie detection and facial reconstruction.
- Apply the knowledge gained from hands-on-experience in some of the basic biochemical processes involved in forensic investigation.

2.2 Course Contents

Theory

Credit: 2

Total weeks: 15

Unit I: Introduction to forensic science and application of biological sciences to forensic investigation (5 weeks)

History and Development of Forensic Science, Biochemical analysis of various biological evidences: blood, semen, viscera, bite marks, and hair. Establishment of identity of individuals: fingerprints, footprints, blood and DNA. Anthropology – skeletal remains, Odontology. Time of death - rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death. case studies

Unit II: Application of chemical sciences to forensic investigation (3 weeks)

Detection of drugs of abuse and narcotics in biological samples, Toxicological examination of viscera, detection of petroleum products and food adulteration. Analysis of inks and their use in questioned document identification. Blood spatter analysis, Case studies

Unit III: DNA Fingerprinting (3 weeks)

Introduction to DNA-and source of DNA in Forensic case work, Techniques of DNA fingerprinting-RFLP, STR, PCR, DNA fingerprinting in paternity disputes, mass disaster and other forensic case work, studying kinship by DNA profiling: Related individuals have similar DNA profiles, DNA profiling and the remains of the Romanovs. Sex identification by DNA analysis: PCRs directed at Y chromosome-specific sequences, Amelogenin gene typing. Case studies

Unit IV: Recent advances in forensics (4 weeks)

Narco analysis: theory, forensic significance, future prospect, *Brain mapping*: introduction, EEG, P-3000 wave, forensic applications, limitation of technique, *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test. *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification, Case studies.

2.3 Practicals

Credit: 2

Total weeks : 15

1. Definition, Identification and Mapping of Crime scene
2. Collection, Preservation, Packaging, and Labeling of biological evidence for their forensic investigation.
3. Preliminary and Confirmatory test for blood/semen/saliva
4. Examination of Micro Evidences: fiber, hair, pollen and soil
5. Fingerprint development from various surfaces and their microscopic and chemical examination

6. Handwriting identification based on class characteristic and individual characteristics
7. Identification of dyes, drugs and ink by TLC
8. Blood spatter analysis
9. DNA Fingerprinting: Sex determination through Y specific STRs and Maternal lineage identification through mitochondrial DNA comparisons.
10. Field trip to a forensic laboratory

2.4 Essential readings:

- James, S.H., Nordby, J.J. & Bell, S. (2014). *Forensic Science: An Introduction to Scientific and Investigative Techniques, Fourth Edition*: Taylor & Francis. ISBN 9781439853832
- Jones, P., & Williams, R.E. (2009). *Crime Scene Processing and Laboratory Workbook First Edition*: CRC Press. ISBN 9780429249976
- Saferstein, R. (2018). *Criminalistics: An Introduction to Forensic Science, Twelveth edition*: Pearson Education. ISBN 10:0134477596, ISBN 13: 9780134477596
- Veeraraghavan, V. (2009). *Handbook of Forensic Psychology, First Edition*: Selective & Scientific Books, ISBN 13: 9788189128166.

Suggested readings:

- Lee, H., Palmbach, T. & Miller, M. (2001). *Henry Lee's crime scene handbook, First Edition*: Academic Press ISBN 9780080507989
- Parikh, C.K. (2016). *Parikh's textbook of medical jurisprudence, forensic medicine and toxicology: for classrooms and courtrooms, Seventh Edition*: CBS Publishers and Distributors. ISBN 9788123926469

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I.	Comprehend the developments in the field of forensic sciences; learn to observe a crime scene for identification of relevant evidences and samples for forensic analysis. Understand the importance of collection, packaging and preservation of samples to ensure reliability of data generated. Understand the importance of precision, reproducibility and accuracy in identification of a biological sample. Learn the methods to	Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Use models of crime scenes for practical training on sample identification and collection. Practical training on microscopic identification of various biological samples, finger print development from	Internal assessment tests. Students will be given questions that are application based and require analytical skills

	identify the accurate age, sex and identity of an individual and identify time and cause of death in a forensic investigation.	surfaces and identification of fingerprints	
II.	Gain knowledge about the methods used to analyse samples for drug testing, ink and stain testing and document and handwriting verification. Concept of blood splatter analysis	Class teaching with black board and power point presentation modes. Discussions on case studies and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding. Practical analysis of urine samples for drug tests. Practical analysis of inks and stains.	Conduct of Internal assessment tests. PowerPoint presentation on the assigned topics.
III.	Learn the importance of DNA fingerprinting in forensic investigations	Power point presentation will be used to teach various methods. Use of blackboard and general discussions in the class. Practical exercises on DNA fingerprinting.	Internal assessment tests will be conducted. Analyzing case studies. Open book tests to promote self-learning.
IV	Understand the physiology and biochemistry behind tests like Narcoanalysis, polygraphy, lie detection and facial reconstruction.	Teaching using chalk and board and video tutorials. Expert lecture on course related topics and field trip to labs.	Internal assessment tests will be conducted. A PowerPoint presentation on any interesting case study and the use of forensic technology in investigation. Practical record book assessment, oral discussion and question-answer sessions on practical topics.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Forensic biology; blood spatter analysis; toxicology; narco-analysis; DNA fingerprinting; polygraph; odontology; forensic entomology.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Membrane Biology	04	02	-	02	Class XII with Science	-

Learning Objectives

The objective of the course is to provide students with the basic understanding of membrane composition, structure-function relationship and properties of membranes. The course will also provide an understanding of the various types of membrane transporters and their molecular mechanisms. This course also provides understanding of molecular mechanisms involved in vesicular transport processes and membrane fusion.

Learning outcomes

On successful completion of the course students will be able to:

- Explain the general composition and structure of biomembranes.
- Describe the basic properties of membranes such as membrane fluidity.
- Elaborate various types of membrane transport mechanisms.
- Apply the knowledge gained about the molecular mechanism of vesicular transport and membrane fusion to understand the functioning of cells.

SYLLABUS OF DSC-9

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE) BCH-DSC-303: MEMBRANE BIOLOGY Semester – III

2.2 Course Contents

Theory

Credits: 2

Total weeks : 15

Unit I: Membrane composition and structure

(5 weeks)

Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols; Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates.

Historical background and various membrane models. Overview of membrane functions.

Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase.

Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter.

Unit II: Membrane dynamics

(2.5 weeks)

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions, microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

Unit III: Membrane transport

(4.5 weeks)

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport glucose transporter and anion transporter. Primary active transporters- P-type ATPases, V-type ATPases, F-type ATPases. Secondary active transporters - lactose permease, Na⁺ - glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na⁺ and K⁺ channel) and ligand-gated ion channels (acetylcholine receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

Unit IV: Vesicular transport and membrane fusion

(3 weeks)

Vesicular transport. Vesicles, Clathrin-Coated Vesicles and COP-Coated Vesicles (COPI and COPII). Molecular Mechanism of Vesicular Transport. Membrane Fusion (dynamin protein, Rab proteins, NSF/ SNAP complex, SNARE proteins). Receptor Mediated Endocytosis: LDL, Transferrin

2.3 Practical:

Credit: 2

Total weeks : 15

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Isolation of membrane phospholipids and separation by TLC.
3. Effect of temperature, pH, detergents, and ionic strength on Tonoplast membrane of beetroot.
4. Determination of CMC of detergents, neutral and ionic
5. Preparation of RBC ghost cell.
6. Separation of RBC membrane proteins by SDS-PAGE.
7. Demonstration of Histidine uptake from the intestinal membrane.

2.4 Essential readings:

1. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). New York, WH: Freeman & Company. ISBN-13: 978-1319208523, ISBN-10:1319208525.
3. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
4. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
5. Wardhan, R., Mudgal, P. (2017). Text Book on Membrane Biology (1st ed.). Singapore, Springer. ISBN-10: 9811071004, ISBN-13: 978-9811071003

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about general composition and structure of biomembranes. They would study various membrane model systems and their application. Learn about lipid shapes and Polymorphic Lipid-Water Systems.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

II	Students would learn about membrane dynamics and various techniques used to study membrane dynamics.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would have knowledge about the various types of membrane transport mechanisms.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
IV	Learn about molecular mechanisms of vesicular transport and membrane fusion.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts and techniques by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords:

Membrane structure composition, membrane fluidity, membrane transport, vesicles, membrane fusion

DISCIPLINE SPECIFIC CORE COURSE – (DSC-12)
Gene Organization, Replication and Repair

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Gene Organization, Replication and Repair (BCH-DSC-403)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides an understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

Learning outcomes

After completion of this course, learners will be able to:

1. Analyse the structure of DNA and various forms of DNA and learn about organisation of genome in various life forms, supercoiling of DNA and its significance
2. Perform isolation of DNA and analyse the purity of isolated DNA sample
3. Evaluate the molecular basis of processes like DNA replication, recombination and transposition and demonstrate the significance of these processes
4. Perform various methods of DNA estimation
5. Discuss the various ways in which the DNA can be damaged leading to mutations, lesions and repair mechanisms

SYLLABUS OF DSC-12

BCH-DSC-12 : GENE ORGANIZATION, REPLICATION AND REPAIR
Semester – IV

2.2 Course Contents

Theory (2 Credits)

Unit I: Structure of DNA and genomic organization

Total Hours: 30
(8 Hours)

Watson and Crick model of DNA, various forms of DNA, Supercoiling of DNA, linking number, Topoisomerases, Topoisomerase inhibitors and their clinical importance, Definition

of a gene, organization of genes in viruses, bacteria and eukaryotes, concept of split genes, introns, exons, satellite DNA, highly repetitive DNA.

Unit II: Replication of DNA

(10 Hours)

The chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, *E coli* DNA polymerases, stages of replication: initiation, elongation, origin of replication, relationship between replication and cell division, replication in eukaryotes, end replication problem, telomerases. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine.

Unit III: Recombination and transposition of DNA

(6 Hours)

Homologous recombination, enzymes in homologous recombination, site-specific recombination, recombinases. Transposition, DNA transposition by cut and paste and replicative mechanism.

Unit IV: Mutations and DNA Repair

(6 Hours)

Importance of mutations in evolution of species, Types of mutations, DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test. Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, translesion DNA synthesis. DNA repair diseases.

2.3 Practical (2 Credits)

Total Hours: 60

1. DNA estimation by DPA
2. Separation of nitrogenous bases by paper chromatography
3. To plot the ultraviolet absorption spectrum of DNA
4. Isolation of chromosomal DNA from *E coli* cells
5. Determination of DNA concentration and purity by UV absorption.
6. Determination of the melting temperature of DNA
7. Demonstration of the mechanism of Transposition and Recombination (Dry Lab)
8. Ames test
9. Exercise with *in silico* tools (NCBI, GenBank, EMBL, DDBJ, NBD, BLAST and Clustal omega)

2.4 Essential readings:

- Lehninger: Principles of Biochemistry (7th ed.) (2017) Nelson, D.L. and Cox, M.M W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
- Molecular biology of the gene: (7th ed), (2014) Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. International). Pearson.

Suggested readings:

- Genetics - A Conceptual Approach,) (6th ed). (2012), Pierce, B.A. W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-

- Lewin's Gene X (10th edition) (2018). Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.
- The Cell: A Molecular Approach (7th ed.) (2009). Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland (Washington DC), Sinauer Associates, MA. ISBN:978-0- 87893-3030.
- *Biochemistry* (6th ed.) (2016). Garrett, R. H., & Grisham, C. M. Brooks Cole. ISBN: 9781305882409

3. Keywords

DNA, Double helix, Supercoiling, Recombination, Transposition, DNA Repair

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)

CORE PAPER

Concepts in Genetics (BCH C-11)

Semester – V

1. Course Objectives

The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of transmission genetics, molecular and developmental genetics, mapping techniques, chromosomal aberrations and population genetics. Students will gain a hands-on training experience of culturing and conducting experiments on the genetic model system *Drosophila melanogaster*. The course also works as preparation for further studies in a Master's programme in molecular biology or related topics.

2.1 Course Learning Outcomes

On successful completion of the course, the students will be:

- Understanding the principles of Mendelian genetics, extensions and applications
- Learning and appreciating the various factors that confer genotypic and phenotypic variability.
- Using the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.
- Able to use statistical tools to analyze biological data.
- Able to apply the principles of transmission and inheritance in real life situations.

2.2 Course Contents

THEORY

CREDITS: 4

TOTAL HOURS: 60

UNIT I: Principles of heredity and transmission genetics:

No of hours: 16

Mendelian genetics and chromosomal basis of heredity: Mendelian laws and ratios; Concept of segregation and independent assortment, and its chromosomal basis. Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism - Sutton and Boveri hypothesis with other supporting experimental evidences; *Extensions to Mendelian genetics:* Complementation test using examples from *Drosophila* eye colour mutants to differentiate allelic variants from gene interaction. Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropic gene interaction - epistatic and non-epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy; *Human pedigree analysis:* Pedigree conventions, characteristics of dominant and recessive inheritance; sex linked, sex influenced and sex limited traits. Applications of pedigree analysis.

UNIT II: Genetics of bacteria and viruses**No. of hours: 7**

Concept of cistron. Bacterial and viral genomes, Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

UNIT III: Linkage, crossing over and mapping techniques:**No. of hours: 10**

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans, LOD score, somatic cell hybridization for positioning genes on chromosomes and physical maps using molecular markers.

UNIT IV: Molecular genetics**No. of hours: 12**

Sex determination and genetic control of development: Genetic basis of sex determination in Humans, *Drosophila melanogaster* and *C. elegans*. *Drosophila* development-maternal effect genes, morphogens and zygotic genes; Genetic basis of flower development in *Arabidopsis*-ABC model; *Non-nuclear inheritance and Epigenetics:* Extra nuclear inheritance, tests for organelle heredity and maternal effect; Mechanism of dosage compensation; X chromosomal inactivation in humans and *Drosophila melanogaster*. Epigenetic mechanisms of transcriptional regulation. Monoallelic expressions and Genomic imprinting.

UNIT V: Chromosomal aberrations**No. of hours: 7**

Variations in chromosome number: aneuploidy and polyploidy. Variations in chromosome structure- inversions, deletions, duplications and translocations.

UNIT VI: Quantitative, Population and Evolutionary Genetics**No. of hours: 8**

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hybrid vigor. Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle. Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

PRACTICALS**CREDITS : 2****TOTAL HOURS : 60**

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.
5. PTC testing in a population and calculation of allelic and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab)

2.3 References

1. Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J. (2017) *An Introduction to Genetic Analysis*, (11th ed.), W.H. Freeman & Company (New York), ISBN: 1464109486
2. Pierce, B.A. (2012) *Genetics - A Conceptual Approach*, (6th ed.), W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
3. Snustad, D.P. and Simmons, M.J. (2012) *Genetics* (6th ed.), John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I.	Understanding Mendel's laws and ratios; Understand relationship between genetic inheritance, generation of variation and cell division; Relating genes to chromosomes- chromosomal basis of heredity; Use of statistical tools in testing genetic hypothesis; Complementation test relating extensions to Mendelian ratios due to allelic variations; Understand gene interactions- both epistatic and non-epistatic; Concept of Penetrance, expressivity, phenocopy and pleiotropy; Understanding how to draw a human pedigree chart and analyze it for determining inheritance patterns	Students will be practically shown examples from crosses of different <i>Drosophila</i> eye colour mutant strains for explaining complementation test. Formulation and testing of genetic hypothesis will be explained using experiments with <i>Drosophila</i> crosses as well as exemplary numerical problems. Students will be encouraged to apply pedigree analysis in real life situations by helping them make their own family pedigrees for certain overt heritable physical features and genetic condition or disease, if any.	Students will be given questions that are application based and require use of statistical tools like probability and chi-square analysis and hypothesis testing for goodness of fit.
II.	Understand the concept of cistron, operon and gene; Basics of bacterial and viral genomes; Mechanisms of genetic exchange in prokaryotes like conjugation, transformation and transduction; Gene mapping in bacteria.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding	Powerpoint presentation on the assigned topics. Students will be given questions that are application based and require analytical skills
III.	Understand the of concept of recombination and linked genes; Use recombination	Teaching will be conducted both through black board	Internal assessment tests will be conducted

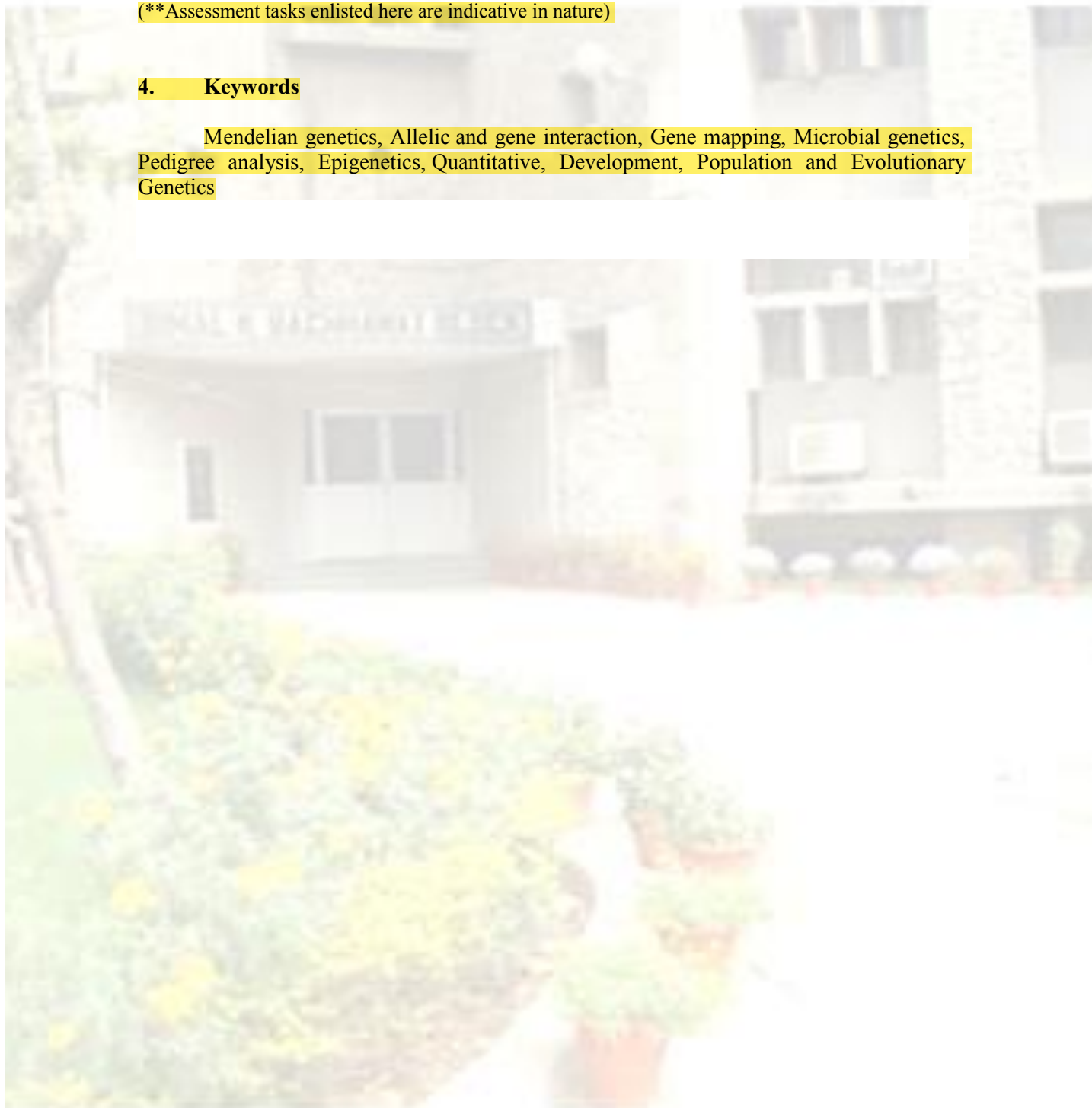
	frequencies to determine gene order and distance; Genetic mapping in eukaryotes using test crosses; Gene to centromere mapping with ordered tetrads and cytogenetic mapping; Detection of linked loci by pedigree analysis in humans and the concept of LOD score; Somatic cell hybridization for locating gene on a chromosome; Physical mapping using molecular markers.	mode and power point presentation mode. Numerical problems for genetic mapping using three point cross would be given for practice in class.	Questions on drawing a genetic map with gene order, map distance. and centromere mapping
IV	Understand the difference in the genetic basis of sex determination in Humans, <i>Drosophila</i> and <i>C.elegans</i>; Understand the role of maternal effect genes on axis formation during development using <i>Drosophila</i> as a model of study Role of zygotic and homeotic genes in development using <i>Drosophila</i> as a model of study; Genetic control of flower development in <i>Arabidopsis</i>; Nonnuclear inheritance and its role in determination of phenotypes; Epigenetic phenomenon like dosage compensation and Genomic Imprinting.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions and quizzes will be conducted to keep the students up-to-date with the information they have received and to gauge their conceptual understanding	A PowerPoint presentation on any topic of interest relating to the concept of Epigenetics, non-nuclear inheritance and sex determination.
V.	Students will learn about various structural and numeric chromosomal aberrations possible in both plants and animals; Understand the disadvantages as well as some advantages of such aberrations.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions using case studies will be conducted to help students understand the karyotype analysis.	Internal assessment tests will be conducted Analysis of case studies in groups.
VI.	Understand the concept of polygenic inheritance, additive gene effect, OTL, heterosis and hybrid vigor; Understand concept of gene pool, allelic and genotypic frequencies; Understand Hardy Weinberg principle and its limitations; Understand concept genetic	Teaching will be conducted both through black board mode and power point presentation mode. Discussions using population genetics based case studies will be conducted. Practical collection of data from	Numerical analysis and case study analysis.

	drift, founder effect, genetic bottleneck; Factors that influence gene flow, fitness of a population and speciation.	population to test Hardy-Weinberg principle.	
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(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Mendelian genetics, Allelic and gene interaction, Gene mapping, Microbial genetics, Pedigree analysis, Epigenetics, Quantitative, Development, Population and Evolutionary Genetics



COURSES OFFERED BY DEPARTMENT OF BOTANY

Category-I

Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE - 7: Phycology - The World of Algae

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Phycology - The World of Algae DSC-7	4	2	0	2	Class XII pass	Nil

Learning Objective:

To provide students with in-depth knowledge of the unique group of algae that are the primary photosynthetic organisms.

Learning Outcomes:

By studying this course students will gain basic knowledge on algae, with reference to:

- the diversity and general characteristics.
- distinguishing features of taxa belonging to different families.
- the various ecological and economic benefits.

Unit 1: Introduction to Algal World**6 hours**

Relevance of studying algae – Industrial (food, feed, fodder), Environmental (climate change, biofuel, acidification of oceans), Evolutionary (range of thallus organization); General characteristics; Ecology, diversity and distribution; Range of thallus organization; Cell structure; Criteria for classification (cell wall, pigment system, reserve food, flagella); Reproduction and life cycle patterns; Classification by Fritsch; Evolutionary classification of Lee (only up to groups); Significant contributions of eminent Phycologists.

Unit 2: Cyanophyceae (Blue-Green Algae)**3 hours**

General characteristics; Occurrence; Cell structure; Heterocyst (structure and function); Morphology, reproduction and life-cycle of *Nostoc*, economic importance.

Unit 3: Chlorophyceae (Green Algae)**6 hours**

General characteristics; Occurrence; Cell structure; Morphology, reproduction and life-cycle of *Chlamydomonas*, *Volvox*, *Chlorella*, *Ulva*, *Oedogonium*, *Coleochaete*; *Chara*; Structure and evolutionary significance of *Prochloron*, economic importance.

Unit 4: Xanthophyceae (Yellow-Green Algae)

2 hours

General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Vaucheria*, economic importance.

Unit 5: Bacillariophyceae (Diatoms) and Dinophyceae (Dinoflagellates)

3 hours

General characteristics, Occurrence, morphology, unique features, economic importance.

Unit 6: Phaeophyceae (Brown Algae)

4 hours

General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Ectocarpus* and *Sargassum*, economic importance.

Unit 7: Rhodophyceae (Red Algae)

4 hours

General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Gracilaria*, economic importance.

Unit 8: Recent advances in algal studies

2 hours

Model systems and their applications in genetic, molecular and evolutionary studies.

Practicals

60 hours

1. Study of algal diversity in different habitats through botanical excursion and submission of digital catalogue/report of various species observed.
2. *Nostoc*: Study of vegetative, reproductive structures from temporary mounts and permanent slides; Ultrastructure of Heterocyst through Electron Micrographs.
3. *Chlorella*: Study of vegetative, reproductive structures from temporary mounts. Study of ultrastructure through Electron Micrographs.
4. *Volvox*: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
5. *Oedogonium*: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
6. *Coleochaete*: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
7. *Chara*: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.
8. *Vaucheria*: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
9. **Diatoms and Dinoflagellates**: Study vegetative, reproductive structures of at least two taxa from water bodies.
10. *Ectocarpus*: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
11. *Sargassum*: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.

12. ***Polysiphonia/ Gracilaria***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.

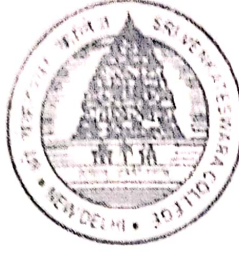
Suggested Readings:

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
3. Lee, R.E. (2018). Phycology, 4th edition: Cambridge University Press, Cambridge.
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer, Dordrecht.
5. Sahoo, D. (2000). Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

Additional Resources:

1. Van den Hoek, C., Mann, D.G., Jahans H.M. (1995). Algae: An Introduction to Phycology. Cambridge University Press.
2. Sharma, O.P. (2011). Algae. Tata Mc Graw Hill Education Private Limited, New Delhi.
3. Smith, G.M. (1955). Cryptogamic Botany. Vol.1. Algae and Fungi. McGraw-Hill Book Company, New York.
4. Vashishta, B.R., Singh, V.P. and Sinha, A.K. (2012). Botany for Degree Students: Algae. S Chand Publishing, New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.



Tirumala Tirupati Devasthanams

శ్రీ వేంకటేశ్వర కళాశాల

Sri Venkateswara College

(University of Delhi)

NAAC Grade A+

CERTIFICATE

This is to certify that the visit to Yamuna Biodiversity Park: Nature Reserve of Delhi was successfully conducted on 07.11.2023 from 2:00 pm to 5:00 pm by Dr. Madhu Raina and Dr. Sachin Kumar of Department of Botany in the offline mode and its event report has been submitted to IQAC for records.

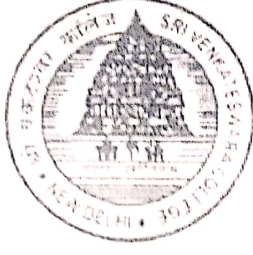
Madhu Raina
8.11.23
Event In-Charge

[Signature]
IQAC Coordinator
Coordinator, IQAC
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021

[Signature]
Principal
PRINCIPAL (Acting)
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021

[Signature]
Principal
శ్రీ వేంకటేశ్వర కళాశాల
Sri Venkateswara College
దिल्ली विश्वविद्यालय / University of Delhi
धौला कुआँ, नई दिल्ली / Dhaura Kuan, New Delhi-21





Tirumala Tirupati Devasthanams

శ్రీ వేంకటేశ్వర కళాశాల

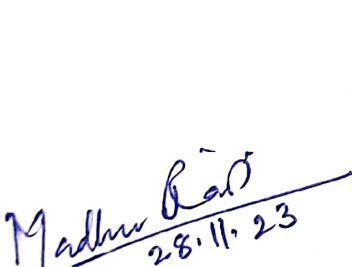
Sri Venkateswara College

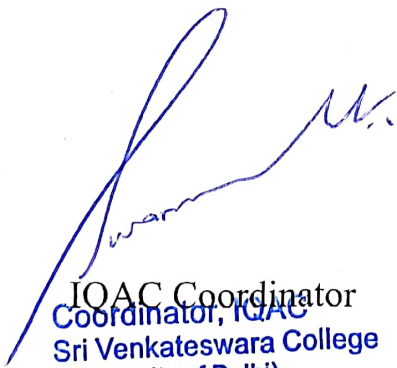
(University of Delhi)

NAAC Grade A+

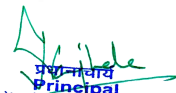
CERTIFICATE

This is to certify that **Visit to Nehru Planetarium, Teen Murti Marg, New Delhi** was successfully conducted on **26.11.2023** from **10:00 am** to **2:00 pm** by **Dr. Madhu Raina** and **Dr. M. Prajna** of **Department of Botany, SVC** in the **offline** mode and its event report has been submitted to IQAC for records.


28.11.23
Event In-Charge


IOAC Coordinator
Coordinator, IQAC
Sri Venkateswara College
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Dhaura Kuan, New Delhi-110021


Principal
PRINCIPAL (Acting)
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021


Principal
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धौला कुआँ, नई दिल्ली / Dhaura Kuan, New Delhi-21





Tirumala Tirupati Devasthanams

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Sri Venkateswara College

(University of Delhi)

NAAC Grade A+

CERTIFICATE

This is to certify that the (Field visit to Botanical Garden of Indian Republic (BGIR), Noida, UP) was successfully conducted on (13/10/2023) from 09.00 am to 04.00 pm by Dr. Muthabathula Prajna and Dr. Madhu Raina of Botany Department in the (Offline) mode and its event report has been submitted to IQAC for records.

M. Prajna

Event In-Charge

Madhu Raina

IQAC Coordinator
Coordinator, IQAC
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021

Principal

Principal

PRINCIPAL
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Dhaura Kuan, New Delhi-110021

Principal
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Dhaura Kuan, New Delhi-110021



Tirumala Tirupati Devasthanams

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Sri Venkateswara College

(University of Delhi)

NAAC Grade A+

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M. Prajna

Event In-Charge

Madhu Raina

IQAC Coordinator
Coordinator, IQAC
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021

Principal

Principal

PRINCIPAL
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021

Principal
Sri Venkateswara College
(University of Delhi)
Dhaura Kuan, New Delhi-110021



COURSE DESCRIPTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Resource Management DSC- 2.3	4	3	1	0	Pass in XII	NIL

Learning Objectives

The course aims to acquaint the learners with the techniques and principles to manage human resources of an organisation.

Learning Outcomes

After completion of the course, learners will be able to:

1. Evaluate the importance of contemporary and emerging HR issues.
2. Analyse the concept and sources of recruitment and selection process.
3. Devise employee training and development programs.
4. Design performance appraisal techniques and compensation schemes.
5. Design HR policies for grievance redressal, employee health, safety, welfare, social security, and stress-free work life balance.

SYLLABUS OF DSC-2.3

Unit 1: Introduction to Human Resource Management (4 hours)

Basic concepts and significance of HRM, Role and functions of HR manager. Emerging issues in human resource management: Workplace diversity, employee empowerment, downsizing, VRS, work life balance, and work from home.

Unit 2: Procurement of Human Resource (9 hours)

Human resource planning- Quantitative and qualitative dimensions; Job analysis – Job description and job specification; Recruitment – concept and sources; Selection – concept and process; Tests and interview; Placement, induction and socialization; Employee retention.

Unit 3: Aspects of Training and Development (12 hours)

Concept and importance; Role specific and competency-based training; Training and development methods – Apprenticeship, understudy, job rotation, vestibule training, case study, role playing, sensitivity training, In-basket, management games, conferences and

seminars, coaching and mentoring, management development programs; Training process outsourcing.

Unit 4: Performance Appraisal and Compensation Management (12 hours)

Performance appraisal- Nature, objectives, process, and methods; Performance management; Potential appraisal; Employee counselling; Employee enhancement: transfer and promotion. Compensation - concept and policies, Types of compensation: base and supplementary compensation; Individual, group and organisation incentive plans; Fringe benefits; Performance linked compensation: employee stock option; pay band compensation system and job evaluation.

Unit 5: Maintenance of employees and Emerging Horizons of HRM (8 hours)

Employee health and safety; Employee welfare; Social security (excluding legal provisions); Employer-employee relations; Grievance handling and redressal; Industrial disputes: Causes and settlement machinery; e-HRM; Human Resource Information System (HRIS) and e-HRM; Impact of HRM practices on organisational performance; HR Audit, Contemporary issues in HRM - emerging job opportunities, work life balance and work from home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.

4. Design performance appraisal techniques and compensation schemes.
5. Design HR policies for grievance redressal, employee health, safety, welfare, social security, and stress-free work life balance.

SYLLABUS OF DSC-2.3

Unit 1: Introduction to Human Resource Management (4 hours)



50 of 50

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49

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Practical Exercises

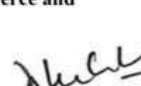
The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

Suggested Readings

- Aswathappa, K. & Dash, S. (2021). *Human Resource Management-Text and cases* (9th ed.). Tata McGraw-Hill.
- Chhabra, T. N. & Chhabra, M. (2020). *Essentials of Human Resource Management*. Delhi: Sun India Publications.
- Decenzo, D. A., & Robbins, S. P. (2009). *Fundamental of Human Resource Management*. New Jersey: Wiley.
- Dessler, G. & Varrkey, B. (2020). *Human Resource Management* (16th ed.). Pearson Paperback.
- French, W. L. (2006). *Human Resource Management*. Boston: Houghton Mifflin.
- Gupta, C. B. (2018). *Human Resource Management*. New Delhi: Sultan Chand & Sons.
- Prasad, L. M. (2018). *Human Resource Management*. New Delhi: Sultan Chand & Sons.
- Pattanayak, B. (2019). *Human Resource Management* (6th ed.). PHI learning.
- Rao, V. S. P. (2020). *Human Resource Management* (2nd ed.). New Delhi: Taxmann Pvt. Ltd.
- Sengupta, A. (2018). *Human Resource Management*. Sage Textbook.

Note: Suggested readings will be updated by the Department of Commerce and uploaded on the Department's website.


REGISTRAR
 श्री वेंकटेश्वर महाविद्यालय
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 धौला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

**SEMESTER-IV
B.Com**

Discipline Specific Core Course- 4.1(DSC-4.1): Entrepreneurship & New Venture Planning

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Entrepreneurship & New Venture Planning DSC- 4.1	4	3	1	0	Pass in Class XII	NIL

Learning Objective:

This course aims at instituting entrepreneurial skills in the students by giving an overview of entrepreneurship and the competencies that are needed to become an entrepreneur. To enable students to explore and launch entrepreneurial ventures in their own areas of interest.

Learning Outcomes:

After completion of the course, learners will be able to:

1. Describe distinct entrepreneurial traits.
2. Recognise the process and nature of entrepreneurship.
3. Identify the different ways in which entrepreneurs manifest in start-ups.
4. Comprehend the entrepreneurial process for initiating new venture creation.
5. Design strategies for the successful implementation of innovative ideas of new ventures.

SYLLABUS OF DSC-4.1

Unit 1: Introduction (9 hours)

Concept and Definitions Entrepreneurship, Entrepreneurial Mind-set, Traits/Qualities of Entrepreneurs, Entrepreneurship process; Theories of entrepreneurship; Factors affecting the emergence of entrepreneurship; Role of an entrepreneur in economic growth as an innovator; Generation of employment opportunities; complementing and supplementing economic growth; Bringing about social stability and balanced regional development of industries.

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Unit 2: Types of Entrepreneurs (9 hours)

Classification and Types of Entrepreneurs; Women Entrepreneurs; Social Entrepreneurship; Corporate Entrepreneurs, Family Business: Concept, structure, and kinds of family firms; Culture and evolution of family firm; Managing Business.

Unit 3: Business plan (9 hours)

Creating Entrepreneurial Venture: Generating Business ideas, Team building, Sources of Innovation, Creativity, and Entrepreneurship; Challenges in managing innovation; Entrepreneurial strategy and Scaling up, Business planning process; Drawing business plans; Failure of the business plan.

Unit 4: Mobilizing Resources (9 hours)

Resource Mobilization for entrepreneurship: Resources mobilization, types of resources, Process of resource mobilization, Arrangement of funds; writing a Funding Proposal, Traditional sources of financing, Venture capital, Angel investors, Business Incubators.

Unit 5: Managerial Aspects of Business and Government Initiatives (9 hours)

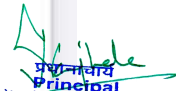
Managing finance; Understanding capital structure; organisation structure and management of human resources of a new enterprise; Marketing-mix; Management of cash; Relationship management; Cost management, Government initiatives for promoting entrepreneurship.

Exercises:

The learners are required to:

1. Discuss various cases of entrepreneurship and distinguish between different entrepreneurial traits.
2. Prepare a business plan for a start-up venture in a rural setting after analyzing the various facets of the rural economy.
3. Analyse and present the key initiatives of the government of India for promoting entrepreneurship in the country in a business area.
4. Analyse and interpret case study on business philosophy at Tata Group, Aditya Birla Group, Reliance Industries Limited, and similar organisations.
5. Participate in business plan competition-designing a business plan proposal and identifying alternative sources of raising finance for the start-ups.

Suggested Readings:


Principal
श्री वेंकटेश्वर महाविद्यालय
Sri Venkateswara College
दिल्ली विश्वविद्यालय / University of Delhi
घोला कुर्छी, नई दिल्ली / Dhola Kurchi, New Delhi-21

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) –:
Management Principles and Applications

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Management Principles and Applications BCH: DSC-1.1	4	3	1	0	Pass in XII	NIL

Learning Objectives

The course aims to familiarize the learner with extant and emerging management theories and practices for reflective and holistic thinking on management principles and practices.

1

Learning outcomes

The Learning Outcomes of this course are as follows:

1. describe the various levels of management and applicability of management principles.
2. evaluate a company's competitive landscape as per Porter's Five-force model.
3. demonstrate various types of authority, delegation and decentralization in authority
4. demonstrate various types of leadership styles and identify the motivation techniques used by leaders.
5. discuss the impact of emerging issues in management.

SYLLABUS OF DSC-1

Unit 1: Introduction (8 hours)

Meaning and importance of management; Coordination mechanisms in organisations; Management theories- classical, neo-classical and modern constructions of management; Managerial functions; Managerial roles (Mintzberg); Managerial competencies. Indian Ethos for Management: Value-Oriented Holistic Management; Learning Lessons from Bhagavat Gita and Ramayana.

Unit 2: Planning (16 hours)

Organisational objective setting; Decision-making environment (certainty, risk, uncertainty); Techniques for individual and group decision-making; Planning vis-à-vis Strategy- meaning and elements of the business firm environment- micro, meso, and macro; Industry structure, Business-level strategic planning.

Unit 3: Organising (12 hours)

Decentralization and Delegation; Factors affecting organisational design; Departmentalization; Organisational structures and Organograms: traditional and modern, comparative suitability and changes over time; formal- informal organisations' interface.

Unit 4: Directing and Controlling (16 hours)

Motivation- meaning, importance and factors affecting motivation; Leadership- meaning, importance and factors affecting leadership, leadership styles, and followership. Controlling- Principles of controlling; Measures of controlling and accountability for performance.

Unit 5: Salient Developments and Contemporary Issues in Management (8 hours)

Management challenges of the 21st Century; Factors reshaping and redesigning management purpose, performance and reward perceptions- Internationalisation, Digitalisation, Entrepreneurship & Innovation, Values & Ethics - Case studies on Indian corporates like Tata, Bhilwara Group, IOC and Godrej, Workplace diversity, Democracy and Sociocracy, Subaltern management ideas from India.

2

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Innovation and Entrepreneurship	2	0	0	2	Class XII	NIL

Learning Objectives

The primary objectives of the course will be to:

- Encourage the process of creative thinking and innovation
- Build an entrepreneurial perspective to identify and tackle problems and explore new opportunities
- Gain insight into building business models and plans
- Identify tools and strategies that entrepreneurs may use for start-up, innovation and reinvention
- Understand how to go from an idea to product and scale it up for sustainability
- Develop skills to work in teams and build connections, collaborations and social networks.

Learning Outcomes

By the end of the course students should be able to:

- Identify and comprehend the concepts of creativity, innovation and invention in various contexts.
- Enrich their theoretical and conceptual foundations in entrepreneurship.
- Gain hands-on experience that shall empower them to identify business and social opportunities and venture in the entrepreneurial landscape.
- Prepare themselves to take informed decisions in establishing start-ups and ongoing innovation in organisations.

PEDAGOGY

While suitable concepts and theory will be utilized, the emphasis of the course will be on inquiry driven hands-on activities and experiential learning in a team setting. As this is essentially a group activity based course, the two lectures scheduled for each week shall be held together. The class to be split up ideally in groups of 5 – 7 students each, who will work

together for the rest of the semester on identifying a specific problem and by semester-end present a feasible innovative prototype capable of being funded as a start-up.

SYLLABUS

Unit I: Understanding Creativity

- Understanding the concept and process of creativity; students exploring within themselves the nature of the creative process; approaches to understanding creativity (Ref. B1)
- Differentiate between invention and innovation (Ref. OR1)
- Understanding entrepreneurial mindset and skills (creativity, decision making, risktaking behaviour, networking) and entrepreneurship in different contexts (eg. Social, Cooperative, Commercial, Public, Not for Profit organisations) (Ref. B1)
- Case studies of some successful innovations/start-ups – Different group can be given a different Case Study and the groups can have a discussion on same (Ref. Suggestive Case Studies A)

(15 practical hours)

Unit II: Ideation

- Identifying a specific problem through observation, contemplation, networking and research (Ref. B2)
- Generating ideas for problem solving using mind mapping, brainstorming, focus groups, idea generation tool kit (SCAMPER) (Ref. B1)
- Learning through failures of others – case studies of some ventures that could not sustain – Different group can be given a different Case Study and the groups can have a discussion on same (Ref. Suggestive Case Studies B)

(15 practical hours)

Unit III: Understanding the business

- Building a business plan using the lean canvas model (Ref. OR2)
- Understanding customers/stakeholders and evaluating the business plan through survey/questionnaire/interview/secondary research (Ref. B1 and B2)
- Designing, prototyping and iteration (Ref. B2)
- Networking and business development (Ref. B3)
- Building and managing organisations (Ref. B3)

- Generating ideas for problem solving using mind mapping, brainstorming, focus groups, idea generation tool kit (SCAMPER) (Ref. B1)
- Learning through failures of others – case studies of some ventures that could not sustain – Different group can be given a different Case Study and the groups can have a discussion on same (Ref. Suggestive Case Studies B)

(15 practical hours)

Unit III: Understanding the business

- Building a business plan using the lean canvas model (Ref. OR2)
- Understanding customers/stakeholders and evaluating the business plan through survey/questionnaire/interview/secondary research (Ref. B1 and B2)
- Designing, prototyping and iteration (Ref. B2)
- Networking and growth strategies (Ref. B3)
- Building and managing organisations (Ref. B3)
- Role of leadership and team based culture (Ref. B3 and OR4)

(20 practical hours)

Unit IV: Venturing Forth

- Financing the innovation: pitching and communicating the idea
- Sources of finance: crowdfunding, venture capital, equity funds, angel investing, borrowing (including government initiatives, bank and public funded schemes) (Ref. OR5 and OR6)
- Various forms of IPR (patent, copyright, trademark, geographical indication, industrial design) (Ref. OR7 and OR8)
- Setting and scaling up (Ref. B3)
- Entrepreneurial resilience and ongoing creativity (Ref. B1)

(10 practical hours)

100

Suggested Readings: Books

B1. The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Jeff Dyer, Hal Gregersen, C.M. Christensen, Harvard Business Review Press, 2011

B2. Design Thinking: Business Innovation, Mauricio Vianna, Ysmar Vianna, Isabel K. Adler, Brenda Lucena, Beatriz Russo, MJV Press, 1st Electronic Edition, 2011
(also available at https://cdn2.hubspot.net/hubfs/1701231/Documents/Design_Thinking_-_The_Book/Design_Thinking_The_Book.pdf)

B3. Contemporary Strategy Analysis: Text and Cases, Robert M Grant, Wiley, 9th Edition, 2016 (Chapter 6 and Chapter 9)

Online Resources

OR1. Discovery, Innovation and Invention
<https://www.laits.utexas.edu/~anorman/long/DII.html>

OR2. How to create your lean canvas
https://leancanvas_production.s3.amazonaws.com/cms/LeanCanvas.pdf

OR3. Organisational behaviour and human relations, Module 12, Creativity in decision making
<https://courses.lumenlearning.com/wm-organizationalbehavior/>

OR4. Organisational behaviour and human relations, Module 13, Leadership
<https://courses.lumenlearning.com/wm-organizationalbehavior/>

OR5. Sources of Funding Innovation and Entrepreneurship
https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020-chapter4.pdf

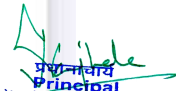
OR6. Government Schemes for Startups
<https://www.startupindia.gov.in/content/sih/en/government-schemes.html>

OR7. Intellectual Property Rights in India
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/627956/IP-Rights-in-India.pdf

OR8. What is Intellectual Property? WIPO 2020 doi:10.34667/tind.42176
<https://www.wipo.int/publications/en/details.jsp?id=4528>

Suggestive Case Studies A

1. Amul
2. Goonj
3. Aravind Eye care systems
4. Apple
5. Pixar
6. ISRO
7. Khan Academy
8. Nyka
9. Swiggy


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UNIVERSITY OF DELHI

CNC-II/093/1(25)/2023-24/69

Dated: 29.05.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 60/ (60-1-2) dated 03.02.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-III of the Department of Commerce under Faculty of Commerce & Business Studies based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

B.COM. (HONS.)

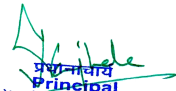
Discipline Specific Course- 3.1(DSC-3.1): Business Mathematics

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES
OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC -3.1: Business Mathematics	4	3	0	1	Pass in XII	NIL

Learning Objectives

The course aims to familiarize the learners with the basic mathematical tools with special emphasis on applications to business and economic situations.


प्रधानाचार्य
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Learning outcomes

After completion of the course, learners will be able to:

1. Assess the applicability of matrices as mathematical tools in representing a system of equations.
2. Apply differential calculus to solve simple business problems.
3. Evaluate business problems involving complex linear relationships between decision variables and their determining factors.
4. Explain mathematical formulation and solution of problems related to finance including different methods of interest calculation, future and present value of money.
5. Develop programming for business problems involving constrained optimisation.

SYLLABUS OF DSC-3.1

Unit 1: Matrices and Determinants (9 hours)

Overview of Matrices. Solution of a system of linear equations (having a unique solution and involving not more than three variables) using matrix inversion method and Cramer's Rule

Leontief Input Output Model (Open Model Only).

Unit 2: Calculus-I (6 hours)

Concepts and rules of differentiation. Concept of Marginal Analysis: Marginal Revenue, Marginal Cost. Concept of Elasticity of demand and supply.

Application of Maxima and Minima problems: Revenue, Cost, Profit, Economic Order Quantity, Optimal trade in time.

Unit 3: Calculus-II (12 hours)

Partial Differentiation: Partial derivatives up to second order. Homogeneity of a function and Euler's theorem. Production Function: Returns to factor, Returns to scale. MRTS and Elasticity of Substitution.

Application of Maxima and Minima problems involving two independent variables.

Integration: Nature of commodities and partial elasticity of demand, Applications of marginal analysis, Consumer Surplus and Producer Surplus.

Unit 4: Mathematics of Finance (9 hours)

Rates of interest: nominal, effective and their inter-relationships in different compounding situations.

Compounding a sum using different types of rates. Applications relating to Depreciation of assets and average due date.

Types of annuities: ordinary, due, and deferred - Discrete and continuous. Perpetuity. Determination of future and present values using different types of rates of interest. Applications relating to Capital Expenditure and Leasing.

Unit 5: Linear Programming (9 hours)

Formulation and Assumptions of LPP, Solution by Simplex Method- maximization and minimization cases. Shadow prices of the resources. Special Cases: Identification of unique and multiple optimal solutions, unbounded solution, infeasibility and degeneracy.

Practical Exercises:

30 hours

The learners are required to:

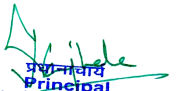
1. Assess the use of matrices in evaluating competing alternatives.
2. Apply differential calculus to solve hypothetical business problems.
3. Evaluate business problems as an application of linear programming.
4. Gather information about various deposit and loan schemes of banks to find out interest rate differentials, and compounded value.
5. Gather information about annuity schemes in the investment markets like periodic home mortgage payments, insurance payments and pension payments, life insurance products as an annuity.
6. Identify the decision-making variables and assess their functional relationship with other variables affecting the decision in a hypothetical business and economic situation.
7. Develop programming for hypothetical business problems involving constrained optimisation.

Suggested Readings:

- Anthony, M., & Biggs, N. (1996). *Mathematics for Economics and Finance*. Cambridge: Cambridge University Press.
- Ayres, F. J. (1963). *Theory and Problems of Mathematics of Finance*. New York: McGraw Hill Publishing.
- Budnick, P. (1986). *Applied Mathematics for Business, Economics, & Social Sciences*. New York: McGraw Hill Publishing.
- Dowling, E. (2011). *Introduction to Mathematical Economics*. New York: McGraw Hill Publishing Kapoor.
- Ghosh & Sinha (2018). *Business Mathematics and Statistics*. Oxford University Press.
- S.K. Sharma and Kaur, G. (2019). *Business Mathematics*. New Delhi: Sultan Chand & Sons (P) Ltd.
- Singh, J. K. (2017). *Business Mathematics*. New Delhi: Himalaya Publishing House.
- Thukral, J. K. (2009). *Mathematics For Business Studies*. New Delhi: Mayur Paperbacks.
- V. K., & Sancheti, D. C. (2014). *Business Mathematics, Theory & Applications*. Delhi: S. Chand Publishing.

Note: Suggested readings will be updated by the Department of Commerce and uploaded on Department's website.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.


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Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Discipline Specific Elective- 3.1(DSE-3.1): Organisational Behaviour

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-3.1: Organisational Behaviour	4	3	1	0	Pass in XII	NIL

Learning Objectives

The objective is to develop an in-depth understanding of the concept of organisational behaviour and its relevance in modern organisations. It also aims to expand the knowledge about the complexities of human behaviour, competitiveness, and interpersonal group dynamics.

Learning outcomes

After completion of the course, learners will be able to:

1. Discuss basic concepts of organisational behaviour and their applicability in contemporary organisations.
2. Analyse various means of managing people at the workplace.
3. Recognise the importance of communication and motivation in an organisation.
4. Critically evaluate the different leadership styles and strategies.
5. Summarise the ways to build supportive organisational culture.

SYLLABUS OF DSE-3.1

Unit 1: Introduction (6 hours)

Organisational Behaviour: Concepts and Determinants; Relationship between Management and OB; Emergence of OB; Hawthorne Study; Contributing disciplines of OB; OB models.

Unit 2: Individual Behaviour (9 hours)

Foundations of Individual Behaviour; Personality - Type A/B, Big five personality types, factors influencing personality; Attitude – concept, components, job related attitudes; Learning- concept, theories and reinforcement; Perception and emotions- concept, perceptual process, factors influencing perception, perceptual errors and distortions; Beliefs and values - concept and types: terminal values and instrumental values.

Unit 3: Communication and Motivation (12 hours)

Communication – Understanding Communication; Persuasive communication; Communication styles; Transactional Analysis (TA), Johari Window.

Motivation – Why people work; Need theories (Maslow's need hierarchy, ERG Theory, McClelland's Theory); Theory X and Theory Y, Two Factors Theory; Contemporary Theories of motivation (Self-Determination Theory, Goal-setting Theory, Reinforcement Theory, Self efficacy Theory).

Unit 4: Group Behaviour and Leadership (12 hours)

Formation of Groups; Group Behaviour - concepts, types- group norms, group roles, and group cohesiveness; Groups Vs Teams; Group decision making – process and types; Organisational conflict – nature, sources, and resolution strategies

Leadership - Concept and theories; Styles of leadership; Leadership continuum; Trait, Behavioural and Situational approach; Leadership grid; Contemporary leadership issue.

Unit 5: Dynamics of Organisational Behaviour (6 hours)

Organisational culture- concept and determinants; Organisational change- importance, types of change, resistance to change, managing change; Stress- individual and organisational factors, prevention and management of stress.

Exercises:

The learners are required to:

1. Analyse the determinants of organisational behaviour in different organisations.
2. Evaluate any personality type as a group activity.
3. Perform a role play on TA and Johari Window.
4. Conduct a primary survey to study leadership styles in different organisations.
5. Practice five different types of stress management techniques including meditation.

Suggested Readings:

- Greenberg, J. (2015). *Behaviour in organisations*, 10th edn. Pearson Education India.
- Hersey, P. K., Blanchard, D., & Johnson, D. (2013). *Management of organisational Behaviour*. Pearson.
- Luthans, F. (2017). *Organisational Behaviour-An evidence based approach*, 12th edn.. McGraw-Hill Education.

- Pareek, U. (2014). *Understanding Organisational Behaviour*. Oxford University Press.
- Robbins, S. T., Judge, T. A. (2019). *Essentials of organisational Behaviour*. Pearson.
- Singh, K. (2015). *Organisational Behaviour: Texts & Cases*, 3rd edn. India: Pearson. Additional Resources

Keywords: Organisational Theories, Personality, Values and Attitudes, Learning, Leadership, Conflict, Organisational Culture.

Note: Latest edition of readings may be used teaching Learning Process The course combines learning through analysis and discussion of case studies and active participation in experiential exercises and simulations. Assessment Methods Class tests/Assignments, Class participation, Presentations, End-semester examination

Note: Suggested readings will be updated by the Department of Commerce and uploaded on Department's website.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Discipline Specific Course- 3.3(DSC-3.3): Principles of Marketing
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES
OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC -3.3: Principles of Marketing	4	3	1	0	Pass in XII	NIL

Learning Objectives

The objective of this course is to provide basic knowledge of concepts, principles, tools and techniques of marketing and to provide knowledge about various developments in the marketing.

Learning outcomes

After completion of the course, learners will be able to:

1. Discuss basic concepts of marketing, marketing philosophies and environmental conditions affecting marketing decisions of a firm.
2. Describe the dynamics of consumer behaviour and process of market selection through STP stages.
3. Analyse the process of value creation through marketing decisions involving product development.
4. Analyse the marketing decisions involving product pricing and its distribution.
5. Explore marketing decisions involving product promotion, and draft promotion mix strategies.

SYLLABUS OF DSC-3.2

Unit-1: Introduction to Marketing and Marketing Environment (9 hours)

Introduction to Marketing: Meaning, Scope and Importance; Marketing Philosophies; Marketing Mix for goods and services.

Marketing Environment: Need for studying marketing environment; Micro environmental factors- company, suppliers, marketing intermediaries, customers, competitors, publics; Macro environmental factors – demographic, economic, natural, technological, politico-legal and socio- cultural.

Unit-2: Consumer Behaviour and Market Selection (9 hours)

Consumer Behaviour: Need for studying consumer behaviour; Stages in Consumer buying decision process; Factors influencing consumer buying decisions.

Market Selection: Market Segmentation: Concept and Bases. Market Targeting, Product Positioning – concept and bases.

Unit-3: Product Decisions and New Product Development (9 hours)

Product Decisions: Concept and classification; Levels of Product. Product mix; Branding-concept, types, significance, qualities of good brand name; Packaging and Labeling-types and functions; Product support service; New product development process; Product life cycle – concept and marketing strategies.

Unit-4: Pricing Decisions and Distribution Decisions (9 hours)

Pricing Decisions: Objectives, Factors affecting price of a product; Pricing methods and strategies.

Distribution Decisions: Channels of distribution- types and functions. Factors affecting choice of distribution channel; Distribution logistics decisions.

Unit-5: Promotion Decisions and Developments in Marketing (9 hours)

Promotion Decisions: Communication process; Importance of Promotion. Promotion mix tools: Distinctive characteristics of advertising, personal selling, sales promotion, public relations, and direct marketing.

Developments in Marketing: Sustainable Marketing, Rural marketing, Social marketing Digital marketing – an overview.

Exercises:

The learners are required to:

1. Submit a report on any one marketing aspect of an organisation/group/cell/society/unit/department operating in your College/Institute.
2. Choose any company engaged in sustainable marketing and prepare a presentation of the analysis of its marketing mix. Propose changes to enhance its marketing mix.
3. Describe and analyse the STP strategy of a multinational company of your choice.
4. With reference to the concept of levels of a product examine the marketing strategy of any company which has customized the augmented product and has gained customer satisfaction.
5. Visit two bank branches (one being a public sector and the other being an international bank branch) and meet the PRO/ manager or a suitable staff member. Outline the key elements of the marketing strategy pursued by the branch managers and compare the implementation of the same. Prepare a report about these observations with a critical analysis of the same.

6. Analyse the distribution strategy of any product of your choice.
7. Draft promotion mix strategy for a hypothetical newly floated fine dining restaurant.

*Note: These are suggestive exercises.

Suggested Readings

- Baines et al. (2021). *Fundamentals of Marketing*. Oxford University Press
- Etzel, M. J., Walker, B. J., Stanton, W. J., & Pandit, A. (2010). *Marketing*. McGraw Hill.
- Jain, P & Singhal, N. (2021). *Principles of Marketing*. Delhi: Scholar Tech Press.
- Kapoor, N. (2021). *Principles of Marketing*. Prentice Hall of India.
- Kotler, P., Armstrong, G., & Agnihotri, P. (2018). *Principles of Marketing*. Pearson Education. Indian edition.
- Kotler, P., Chernev, A., & Keller, K. L. (2022). *Marketing Management*. United Kingdom: Pearson Education.
- Levy, M. & Grewal, D. (2022). *Marketing*. United States: McGraw-Hill Education.
- Mamoria C.B. & Bhatacharya, A. (2022). *Marketing Management*. Delhi: Kitab Mahal.
- Sharma, K. & Aggarwal S. (2021). *Principles of Marketing*. Delhi: Taxmann Publications.

Note: Suggested readings will be updated by the Department of Commerce and uploaded on Department's website.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Discipline Specific Core Course- 2.3 (DSC-2.3): Human Resource Management

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Resource Management DSC- 2.3	4	3	1	0	Pass in XII	NIL

Learning Objectives

The course aims to acquaint the learners with the techniques and principles to manage human resources of an organisation for better performance and workplace environment.

Learning Outcomes

After the completion of the course, the learners will be able to:

1. Evaluate the importance of contemporary and emerging HR issues.
2. Analyse the concept and sources of recruitment and selection process.
3. Devise employee training and development programs.
4. Design performance appraisal techniques and compensation schemes.
5. Design HR policies for employee engagement and experience; grievance redressal, employee health, safety, welfare, social security, and stress-free work life balance.

SYLLABUS OF DSC-2.3

Unit 1: Introduction to Human Resource Management (9 hours)

Concept and functions; Role, status and competencies of HR manager; HR policies; Evolution of HRM; Emerging challenges of HRM- Workplace diversity, empowerment, downsizing, VRS, work life balance.

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

Suggested Readings

- Aswathappa, K. & Dash, S. (2021). *Human Resource Management-Text and cases* (9th Ed.), Tata McGraw-Hill.

Unit 2: Procurement of Human Resource (9 hours)

Human resource planning- Quantitative and qualitative dimensions; Job analysis – Job description and job specification; Recruitment – concept and sources; Selection – concept and process; Test and interview; Placement, induction and socialization; Retention of employees.

Unit 3: Upgrading Employees: Training and Development (9 hours)

A. Concept and significance; Role specific and competency-based training; Training and development methods – Apprenticeship, understudy, job rotation, vestibule training, case study, role playing, hands on, shadowing, e-learning, sensitivity training, In-basket, management games, conferences and seminars, coaching and mentoring, management development programs; Training process outsourcing.

B. Scope of training; On board, soft skills, technical skills, product & service, quality, anti-harassment, legal.

Unit 4: Performance Appraisal and Compensation Management (9 hours)

Performance appraisal- Nature, objectives and process; Performance management; Methods of performance appraisal; Potential appraisal; Employee counselling; Job Transfer and promotion.

Compensation - Concept and policies, Base and supplementary compensation; Individual, group and organisation incentive plans; Fringe benefits; Performance linked compensation; Employee stock option; Pay band compensation system; Job evaluation.

Unit 5: Employee Maintenance, Engagement and Emerging Horizons (9 hours)

Employee health and safety; Employee welfare; Social security (excluding legal provisions);

Employer-employee relations; Grievance handling and redressal; Industrial disputes: Causes and settlement machinery, Stress-free environment, Rejuvenation breaks and leisure activities.

Emerging Horizons; Redundant manpower, e-HRM; Human Resource Information System (HRIS); HR Audit, Emerging job opportunities, Talent management, Employee burnout, Work life balance, Work from Home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

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Emerging Horizons; Redundant manpower, e-HRM; Human Resource Information System (HRIS); HR Audit, Emerging job opportunities, Talent management, Employee burnout, Work life balance, Work from Home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

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- Aswathappa, K. & Dash, S. (2021). *Human Resource Management-Text and cases* (9th Ed.), Tata McGraw-Hill.

- Chhabra, T. N. & Chhabra, M. (2020). *Human Resource Management*. New Delhi: Sun India Publications.
- Decenzo, D. A., & Robbins, S. P. (2009). *Fundamental of Human Resource Management*, New Jersey: Wiley.
- Dessler G. & Varrkey B. (2020). *Human Resource Management*, Sixteenth Edition, Pearson Paperback.
- French, W. L. (2006). *Human Resource Management*. Boston: Houghton Mifflin.
- Gupta, C. B. (2018). *Human Resource Management*. New Delhi: Sultan Chand & Sons.
- Pattanayak, B. (2019). *Human Resource Management* (6th ed.). PHI learning
- Prasad, L. M. (2018). *Human Resource Management*. New Delhi: Sultan Chand & Sons
- Rao, V. S. P. (2020). *Human Resource Management* (2nd Ed.). New Delhi: Taxmann Pvt. Ltd.
- Sengupta, A. (2018). *Human Resource Management*, Sage Textbook.

Note: Suggested readings will be updated by the Department of Commerce and uploaded on the Department's website.

Unit 2: Procurement of Human Resource (9 hours)

Human resource planning- Quantitative and qualitative dimensions; Job analysis – Job description and job specification; Recruitment – concept and sources; Selection – concept and process; Test and interview; Placement, induction and socialization; Retention of employees.

Unit 3: Upgrading Employees: Training and Development (9 hours)

A. Concept and significance; Role specific and competency-based training; Training and development methods – Apprenticeship, understudy, job rotation, vestibule training, case study, role playing, hands on, shadowing, e-learning, sensitivity training, In-basket, management games, conferences and seminars, coaching and mentoring, management development programs; Training process outsourcing.

B. Scope of training; On board, soft skills, technical skills, product & service, quality, anti-harassment, legal.

Unit 4: Performance Appraisal and Compensation Management (9 hours)

Performance appraisal- Nature, objectives and process; Performance management; Methods of performance appraisal; Potential appraisal; Employee counselling; Job Transfer and promotion.

Compensation - Concept and policies, Base and supplementary compensation; Individual, group and organisation incentive plans; Fringe benefits; Performance linked compensation; Employee stock option; Pay band compensation system; Job evaluation.

Unit 5: Employee Maintenance, Engagement and Emerging Horizons (9 hours)

Employee health and safety; Employee welfare; Social security (excluding legal provisions);

Employer-employee relations; Grievance handling and redressal; Industrial disputes: Causes and settlement machinery, Stress-free environment, Rejuvenation breaks and leisure activities.

Emerging Horizons; Redundant manpower, e-HRM; Human Resource Information System (HRIS); HR Audit, Emerging job opportunities, Talent management, Employee burnout, Work life balance, Work from Home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

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YOGA IN PRACTICE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Yoga in Practice	2			2	0	Class XII Pass

Total Credits: 02

Learning Objectives:

Students will be able to discern real significance of yogic operations from original sources and will be prone to practicing in their day to day life.

Learning Outcomes:

- (i) Student will form an understanding of the concept of yoga.
- (ii) Students will learn various aspects of the science of yoga.
- (iii) Theoretical and practical knowledge of Asanas and pranayams to lead a balanced life.

SYLLABUS OF YOGA IN PRACTICE

Unit: I

Credit: 01

- (i) Definition and types of yoga:
Karma yoga, Gyana yoga, Bhakti yoga, Laya yoga, Raja yoga, Hatha yoga, Mantra yoga, Kundalini yoga. (योग एवं स्वास्थ्य – अध्याय - 1)
- (ii) Ashtanga Yoga:
Yam- Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha.
Niyam- Sauch, Santosha, Tapa, Swadhyaya, Ishwarpranidhana
Asan, Pranayam- (the types of Pranayama: Puraka, rechak & Kumbhaka), Pratyahara,

Human resource planning- Quantitative and qualitative dimensions; Job analysis – Job description and job specification; Recruitment – concept and sources; Selection – concept and process; Test and interview; Placement, induction and socialization; Retention of employees.

Unit 3: Upgrading Employees: Training and Development (9 hours)

A. Concept and significance; Role specific and competency-based training; Training and development methods – Apprenticeship, understudy, job rotation, vestibule training, case study, role playing, hands on, shadowing, e-learning, sensitivity training, In-basket, management games, conferences and seminars, coaching and mentoring, management development programs; Training process outsourcing.

B. Scope of training; On board, soft skills, technical skills, product & service, quality, anti-harassment, legal.

Unit 4: Performance Appraisal and Compensation Management (9 hours)

Performance appraisal- Nature, objectives and process; Performance management; Methods of performance appraisal; Potential appraisal; Employee counselling; Job Transfer and promotion.

Compensation - Concept and policies, Base and supplementary compensation; Individual, group and organisation incentive plans; Fringe benefits; Performance linked compensation; Employee stock option; Pay band compensation system; Job evaluation.

Unit 5: Employee Maintenance, Engagement and Emerging Horizons (9 hours)

Employee health and safety; Employee welfare; Social security (excluding legal provisions);

Employer-employee relations; Grievance handling and redressal; Industrial disputes: Causes and settlement machinery, Stress-free environment, Rejuvenation breaks and leisure activities.

Emerging Horizons; Redundant manpower, e-HRM; Human Resource Information System (HRIS); HR Audit, Emerging job opportunities, Talent management, Employee burnout, Work life balance, Work from Home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

Suggested Readings

- Aswathappa, K. & Dash, S. (2021). *Human Resource Management-Text and cases* (9th Ed.), Tata McGraw-Hill.

Dharana, Dhyana & Samadhi etc.

(iii) Shat Chakra:

Mooladhara, Swadhishtana, Manipur, Anahata, Vishudha, Aagya, Sahasrara-
(Sahasradhara chakra). (योग एवं स्वास्थ्य - अध्याय - २-३)

Unit: II

Credit: 01

Asana,s and their advantages:-

(i) Asana in standing position:

Surya Namaskara, Tadasana, Padahasthasana, Garudasana, Natarajasana, Cakrasana.

(ii) Asana in sitting position:

Padmasana, Vajrasana, Siddhasana, Bhadrasana, Gomukhasana, Shashankasana,
Mandukasana, Kukkutasana.

(iii) Asana in stomach side position:

Dhanurasana, Bhujangasana, Mayurasana, Marjarasana, Makarasana.

(iv) Asana in backbone side position:

Uttanapadasana, Naukasana, Sarvangasana, Sheershasana, Savasana etc.

(v) Practice of pranayama- Purak, Rechak and Kumbhaka. (योग एवं स्वास्थ्य - अध्याय - ३-४,६)

[D] References:

1. योग दर्शन - महर्षि पतंजलि, टीकाकार-हरिकृष्णदास गोयन्दका, गीता प्रेस, गोरखपुर, उत्तर प्रदेश, ४० वां पुनर्मुद्रण।
2. योग एवं स्वास्थ्य - डॉ० विजय कुमार, चौखम्भा विश्वभारती, वाराणसी, उत्तर प्रदेश, प्र० संस्करण - २०२१।

3. प्राणायाम रहस्य -(वैज्ञानिक तथ्यों के साथ)- स्वामी रामदेव, दिव्य प्रकाशन, दिव्य योग मन्दिर ट्रस्ट, पतंजलि योगपीठ,

कनखल, हरिद्वार।

4. योग साधना एवं योग चिकित्सा रहस्य- स्वामी रामदेव, दिव्य प्रकाशन, दिव्य योग मन्दिर ट्रस्ट, पतंजलि योगपीठ,

कनखल, हरिद्वार।

5. शतयुर्वे पुरुषः - स्वामी रामेश्वरानन्द सरस्वती, आर्ष प्रकाशन, कुंडेवाला, दिल्ली- सं० २०६२। (ई- वैदिक पुस्तकालय, मुम्बई)

Additional Resources:

1. योग धिपी - स्वामी अद्वैतानन्द सरस्वती, गुरुकुल वृन्दावन स्नातक शोध संस्थान, आसफ अली रोड, नई दिल्ली -२००६।
2. व्यायाम का महत्त्व - स्वामी ओमानन्द सरस्वती, हरयाणा साहित्य संस्थान, गुरुकुल झज्जर, हरयाणा -२००६।

alysis - Job
- concept and
employees.

Training and development methods - Apprenticeship, understudy, job rotation, resource training, case study, role playing, hands on, shadowing, e-learning, sensitivity training, In-basket, management games, conferences and seminars, coaching and mentoring, management development programs; Training process outsourcing.

B. Scope of training; On board, soft skills, technical skills, product & service, quality, anti-harassment, legal.

Unit 4: Performance Appraisal and Compensation Management (9 hours)

Performance appraisal- Nature, objectives and process; Performance management; Methods of performance appraisal; Potential appraisal; Employee counselling; Job Transfer and promotion.

Compensation - Concept and policies, Base and supplementary compensation; Individual, group and organisation incentive plans; Fringe benefits; Performance linked compensation; Employee stock option; Pay band compensation system; Job evaluation.

Unit 5: Employee Maintenance, Engagement and Emerging Horizons (9 hours)

Employee health and safety; Employee welfare; Social security (excluding legal provisions);

Employer-employee relations; Grievance handling and redressal; Industrial disputes: Causes and settlement machinery, Stress-free environment, Rejuvenation breaks and leisure activities.

Emerging Horizons; Redundant manpower, e-HRM; Human Resource Information System (HRIS); HR Audit, Emerging job opportunities, Talent management, Employee burnout, Work life balance, Work from Home.

Practical Exercises

The learners are required to:

1. Design a human resource plan with a focus on contemporary and emerging HR issues.
2. Perform a role play and conduct an orientation cum induction programme for new recruits.
3. Design a training and development plan for a hypothetical organisation.
4. Design performance appraisal techniques and compensation schemes for a hypothetical organisation.
5. Design employee welfare scheme for a hypothetical organisation.

Suggested Readings

- Aswathappa, K. & Dash, S. (2021). *Human Resource Management-Text and cases* (9th Ed.), Tata McGraw-Hill.

VAC 1: ETHICS AND CULTURE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethics and Culture	02	1	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To help students explore ethical and cultural dimensions of their lives.
- To provides a forum for students to pause, revisit their assumptions and beliefs, and become mindful of their thoughts, emotions and actions.
- To give the students an opportunity to express themselves and inquire into their decision making processes.
- To cultivate ethical values and participate in the creation of a society based on acceptance, compassion, and justice.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explore perspectives on ethics in thoughts, words and actions
- Evolve ethical decision making practises
- Understand the need for an ethical society and culture
- Introspect, become conscious of and assess one's stance in life
- Cultivate empathy, tolerance and compassion
- Apply the values learnt in the course to everyday life

SYLLABUS OF ETHICS AND CULTURE

UNIT – I Introduction - The Basis of Ethics

(3 Weeks)

- Getting to Know Each Other
- What to Expect from the Course?
- Recognition of Our Common Humanity
- Empathy, Compassion and Justice

UNIT – II The Role of Intelligence, Reason and Emotions

(4 Weeks)

- Discernment: What Is The Right Thing To Do?
- The Art of Conflict Resolution
- Destructive and Constructive Emotions
- The Need for Emotional Balance

UNIT – III Cultivating Inner Values- Ethics in the World of Work and Play

(4 Weeks)

- Training the Mind: Mindfulness and Kindness
- Meditation
- Discovering your Vocation and Interests
- Self-discipline, Integrity, Commitment, Creativity
- Work-Life Balance

UNIT – IV Striving for a Better World | Outreach Activities

(4 Weeks)

- Means and Ends
- Debate and Dialogue
- Culture as Shared Values
- Creating and Sustaining Ethical Cultures: The Role of Philosophy, Religion, Literature, Theatre, Cinema, Music, Media
- Outreach Activities

Practical component (if any) –

(15 Weeks)

Unit 1

1. The teacher may ask students to introduce themselves, sharing their regional and cultural roots. They may be asked to reflect on those aspects of their identities that reflect their cultural roots.
2. After a round of initial introduction, the teacher may ask students to list down a set of values that they think they have developed through their parents and grandparents. Are these values unique to their families, regional and/or ethnic backgrounds? Of these, which are the values they would like to sustain and which are the ones they would wish to modify?
3. The teacher may draw upon the values discussed by students in the previous lesson. Using these as the base, the teacher may ask students to think of ethical values that form the basis of their decisions.

4. The teacher may ask students to think of people who they think have lived an 'ethical life'. These may be people who they know from their personal lives or people known for upholding ethical values in the face of adversity.
5. Students are encouraged to identify what common human values are necessary are Realise shared common humanity– the feeling of interconnectedness/interdependence.
6. Class to be divided in small groups to discuss how each would make an effort to cultivate new morals/ethical values for betterment of their local environment.
7. Celebrating 'Sharing and Caring' based on regional diversity can be encouraged.
8. Engage students to do activities of 'being in the shoes of others' (peers, parents, siblings, house help/support or in any local community grappling with problems) to understand the problems empathetically.
9. The students can be asked to make bookmarks/cards to remind them about virtues pertaining to empathy versus sympathy, need versus greed, just versus unjust or compassion versus insensitivity.
10. Compassion is about cultivation of it as a daily value so students can in small groups undertake compassion based activities of looking after animals, birds, needy, elderly, differently abled, non-privileged etc. and share their thoughts in the class.

Unit 2

1. Make the student think of a hard decision they have made. What made it hard? How did you make the decision? How do you assess it retrospectively?
2. Encourage students to think of judgements and decisions based on the dilemmas and challenges they faced? How do they go about making these decisions?
3. The teacher may introduce any well known story and ask the students to discuss the story from the point of view of the different characters.
4. Ask students how willing they are to deal with a conflict when it occurs. What strategies do they adopt to resolve the conflict?
5. The teacher may ask students to prepare posters with captions like "avoidance", "competition", "cooperation" and "adaptation" and then may ask students to identify with one of these styles which according to them best represents their style of dealing with conflict.
6. The students may be asked to discuss different such similar situations that they may have encountered and a discussion may be initiated on how they resolve those conflicts.
7. The students can be asked to write down certain destructive emotions that they are experiencing presently. How would they work to make them constructive? A classroom discussion could follow around this.

8. Ask the students to note down a list of constructive emotions experienced by them recently. Were the constructive emotions less powerful as compared to the destructive ones experienced by them? Discussion in class can follow.
9. How do you (i) express, (ii) handle anger/ disgust/ distress/ fear (any destructive emotion can be taken up). A healthy discussion in the class can take place around this.
10. Students may be asked to practice a simple breathing exercise. They can sit straight with eyes opened or closed in a comfortable position to just observe their breathing. They can repeat this exercise six to eight times and share (if they like) their experience of silence.
11. To identify your interests and develop a meaningful hobby.
12. Have an open conversation in the class about happiness.

Unit 3

1. The students could observe various emotions that bottle-up in their minds and be asked to watch the flow of emotions non-judgmentally.
2. Students may be asked to recall their journey to the college that morning. Do they remember road signs, faces of people they crossed, the roads that they took, the people they interacted with, the sights and smells around them, or anything else?
3. Students could be asked to cultivate the habit of simple greeting as practice of gratitude and celebrate a day of joyful giving.
4. The students can close their eyes for 2-3 minutes and be asked to observe their thoughts, list them and categorise them into 'to be kept' or 'to let go'.
5. The teacher may ask students to close their eyes and imagine a situation in which they are truly happy. Students could wish for the well-being of two students in the same classroom in their meditative state.
6. Students could meditate on who has been their inspiration and the qualities of the person who has inspired them and then express gratitude to the person concerned.
7. The teacher may ask the students to think retrospectively about what they thought they would take up as a vocation when they were younger. How and why their choices were influenced and changed, if at all.
8. The teacher may ask the students to imagine and chart a journey and destination for themselves. They may also talk about the challenges they foresee.
9. The teacher may encourage the students to maintain a daily diary of their scheduling of time or a worklog and see how much time they effectively give to their work. The teacher may help the students identify the distractors and where one may be 'wasting' time and energy. The activity is designed to help students understand the value of effective time utilisation.

10. In this lesson, the teacher may ask the students to draw up a list of team ethics. They may build this based on their experiences of working with each other in groups.
11. The teacher may ask the students to share an incident each where they felt pressurised/ bored to complete some work. How did they deal with their stress and monotony of work?

Unit 4

1. Students will be asked to work in pairs and develop situations that pose ethical dilemmas and how to resolve them.
2. Students may be asked to look at a film or at an advertisement and discuss what they think about the question/s posed in them. The teacher may ask them if they can think of an alternative ethical approach to the problem posed.
3. Students will be asked to think of situations in which they lost their temper. Have they ever felt that in a fit of emotion they said something that they regretted later? If they had paused to listen and then respond, what would the other person have said? How would the outcome of the situation have been different?
4. A debate on any relevant topic may be conducted in the class. After the first round the students may be asked to adopt and argue their opponents point of view. At the end of this exercise the students can have an open discussion on which position finally appealed to them.
5. The teacher may give a short story to the students and ask them to change the ending. They may be asked to observe how characters and their views may have undergone change in the process.
6. There can be a discussion around a topic such as, the idea of corporal punishment, euthanasia etc. Students can be given a sheet of paper and can be asked to write for or against the theme. The idea is to enable them to understand that the positions they have taken vis-a-vis the theme are a result of different value orientations.
7. Popular foods from many parts of India can be discussed. Their origins can be traced to chart a kind of food history.
8. The teacher on the basis of discussions with students can draw from Philosophy, Religion, Literature, Theatre, Cinema, and Media to highlight that the choices people/characters make are grounded in their culture.
9. The students can discuss classical/folk dances that are performed in their respective groups. Details can be drawn based on the number of dancers, music (live or recorded) and costumes. 3. The role of oral traditions and literature in indicating the importance of ethics in our everyday lives can be discussed.

Suggested Activities for Outreach: Social/ Community Engagement and Service

In the weeks that follow, students will be expected to engage in outreach activities that shall enable them to put into practice some of the ethical considerations deliberated upon and imbibed in the previous modules. A list of suggested outreach activities is as follows:

- Adopt a village with the aim of cultural and ethical learning
- Discussing health and hygiene issues in a community
- Tutoring students
- Gender sensitisation
- Working on environmental issues
- Working with Child Care Centres such as Anganwadis and Balwadis
- Working with differently abled students
- Preserving cultural and heritage sites
- Spending time with senior citizens including in a Senior Citizens Home
- Extending care to animals in animal welfare shelters
- Addressing issues relating to Reproductive Health
- Spreading awareness about adolescent health
- Addressing issues relating to mental health
- Health and nutrition awareness
- Swacchata Abhiyaan
- Sensitisation towards disease awareness
- Vriksharopan
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Suggested Readings:

- Aristotle. Nichomachean Ethics. London: Penguin Classics, 2004
- Swami Vivekananda. The Complete Works of Swami Vivekananda. Advaita Ashrama, 2016.
---https://www.ramakrishnavivekananda.info/vivekananda/complete_works.html
- Panch Parmeshwar in English translation as The Holy Panchayat by Munshi Premchand
- The Silas Marner by George Eliot
- We are Seven by Wordsworth
- The Chimney Sweeper by William Blake

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

GE VI

Delhi through the Ages

Course Objectives:

The aim of this paper is to acquaint the students with the historical evolution of Delhi. Students are introduced to significant archaeological sites and cities of Delhi from the prehistoric to the contemporary period. The paper focuses on how ecological and historical aspects of Delhi contributed to the gradual growth of the city's hybrid cultural milieu.

Learning Outcomes:

After the completion of this Course, the students will be able to:

- Analyze the historical contexts of tangible and intangible heritage of Delhi.
- Discuss the Ecology of Delhi and outline changes in it through the ages.
- Describe the archaeological cultures that flourished in and around Delhi.
- Analyze the processes leading to the establishment of urban settlements of Delhi
- Outline the importance of Shahjahanabad and its importance in the development of the great imperial city of Delhi.
- Trace the role of Delhi College in the political and literary culture of Delhi.
- Discuss various aspects of the Revolt of 1857 and its consequences for the future development of Delhi.
- Delineate the processes leading to the making of the New Imperial Capital under the British.
- Analyze the impact of Partition on the structure and settlement pattern of Delhi.
- Describe Delhi's importance as economic and cultural centre.

Course Content:

Unit I. Many pasts of Delhi: Ecology, Archaeology and History

Unit II. Cities of Delhi: Urban Settlements from the 13th and 14th centuries – Focus on any two Mehrauli, Siri, Tughluqabad, Firuzabad

Unit III. 18th and early 19th Century Shahjahanabad: Politics, Literary Culture and Delhi College

Unit IV. Delhi in 1857: Revolt and Re-conquest

Unit V. Making of the New Imperial Capital: Delhi 1911-1930

Unit VI. Delhi in 1947: Partition and After

Unit VII. Delhi as economic and cultural centre: Case study (Any Two)

- a. Crafts and artisans

- b. Music
- c. *Hazrat-i Dehli*
- d. Tombs of Delhi
- e. Coronation park

ESSENTIAL READINGS AND UNIT-WISE TEACHING OUTCOMES:

Unit-1. This section should apprise students about the early pasts of Delhi by focussing on its ecology, archaeology and historical Methodology. **(Teaching Time: 2 weeks approx.)**

- Singh, Upinder. (Ed.). (2006). *Delhi: Ancient History*. New Delhi, Social Science Press. (see the articles by Grover and Bakliwal; Dilip K. Chakrabarti and Nayanjot Lahiri; A.K. Sharma; B. R. Mani; and B. D. Chattopadhyaya; pp. 3-25, 36-40, 68-76).
- Singh, Upinder. (Ed.). (2010). *Dilli: Prachin Itihas*. New Delhi: Orient Blackswan (above text published in Hindi, refer to same articles).
- Singh, Upinder. (1999). *Ancient Delhi*. Delhi: Oxford University Press, pp. 46-62, 75-87

Unit-2. In this section the learning outcomes would focus on the readings and field trips that students would plan pertaining to 13-14th century settlements in Delhi with specific focus on any two: Mehrauli, Siri, Tughluqabad, Firuzabad. **(Teaching Time: 3 weeks approx.)**

- Singh, Upinder. (Ed.). (2006). *Delhi: Ancient History*. New Delhi: Social Science Press (articles by B. R. Mani and I. D. Dwivedi; pp. 185-211).
- Kumar, Sunil. (2011). "Courts, Capitals and Kingship: Delhi and its Sultans in the Thirteenth and Fourteenth Centuries CE." in Albrecht Fuess and Jan Peter Hartung, (eds.). *Court Cultures in the Muslim World: Seventh to Nineteenth Centuries*. London: Routledge, pp. 123-48.

Unit-3. This segment should apprise students about the politics, literary culture and the role of Delhi College in 18th and early 19th Century Shahjahanabad. **(Teaching Time: 2 weeks approx.)**

- Farooqui, Amar. (2013). *Zafar and the Raj: Anglo-Mughal Delhi, 1800-1850*. Delhi: Primus Books. (Ch.6, "The Palace and the City", pp. 106-133).
- Naim, C. M. (2004). "Ghalib's Delhi: A Shamelessly Revisionist Look at Two Popular Metaphors." in *Urdu Texts and Contexts: The Selected Essays of C. M. Naim*. Delhi: Permanent Black, pp. 250-79.

- Ataulloh. (2006-2007). "Mapping 18th Century Delhi: The Cityscape of a Pre-Modern Sovereign City." *Proceedings of the Indian History Congress*. Session 67, pp. 1042-1057.

Unit-4. The unit should familiarise students about the revolt and the process of British reconquest of Delhi in 1857. It would examine political developments and their legacy during 1857 and how the rebellion in Delhi influenced the city. **(Teaching Time: 3 weeks approx.)**

- Gupta, Narayani. (1999). *Delhi between the Empires: 1803-1931*. Delhi: Oxford University Press, pp. 20-31, 50-66.
- Lahiri, Nayanjot. (2003). "Commemorating and Remembering 1857: The Revolt in Delhi and its Afterlife". *World Archaeology* vol. 35 no.1, pp. 35-60.

Unit-5. This section examines the motivation, planning and the ideological impact that the British wanted to make through the making of the new Imperial Capital in Delhi. **(Teaching Time: 2 weeks approx.)**

- Gupta, Narayani. (1999). *Delhi between the Empires: 1803-1931*. Delhi: Oxford University Press, pp 160-182.
- Metcalf, Thomas R. (1986). "Architecture and Empire: Sir Herbert Baker and the Building of New Delhi." in R. E. Frykenberg, (ed.). *Delhi through the Ages*. Delhi: Oxford University Press. pp. 391-400.

Unit-6. This section explores and reflects Delhi during and post-Partition. It examines physical and social transformation of Delhi from the colonial to the contemporary times. **(Teaching Time: 2 weeks approx.)**

- Pandey, Gyanendra. (2001). *Remembering Partition*. Cambridge: Cambridge University Press, pp. 121-51
- Kidwai, Begum Anis. (2011). *In Freedom's Shade*. (Trans. by Ayesha Kidwai.) New Delhi: Penguin. (Chapters 3 and 4.)
- Tan, Tai Yong and Gyanesh Kudaisya. *The Aftermath of Partition in South Asia*. New York: Routledge (Ch.7, "Capitol Landscapes", pp. 193-200).

Unit-7. The segment would help students focus on intensive understanding of the city through the essential and suggested readings and fieldwork on any of the two mentioned subjects/sites. **(Teaching Time: 2 weeks approx.)**

Suggested Readings:

- Dalrymple, William. (2004). *City of Djinns: A Year in Delhi*. New Delhi: Penguin, pp. 27-37.
- Koch, Ebba. (2001). "The Mughal Waterfront Garden." *Mughal Art and Imperial Ideology*. New Delhi: Oxford University Press, pp. 183-202.
- Lowry, Glenn D. (1987). "Humayun's Tomb: Form, Function, and Meaning in Early Mughal Architecture." *Muqarnas* vol. 4, pp. 133-148
- Metcalf, Thomas. (1989). *Imperial Visions*. New Delhi: Oxford University Press, pp. 211-39.
- Pernau, Margrit (Ed.). (2006). *The Delhi College*. New Delhi: Oxford University Press, pp. 1-32.
- Pinto, Desiderio S.J. (2004). "The Mystery of the Nizamuddin Dargah: the Account of Pilgrims." in Christian W. Troll, (ed.). *Muslim Shrines in India*. New Delhi: Oxford University Press, pp. 112-124.
- Spear, Percival. (2002). *Twilight of the Mughals* (sic). In *The Delhi Omnibus*. Delhi: Oxford University Press. (Chapter IV).
- Tarlo, Emma. (2000). "Welcome to History: A Resettlement Colony in the Making." in Veronique Dupont et al, (ed.). *Delhi: Urban Spaces and Human Destinies*. Delhi: Manohar, pp. 75-94.

Teaching Learning Process:

Classroom teaching supported by group discussions or group presentations on specific themes/readings. Given that the students enrolled in the course are from a non-history background, adequate emphasis shall be given during the lectures to what is broadly meant by the historical approach and the importance of historicising various macro and micro-level developments/phenomena. Interactive sessions through group discussions or group presentations shall be used to enable un-learning of prevailing misconceptions about historical developments and time periods, as well as to facilitate revision of issues outlined in the lectures. Supporting audio-visual aids like documentaries and power point presentations, and an appropriate field-visit will be used where necessary.

Assessment Methods:

Students will be regularly assessed for their grasp on debates and discussions covered in class. Two written submissions; one of which could be a short project, will be used for final grading of the students. Students will be assessed on their ability to explain important historical trends and thereby engage with the historical approach.

Internal Assessment: 25 Marks

Written Exam: 75 Marks

Total: 100 Marks

Keywords:

Settlements, Sultanate Delhi, Mughal Delhi, Delhi College, 1857, New Delhi, Partition

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
Offered By Department Of History
Category-IV

GENERIC ELECTIVES (GE-1): Delhi Through the Ages: The making of its early Modern History

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Delhi Through the Ages: The making of its early Modern History	4	3	1	0	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

The objective of the paper is to explore the city of Delhi from its early history to the eighteenth century. The city grew into one of the largest cities in the world and was the capital of some of the great empires. As capital Delhi profited from continuous immigration, state patronage and vibrant cultural life. The city was not merely dependent upon its rulers for cultural and political sustenance. The course also focuses on Sufis, litterateurs and merchants who also gave the city its unique character and resilience in the face of political turbulence.

Learning outcomes

Upon completion of this course the student shall be able to:

- To acquaint students with the history of Delhi till the early modern period.
- Analyse the processes of urbanization as shaped by political, economic and social changes

SYLLABUS OF GE-1

Unit I: Ancient Delhi and adjoining sites: (12 hours)

1. Indraprastha- Hastinapur, Panipat, Tilpat
2. Ashokan Edicts
3. Mehrauli Iron Pillar
4. Lalkot

Unit II: From Settlements to Cityscape - Understanding the 10th and 14th Century Cities of Delhi. Case Study Any Two: (16 hours)

1. Anangpur Fort
2. Dehli-i Kuhna's Masjid-i Jami
3. Siri
4. Ghiyaspur-Kilukhari
5. Tughulqabad
6. Firuzabad

Unit III: 16th to 17th Century Delhi: (16 hours)

1. Humayun's Garden Tomb
2. Morphology of Shahjahanabad

Unit IV: 18th Century Delhi - Understanding political and social changes (16 hours)

Essential/recommended readings

Unit 1: This unit will introduce students to the early history of Delhi, focusing on Indraprastha, ancient edicts and pillars and the Tomar and Chauhan constructions. (Teaching Time: 12 hours)

- Richard J. Cohen, "An Early Attestation of the Toponym Dhillī", Journal of the American Oriental Society, Vol. 109 (1989), pp. 513-519.
- Singh, Upinder. (2006). Ancient Delhi, Delhi: Oxford University Press
- Mani, B.R. (1997). Delhi: Threshold of the Orient; (Studies in Archaeological Investigations), Aryan Books International

Unit 2: This unit will study the cities of Sultanate Delhi in the 10th to 14th centuries. It will discuss the various reasons for the shift of capitals and the changing character of the city. Case studies of any two of these cities will be undertaken. Students will be encouraged to plan field trips related to the themes and readings. (Teaching Time: 16 hours)

- B.R.Mani and I.D.Dwivedi (2006). 'Anangpur Fort: The Earliest Tomar Settlements Near Delhi', in Upinder Singh, ed., Delhi: Ancient History, Social Science Press, New Delhi, pp 200-204.
- Ali, Athar. (1985). "Capital of the Sultans: Delhi through the 13th and 14th Centuries", in
- R.E. Frykenberg, ed., Delhi Through the Age: Essays in Urban History, Culture and Society, Delhi: Oxford University Press, pp. 34-44
- Kumar, Sunil. (2019) "The Tyranny of Meta-Narratives; Re-reading a History of Sultanate Delhi", in Kumkum Roy and Naina Dayal. (Ed.). Questioning Paradigms, Constructing Histories: A Festschrift for Romila Thapar, Aleph Book Company, pp 222-235.
- Kumar, Sunil. (2011). "Courts, Capitals and Kingship: Delhi and its Sultans in the Thirteenth and Fourteenth Centuries CE" in Albrecht Fuess and Jan Peter Hartung. (eds.). Court Cultures in the Muslim World: Seventh to Nineteenth Centuries, London: Routledge, pp. 123-148
- Kumar, Sunil. (2009) 'Qutb in Modern Memory'. In: Kaul, Suvir, (ed.), Partitions of Memory. Delhi: Permanent Black, pp. 140-182.
- Jackson, Peter. (1986). 'Delhi: The Problem of a Vast Military Encampment', in: R.E. Frykenberg (ed.). Delhi Through the Ages: Essays in Urban History, Culture, and Society, New Delhi: Oxford University Press, 1986), pp.18-33.

- Haidar, Najaf. (2014). 'Persian Histories and a Lost City of Delhi', Studies in People's History, vol. 1, pp. 163–171
- Aquil, R. (2008). "Hazrat-i-Dehli: The Making of the Chishti Sufi Centre and the Stronghold of Islam." South Asia Research 28: 23–48.
- Welch, Anthony and Howard Crane. (1983). "The Tughluqs: Master Builders of the Delhi Sultanate ": Muqarnas, vol. 1 pp. 123-166.
- Welch, Anthony. (1993). Architectural Patronage and the Past: The Tughluq Sultans of India: Muqarnas, Vol. 10, Essays in Honor of Oleg Graber, pp. 311-322, Published by Brill. <https://www.jstore.org/stable/1523196>

Unit 3: This unit will explore the structure and meanings of Humayun's Garden Tomb and morphology of the imperial city of Shahjahanabad, in the 16th and 17th centuries (Teaching time: 16 hours)

- Chandra, Satish. (1991). "Cultural and Political Role of Delhi, 1675-1725", in R.E. Frykenberg, Delhi through the Ages: Essays in Urban History, Culture and Society, Delhi: Oxford University Press, pp. 106-116.
- Blake, Stephen, (1985). "Cityscape of an Imperial City: Shahjahanabad in 1739", in R.E. Frykenberg, Delhi Through the Ages: Essays in Urban History, Culture and Society, Oxford University Press, pp. 66-99.
- Hasan, Nurul, S. (1991). "The Morphology of a Medieval Indian City: A Case Study of Shahjahanabad", In Indu Banga (ed.). The City in Indian History, Delhi: Manohar, pp. 87-98.
- Gupta. Narayani. (1993). "The Indomitable City," in Eckart Ehlers and Thomas Krafft, eds., Shahjahanabad / Old Delhi: Tradition and Change. Delhi: Manohar, pp. 29-44.
- Koch, Ebba. (1994). "Diwan-i' Amm and Chihil Sutun: The Audience Halls of Shah Jahan". Muqarnas, vol. 11, pp. 143-165.
- Lowry, Glenn D. (1987). Humayun's Tomb: Form Function, and Meaning in Early Mughal Architecture. Muqarnas, Vol. 4, pp. 133-148
- Dickie, James (Zaki, Yakub), (1985). The Mughal Garden: Gateway to Paradise, Muqarnas, Vol. 3, pp. 128-137.
- Koch, Ebba. (1997). 'Mughal Palace Gardens from Babur to Shahjahan (1526-1648), Muqarnas, pp. 143-165.
- Rezavi, Syed Ali Nadeem, (2010). "The Mighty Defensive Fort': Red Fort at Delhi Under Shahjahan -- Its Plan and Structures as Described by Muhammad Waris." Proceedings of the Indian History Congress 71, pp. 1108–1121.

Unit 4: This unit will discuss the developments in Shahjahanabad in the 18th century. The 'decline' in the authority meant turbulence in the city, but it also empowered new groups of people and created a cultural and social dynamism that was embraced by some and seen as a challenge by others. (Teaching Time: 16 hours)

- Alam, Muzaffar. (2013) "Introduction to the second edition: Revisiting the Mughal Eighteenth Century" in The Crisis of Empire in Mughal North India: Awadh and the Punjab 1707-1748, Delhi: Oxford University Press, pp. xiii-lxiv
- Ataullah. (2006-2007). "Mapping 18th Century Delhi: the cityscape of a pre-Modern sovereign city" Proceedings of the Indian History Congress, vol. 67 pp. 1042-1057.

- Chenoy, Shama Mitra. (1998). *Shahjahanabad, a City of Delhi, 1638-1857*. New Delhi: Munshiram Manohar Lal Publishers.
- Raziuddin Aquil, (2017) "Violating Norms of Conduct" in *The Muslim Question: understanding Islam and Indian History*, Delhi: Penguin Random House, pp. 133-156.

Suggested readings

- Anthony Welch, 'A Medieval Centre of Learning in India: The Hauz Khas Madrasa in Delhi', *Muqarnas*, 13 (1996): 165-90;
- Anthony Welch, 'The Shrine of the Holy Footprint in Delhi', *Muqarnas*, 14 (1997): 116-178;
- Asher, Catherine B. (2000). "Delhi Walled: Changing Boundaries" in James D. Tracy, *City Walls: The Urban Enceinte in Global Perspective*, Cambridge: Cambridge University Press, pp. 247-281.
- Bayly, Christopher Alan. (1986). "Delhi and Other Cities of North India during the 'Twilight'", in *Delhi through the Ages: Essays in Urban History, Culture, and Society*, edited by Robert Eric Frykenberg, Delhi: Oxford University Press, pp. 221-36.
- Blake, Stephen P. (1991). *Shahjahanabad: The Sovereign City in Mughal India, 1639-1739*. Cambridge; New York: Cambridge University Press.
- Chandra, Satish. (1991). "Cultural and Political Role of Delhi, 1675-1725", in R.E. Frykenberg, *Delhi through the Ages: Essays in Urban History, Culture and Society*, Delhi: Oxford University Press, pp. 106-116.
- Hasan, Zafar. (1922). *A Guide to Nizamu-d Din*. New Delhi: *Memoirs of the Archaeological Survey of India* #10
- Habib, Irfan. (1978). 'Economic History of the Delhi Sultanate -- an Essay in Interpretation', *Indian Historical Review* vol. 4, pp. 287-303.
- Flood, Finbarr B. (2008). "Introduction" in Finbarr B. Flood, *Piety and Politics in the Early Indian Mosque*, Delhi: Oxford University Press, pp. xi-lxxviii
- Matsuo, Ara. (1982). "The Lodi Rulers and the Construction of Tomb-Buildings in Delhi". *Acta Asiatica*, vol. 43, pp. 61-80.
- Moosvi, Shireen. (1985) "Expenditure on Buildings under Shahjahan--A Chapter of Imperial Financial History." *Proceedings of the Indian History Congress*, vol. 46 pp. 285-99.
- Page, J.A. (1926). *An Historical Memoir on the Qutb*. New Delhi: *Memoirs of the Archaeological Survey of India* #22
- Page, J.A. (1937). *A Memoir on Kotla Firoz Shah, Delhi*. New Delhi: *Memoirs of the Archaeological Survey of India* #52
- Shamsur Rahman Faruqi, (2001). "A True Beginning in the North" and "A Phenomenon called 'Vali'" in *Early Urdu Literary Culture and History*, Delhi: Oxford University Press, pp. 109-126, 129-142.
- Shokoohy, Mehrdad. (2007). *Tughluqabad: a paradigm for Indo-Islamic Urban planning and its architectural components*. London: Araxus Books.
- Singh, Upinder. ed., (2006) *Delhi: Ancient History*, Delhi: Social Science Press
- Flood, Finbarr B. (2003). "Pillars, Palimpsests, and Princely Practices: Translating the past in Sultanate Delhi" *RES: Anthropology and Aesthetics*, No. 43, *Islamic Arts*, pp. 95-116.

- Cipolla, Carlo M., (ed). (1994), Before the Industrial Revolution: European Society and Economy 1000-1700. New York: WW Norton & Co.
- Cipolla, Carlo M., (ed). (1976). Fontana Economic History of Europe, Vols. II, III. New York: Barnes and Noble.
- Dickens, A.G. (1974). German Nation and Martin Luther. London: Edward Arnold.
- Dobb, Maurice. (1963). Studies in the Development of Capitalism. London: Routledge and Kegan Paul.
- Findlen, Paula, (ed). (2002). The Italian Renaissance. The Essential Readings. Oxford: Blackwell Publishers Ltd.
- Hilton, Rodney. (2007) Samantvaad se Poonjivaad mein Sankraman. New Delhi. Granth Shilpi.
- Kamen, Henry. (1996). European Society, 1500-1700. London: Routledge.
- Lee, Stephen. (1984). Aspects of European History 1494-1789. London: Methuen & Co. Ltd. (2nd edition)
- Lynch, John. (1984). Spain under the Habsburgs, Vol. I, Empire and Absolutism, 1516- 1598. New York: New York University Press.
- Parry, J. H. (1963). Age of Reconnaissance. London: Weidenfield & Nicolson.
- Scammell, G.V. (1989). The First Imperial Age: European Overseas Expansion 1400- 1715. London/New York: Routledge.
- Verma, Lal Bahadur. (2008). Europe ka Itihaas. Bhaag 9. (Delhi: Prakashan Sansthan)
- Wiesner-Hanks, Merry E. (2006). Early Modern Europe: 1450-1789. Cambridge: Cambridge University Press.
- Wood, E.M. (2002). The Origin of Capitalism: A Longer View. London: Verso, (rev. ed.).

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): History of Modern China (1840 – 1950s)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
History of Modern China (1840 – 1950s)	4	3	1	0	12 th Pass	NIL

Learning Objectives

The course studies the transformation of China from an imperial power into a modern nation taking its place among a constellation of world powers. This transition has been studied in the context of the impact of a specific form of western imperialism on China and the country's numerous internal fissures and contradictions. This paper seeks to focus on a range of responses to the tumultuous changes taking place: various strands of reform (from liberal to authoritarian), popular movements, and revolutionary struggles. It facilitates an understanding of the multiple trajectories of China's political and cultural transition from a late imperial state, to a flawed Republic, to the Communist Revolution led by Mao Tse Tung. The paper shall expose students to historiographical debates pertaining to each of these themes, keeping in mind historical and contemporary concerns centred on such issues.

Learning outcomes

Upon the completion of this course the student shall be able to:

- Develop an in-depth understanding of China's engagement with the challenges posed by imperialism, and the trajectories of transition from feudalism to a bourgeois/ capitalist modernity.
- To locate these historical transitions in light of other contemporaneous trajectories into a global modernity, especially that of Japan.
- Analyse significant historiographical shifts in Chinese history, especially with reference to the dis-courses on nationalism, imperialism, and communism.
- Investigate the political, economic, social and cultural disruptions caused by the breakdown of the centuries old Chinese institutions and ideas, and the recasting of tradition to meet modernist challenges.
- Comprehend the genesis and unique trajectories of the Chinese Communist Revolution.
- Locate the rise of China and Japan in the spheres of Asian and world politics respectively.

SYLLABUS OF DSC-3

Unit I: Late Imperial China and Western Imperialism

1. Confucian Value System; Society, Economy, Polity
2. Opium Wars and the Unequal Treaty System (9 lectures)

Unit II: Popular Movements and Reforms in the 19th century

1. Taiping and Boxer Movements – Genesis, Ideology, Nature
2. Self-Strengthening Movement; Hundred Days Reforms of 1898 (13 lectures)

Unit III: Emergence of Nationalism

- The Revolution of 1911: Nature and Significance
- The May Fourth Movement of 1919 (10 lectures)

Unit IV: Communist Movement in China

1. 1921-1927: Formation of the CCP and the First United Front

2. 1928-1949: Evolution of Maoist Strategy and Revolutionary Measures in Kiangsi and Yen-an ; Communist victory (13 lectures)

Practical component (if any) - NIL

Essential/recommended readings

Unit I: This unit will introduce the students to the salient features of Late Imperial China and its confrontation with Western Imperialism. As a backdrop, it will discuss Confucianism. **(Teaching Time: 9 hrs. approx.)**

- Chesneaux, J. (Ed.). (1972). Popular Movements and Secret Societies in China 1840-1950. Stanford: Stanford University.
- Fairbank, J.K. and Merle Goldman. (2006). China: A New History. Harvard: Harvard University Press, (Chapter 9).
- Hsu, C. Y. Immanuel, (1970) The Rise of Modern China, Oxford University Press.
- Sharma, K. R. (2022). The Third Birth of Confucius: Reconstructing the Ancient Chinese Philosophy in the Post-Mao China. New Delhi: Manohar. (Chapters 1-5).

Unit II: This unit examines the nature and consequences of popular movements and reforms attempted by the ruling elite. **(Teaching time: 12 hrs. approx.)**

- Pfeffer, N. (1994). The Far East- A Modern History. New Delhi: Surjeet Publications, (Chapter 6 & Chapter 7).
- Chung, Tan. (1978). China and the Brave New World: A Study of the Origins of the Opium War. New Delhi: Allied Publishers, (Chapter 2, Chapter 6 & Chapter 7).
- Vinacke, H.M. (1982). A History of the Far East in Modern Times. Delhi: Kalyani Publishers, (Chapter 2).
- Chesneaux, J. (1973). Peasant Revolts in China 1840-1949. London: Thames and Hudson, (Chapter 2).
- Cohen, P.A. (1997). History in Three Keys: The Boxer as Event, Experience and Myth. New York: Columbia University Press.
- Fairbank, J.K. and Merle Goldman. (2006). China: A New History. Harvard: Harvard University Press, (Chapter 10 & Chapter 11).
- Gray, J. (1990 reprint). Rebellions and Revolutions: China from 1800s to the 1980s. Oxford: Oxford University Press, (Chapter 3 & Chapter 6).
- Greenberg, M. (1951). British Trade and the Opening of China. Cambridge: Cambridge University Press.
- Michael, F.H. (1966-1971). The Taiping Rebellion: History and Documents. Seattle: University of Washington Press.
- Purcell, V. (1963). The Boxer Rebellion: A Background Study. Cambridge: Cambridge University Press, (Chapter 6, Chapters 9, Chapter 10 & Conclusion).
- Tan, Chester C. (1967). The Boxer Catastrophe, New York: Octagon Books.
- Teng, S.Y. (1971). The Taiping Rebellion and the Western Powers: A Comprehensive Survey. Oxford: Clarendon Press.
- Tan Chung. (1986). Triton and Dragon: Studies on the 19th Century China and Imperialism. New Delhi: Gian Publishing House.
- Shih, Vincent. (1967). Taiping Ideology: Its Sources, Interpretations, and Influences. Seattle: University of Washington Press.

Unit III: This unit examines the history of the emergence of nationalism in China; nature, character and significance of the Revolution of 1911 and the May Fourth Movement. **(Teaching time: 12 hrs. approx.)**

- Wright, M. C. (Ed.). (1968). China in Revolution: the First Phase, 1900-1913. London: Yale University Press, (Introduction).
- Zarrow, P. (2005). China in War and Revolution 1895-1949. London: Routledge.
- Lazzarani, Edward J. (Ed.). (1999). The Chinese Revolution. Westport, Connecticut: Greenwood Press, pp 19-32.
- Bianco, L. (1967). Origins of the Chinese Revolution 1915-1949. Stanford: Stanford University Press, (Chapter 2).
- Chow, Tse-tung. (1960). The May Fourth Movement. Stanford: Stanford University Press, (Chapter 1, Chapter 14).
- Spence, J. (1999). The Search for Modern China. New York: W.W. Norton, (Chapters 11 and 13).
- Shinkichi, E. and H. Z. Schiffrin, (Ed.). (1984). The 1911 Revolution in China: Interpretive Essays. Tokyo: University of Tokyo Press, pp. 3-13.

Unit IV: This unit examines the emergence of Communism in China, the relations between the CCP and the KMT (Nationalist Party) and the evolution of the distinctive traits of Maoist Strategies of Revolution. **(Teaching Time: 12 hrs. approx.)**

- Bianco, L. (1967). Origins of the Chinese Revolution 1915-1949. Stanford: Stanford University Press, (Chapter 3 -4).
- Fairbank, J.K. (1987). The Great Chinese Revolution 1800-1985, Part Three. London: Chatto and Windus, (Chapters 12-14).
- Harrison, J.P. (1972). The Long March to Power: A History of the Chinese Communist Party, 1921- 1972, London: Macmillan, (Chapter 2-3 & Chapter 9).
- Isaacs, H. (1961). The Tragedy of the Chinese Revolution. Stanford: Stanford University Press, (Preface, Chapters 1-4 & Chapter 18).
- Johnson, Chalmers A. (1962). Peasant Nationalism and Communist Power: The Emergence of Revolutionary China, 1937-1945. Stanford: Stanford University Press, (Chapter I).
- Selden, M. (1971). The Yen-an Way in Revolutionary China. Cambridge: Harvard University Press, (Chapter 1 & Chapter 6).
- Sheridan, J.E. (1975). China in Disintegration: The Republican Era in Chinese History 1912-1949. London: Free Press, Collier Macmillan Publishers, (Chapter 4).
- Snow, E. (1937). Red Star over China, Part Three. London: Victor Gollancz, (Chapter 2).
- Spence, J. (1999). The Search for Modern China. New York: W.W. Norton, (Chapter 16).
- Vohra, Ranbir. (1987). China's Path to Modernization: A Historical Review From 1800 to the Present. Englewood: New Jersey.: Prentice Hall.
- Waller, D. Kiangsi Soviets Republic: Mao and the National Congress of 1931 and 1934. Berkeley: University of California Press.

Suggested Readings:

PROSPECTING E-WASTE FOR SUSTAINABILITY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Prospecting E-Waste for Sustainability	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide in-depth knowledge on the effective mechanisms to regulate the generation, collection, and storage of e-waste
- To gain insights into the internationally/nationally acceptable methods of transport, import, and export of e-waste within and between countries
- To develop a holistic view on recycling, treatment, and disposal of e-waste and related legislative rules.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to holistically analyze the environmental impacts of e-waste
- After studying this course, students will be able to apply the skills and various concepts for sustainable management of e-waste
- After studying this course, students will be able to decipher the role of various national and international regulations for e-waste management
- After studying this course, students will be able to provide specific recommendations for improved methods for handling e-waste at different stages such as generation, collection, storage, transport, and recycling

SYLLABUS

Practical/Hands-on Exercises

(02 Credits: 60 hours)

1. Identification of e-waste and its types
2. Composition of e-waste and segregation- from the material provided
3. Dismantling of e-waste and handling process
4. Visit a nearby e-waste handling facility
5. Environmental protection laws and producer's responsibility for e-waste management
6. Build an understanding of how regulatory mechanisms can be utilized in the management of e-waste in educational institutions.
7. Discussion on plausible ways and implementation of e-waste reduction from the source
8. Evaluation of the status of e-waste handling at your institution and suggest practical solutions as per the existing norms of E-Waste (Management) Rules, 2016 and beyond.

9. Estimate how recycling of e-waste in metro cities will go in sync with the circular economy
10. Develop an understanding and itinerary of the process for procuring e-waste import permissions.
11. Inventory of the e-waste disposal mechanisms.
12. Study the evolution of e-waste management rules and its implementation- Hazardous Waste Rules, 2008, E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016
13. Study the international laws on e-waste management- the international legislations: The Basel Convention; The Bamako Convention; The Rotterdam Convention; Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union; Restrictions of Hazardous Substances (RoHS) Directive

Teaching and learning interface for practical skills:

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective sector(s):

- Electric and electronic industries,
- E-waste Recycling Unites,
- Private entrepreneurs,
- Environmental consultancies,
- Pollution Boards, and
- Environmental NGOs

Suggested Readings:

- Hester, R.E. and Harrison, R.M., 2009. Electronic Waste Management: Design. Analysis and Application. Royal Society of Chemistry Publishing. Cambridge, UK.
- Fowler, B.A., 2017. Electronic Waste: Toxicology and Public Health Issues. Academic Press.
- Gaidajis, G., Angelakoglou, K. and Aktsoglou, D., 2010. E-waste: environmental problems and current management. Journal of Engineering Science and Technology Review, 3(1), pp.193-199.
- Janyasuthiwong, S., 2020. Metal Removal and Recovery from Mining Wastewater and E-waste Leachate. CRC Press.

Examination scheme and mode:

Evaluation scheme and mode II be as per the guidelines notified by the University of Delhi.

SEC V

Popular Culture

Course Objective:

One of the purposes of learning History is to be able to evolve a critical lens with which one can make sense of one's immediate and lived experience. Popular culture happens to be a major component of that experience, surrounding us at all times, particularly since it is easy to access. This course aims to provide students with a critical understanding of popular culture. One of the objectives of the course is to help the student attempt to define popular culture through a study of the complex theoretical discussion on the subject. This theoretical engagement is expected to enable learners to comprehend various aspects of popular culture both in non-Indian and Indian contexts focussing particularly on themes pertaining to religion, performative traditions, food cultures as well as the constitution of a 'new public' with regard to its patterns of consumption of culture, in contemporary times.

Learning Outcomes:

Upon successful completion of course students will be able to:

- Engage with a range of theoretical perspectives in an attempt to define popular culture,
- Describe the methodological issues involved in a historical study of popular culture,
- Identify the relevant archives necessary for undertaking a study of popular culture, while pointing out the problems with conventional archives and the need to move beyond it,
- Interpret the above theoretical concerns to actual historical studies, through a case study,
- Estimate the popular aspects of everyday experience of religion and religiosity, through a wide range of case studies relating to festivals and rituals, healing practices as well as pilgrimage and pilgrim practices,
- Examine the role of orality and memory in popular literary traditions,
- Demonstrate the evolution of theatre and dance within the popular performative traditions,
- Analyse the role of technology in the transformation of music from elite to popular forms,
- Examine the relationship between recipes/recipe books and the construction of national/regional identities,
- Identify the history of the cultures of food consumption and its relationship with the constitution of a modern bourgeoisie,
- Examine the process of emergence of a pattern of 'public consumption' of culture in contemporary times, with specific reference to art, media and cinema

Course Content:

Unit I: Understanding Popular Culture: Some Issues

- [a] Defining Popular Culture : Popular Culture as Folk Culture, Mass Culture, as the 'other' of High Culture, People's culture, etc.
- [b] Popular Culture and History: The Historian and the archives
- [c] Popular Culture in Early Modern Europe or the City of Mumbai

Unit II: Some Aspects of Popular Culture in India

(Students should choose any three from the four rubrics [a] – [d] mentioned below)

- [a] Religion and everyday practice
 - (i) Festivals and Rituals: Case studies of Navaratri in Madras / Urs in Ajmer / Kumbh Mela
 - (ii) Everyday healing and petitioning the divine: Case studies of Jinns in Delhi / Popular Hinduism / Tantric practices
 - (iii) Sacred Geographies, Sacred Spaces: Pilgrimage and pilgrim practices
- [b] Performative Traditions
 - (i) Orality, Memory and the Popular: Case studies of women's Ramayanas in the oral tradition Andhra/ Rajasthan
 - (ii) Theatre and Dance:
 - (iii) Music: Popular music and Technology; Case studies of Devotional music / the Ghazal and the Cassette
- [c] Food Cultures
 - (i) Recipes and the national project: Popular recipe books
 - (ii) Food and Public Cultures of Eating: Udipi Hotels, Dum Pukht, South Asian food in a global world
 - (iii) Cultures of Consumption: Tea-Coffee and the Indian Middle Class
- [d] Making of a new 'Public'
 - (i) Popular Art: Imagining the nation in Calendar art
 - (ii) Print media: Amar Chitra Katha
 - (iii) Cinema: Constructing Family, Gender and Marriage through popular cinema

ESSENTIAL READINGS AND UNIT-WISE TEACHING OUTCOMES:

Unit I: This unit introduces students to various theoretical dimensions of popular culture coming through more abstract readings on the subject culled from early modern European and contemporary Indian history. This will establish the foundations on the basis of which the student can focus on more detailed case studies of popular culture in the second rubric. **(Teaching Time: 5 weeks approx.)**

- Storey, John. (1996). *Cultural Studies and the Study of Popular Culture: Theories and Methods*. Edinburgh: Edinburgh University Press.
- Groot, Jerome de. (2009). *Consuming History: Historians and heritage in contemporary popular culture*. London: Routledge
- Jain, Jyotindra. (2007). *India's Popular Culture: Iconic Spaces and Fluid Images*. Marg Publications. vol. 59 no.2, pp. 6-31, 60-75, 90-113.
- Burke, Peter. (2009). *Popular Culture in Early Modern Europe*. Surrey: Ashgate, pp. 23-132.

or

- Prakash, Gyan. (2010). *Bombay Fables*. Delhi: Harper Collins, pp. 75-156.

Unit II: This rubric introduces students to different aspects of popular culture through precise case studies. These will cover subjects like popular festivals, religious practices, oral traditions, recorded music, recipe books, popular restaurants, consumption of tea/coffee, calendar art, comics and TV serials. Students are required to choose readings to correlate with their three choices from the four available. **(Teaching Time: 11 weeks approx.)**

- Hancock, Mary Elizabeth. (2018). *Womanhood in the Making: Domestic Ritual and Public Culture in Urban South India*. New York: Routledge.
- Kakkar, Sudhir. (1991). *Shamans, Mystics and Doctors: A Psychological Inquiry into India and its Healing Traditions*. Chicago: University of Chicago Press.
- Taneja, Anand Vivek. (2018). *Jinnealogy: Time, Islam and Ecological Thought in the Medieval Ruins of Delhi*. Stanford: Stanford University Press.
- Mohammad, Afsar. (2013). *The Festival of Pirs: Popular Islam and Shared Devotion in South India*. Delhi: Oxford University Press.
- Waghorne, Joanne Punzo. (2004). *Diaspora of Gods: Modern Hindu Temples in an Urban Middle Class World*, Delhi: Oxford University Press.
- Henn, Alexander. (2014). *Hindu-Catholic Engagements in Goa: Religion, Colonialism and Modernity*. Delhi: Orient BlackSwan, pp. 126-168.
- Rao, Velcheru Narayana. (2016). *Text and Tradition in South India*. Delhi: Permanent Black. (The section on "A Ramayana of their Own", pp. 240-69).
- Bharucha, Rustam. (2003). *Rajasthan: An Oral History, Conversations with Komal Kothari*. Delhi: Penguin.
- Rege, Sharmila. (2002). "Conceptualising Popular Culture: Lavani and Powada in Maharashtra". *Economic and Political Weekly* vol. 37 no.11, pp. 1038-1047.
- Oberoi, Patricia. (2006). *Freedom and Destiny: Gender, Daily and Popular Culture in India*. Delhi: Oxford University Press.

- Manuel, Peter. (1993). *The Cassette Culture: Popular Music and technology in North India*. Chicago: University of Chicago Press.
- Appadurai, Arjun. (1988). "How to Make a National Cuisine: Cookbooks in Contemporary India". *Comparative Studies in Society and History* vol. 30 no.1, pp. 3-24.
- Ray, Krishnendu and Tulasi Srinivas (2012). *Curried Cultures: Globalization, Food and South Asia*. Los Angeles: University of California Press.
- Bhadra, Gautam. (2005). *From an Imperial Product to a National Drink: The Culture of Tea Consumption in Modern India*. Kolkata: CSSSC.
- Venkatachalapathy, A. R. (2006). *In Those Days There Was No Coffee: Writings in Cultural History*. Delhi: Yoda Press.
- Oberoi, Patricia. (2006). "Unity in Diversity? Dilemmas of Nationhood in Indian Calendar Art." in Dilip M Menon, (ed.). *Readings in History: Cultural History of Modern India*. Delhi: Social Science Press.
- Ramaswamy, Sumathi. (2001). "Maps and Mother Goddesses in Modern India." *Imago Mundi* vol. 53 no.1, pp. 97-114.
- Jain, Kajri. (2007). *Gods in the Bazaar: The Economies of Indian Calendar Art*. London: Duke University Press.
- Chandra, Nandini. (2008). *The Classic Popular Amar Chitra Katha, 1967-2007*. Delhi: Yoda Press.
- Aguiar, Marian. (2013). "Arranged Marriage: Cultural Regeneration in Transnational South Asian Popular Culture". *Cultural Critique* vol. 84, pp. 181-213.
- Oberoi, Patricia. (2006). *Freedom and Destiny: Gender Family and Popular Culture in India*. Delhi: Oxford University Press.

Online Resources:

- Students should use the online resources from the project entitled "Visual Pilgrim Project: Mapping Popular Visuality and Devotional Media at Sufi Shrines and Other Islamic Institutions in South Asia":
- Abeer Gupta, The Visual and Material Culture of Islam in Ladakh
- Amit Madheshiya and Shirley Abraham, Syncretic posters at the Sailani baba shrine in Maharashtra: Exploring portability of religious iconography through networks of circulation
- Snehi, Yogesh. (2013). "Replicating Memory, Creating Images: Pirs and Darghas in Popular Art and Media of Contemporary Punjab". *South Asia's Islamic Shrines and Transcultural Visuality* (online journal).
- Torsten Tschacher, 'You have to Grant Your Vision': Ideas and Practices of Visuality in Popular Muslim Art in Tamil Nadu

Teaching Learning Process:

Classroom lectures on the key concepts, case studies and important arguments/debates reflected in the course readings. Classroom lectures shall be combined with group discussions on specific readings and presentations stemming from field work. Overall, the Teaching Learning Process shall be geared towards closely linking essential theoretical assessments with active practical work, i.e. the practical/application aspect of historical analysis. Moreover, the process shall work towards providing basic exposure to related fields of studies connected to the discipline history and to avenues of interdisciplinary postgraduate studies.

Assessment Methods:

Students will be regularly assessed for their grasp on themes through debates and discussions covered in class. One written assignment and one presentation of the report prepared by students individually or in a moderate sized group will be used for final grading of the students.

Internal Assessment: 25 Marks

Written Exam: 75 Marks

Total: 100 Marks

Keywords: Definitions of popular culture, History, contemporary Mumbai, Festivals, Navratri, Urs, Jinns, Pilgrimage, Oral traditions, Cassettes, Devotional music, recipe books, Udupi restaurants, Dum Pukht food, Tea and Coffee, Calendar Art, Amar Chitra Katha, Popular television and cinema.

Value Addition Course
CULTURE AND COMMUNICATION

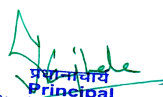
Course Title and Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the Course
		Lecture	Tutorial	Practical/Practice		
Culture and Communication	02	1	0	1	Pass in Class 12th	NIL

Learning Objectives:

- To focus on traditional values disseminated from Indian cultural heritage.
- To understand the interconnections between the legacy of our past and needs of our contemporary society.
- To learn to adapt, interact and celebrate our diversity and pluralistic culture.
- To develop communication skills in speaking, listening, reading and writing and apply them in our quotidian life as young citizens of contemporary India.
- To integrate ethical values and life skills.

Course Outcomes:

- Students will be able to appreciate the relevance of ancient Indian wisdom and core ethical values in our contemporary life.
- Students will be able to engage in a dialogue between the past and the present and inculcate the best principles towards a meaningful life.
- Students will be encouraged to involve themselves in team work and group activities to address challenges faced in metropolitan cities.
- Students will be able to develop communication skills, that is, analytical reading, empathetic listening, considerate speaking as well as informed writing.
- Extension activities will equip the students, drawn from diverse backgrounds, with life skills and confidence to integrate with a multicultural environment and work towards an inclusive community.
- Students will be encouraged to envisage and work towards an ethically robust society and thereby strengthen the nation.


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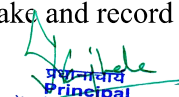
Unit I: Ethical Values from Indian Cultural Heritage • <i>Vasudhaiva Kutumbakam</i> • United We Stand, Divided We Fall • <i>Ek Bharat, Shresht Bharat</i>	3 classes
Unit II: Developing Life Skills • Empathy • Adaptability • Conserving our natural resources • Sharing knowledge resources	4 classes
Unit III: Effective Communication in Everyday Life • empathetic listening • considerate speaking • analytical reading • informed writing	8 classes

Practical/ Practice Component

(15 sessions of 2 hours each= 30 hours)

As hands-on experience is an essential component of the course, this section will focus on the practical aspects to correlate with the fundamental principles and learnings of the theory portion. Students will be encouraged to use the communication tools learnt through Unit 3 and corroborate the continuities of core principles studied in Unit 1 and 2.

- Students will be asked to conduct surveys/interviews in their neighbourhood or commuting routes to assess the nature and quality of negotiating our cultural diversity and pluralist traditions.
- Students would be assigned visits to old-age homes, hospitals, cancer wards, etc. to interact and write about their experiences with old people, caregivers, patients, nursing staff, helpers, etc.
- They will also be assigned visits to historically important places and monuments within the city and also converse with the tourists in order to trace a comprehensive view of the rich cultural history of India. They may create video documentaries, take and record


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tourists' interviews and/or write a journal entry of the visit using the communication skills learnt.

- Students shall make group presentations or individual reports on the activities undertaken. Discussions with classmates and the teacher shall be undertaken to evolve clarity of vision on the ethical values and effective communication skills learned through this course.

ESSENTIAL READINGS:

- Ramanujan, A.K. 'A Flowering Tree', *Cultural Diversity, Linguistic Plurality & Literary Traditions in India*. Department of English, OUP, 2015. pp 125-138
- Haksar, A. N. D. 'Chanakya Niti Shastra', *Chanakya Niti*. India, Penguin Random House India Private Limited, 2020.
- Dhanavel. S.P. *English and Soft Skills*. Orient Black Swan, 2010.
- Murthy, Sudha. 'The Nobel Prize', *Wise & Otherwise*. India, Penguin Random House India Private Limited, 2006.
- Murthy, Sudha. 'How to Beat the Boys', *Three Thousand Stitches: Ordinary People, Extraordinary Lives*. Penguin Books, 2017.
- Soyinka, Wole. 'Telephone Conversations', *The Individual and Society*, Department of English, Pearson Education, 2006. pp 122-23
- Bansode, Hira. 'Bosom Friend', *The Individual and Society*, Department of English, Pearson Education, 2006. pp 49-50

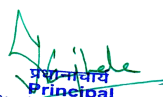
Assessment Methods*

Internal Assessment: 25%

End Semester Theory Exam: 25%

Practical: 50%

*Subject to directions from the Examination Branch/University of Delhi from time to time


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DISCIPLINE SPECIFIC CORE COURSE– 9: DISCRETE MATHEMATICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Discrete Mathematics	4	3	0	1	Class XII pass with Mathematics	Algebra and Linear Algebra

Learning Objectives

The primary objective of the course is to:

- Make students embark upon a journey of enlightenment, starting from the abstract concepts in mathematics to practical applications of those concepts in real life.
- Make the students familiar with the notion of partially ordered set and a level up with the study of lattice, Boolean algebra and related concepts.
- Culminate the journey of learning with practical applications using the knowledge attained from the abstract concepts learnt in the course.

Learning Outcomes

This course will enable the students to:

- Understand the notion of partially ordered set, lattice, Boolean algebra with applications.
- Handle the practical aspect of minimization of switching circuits to a great extent with the methods discussed in this course.
- Apply the knowledge of Boolean algebras to logic, set theory and probability theory.

SYLLABUS OF DSC - 9

Unit – 1 (15 hours)

Cardinality and Partially Ordered Sets

The cardinality of a set; Definitions, examples and basic properties of partially ordered sets, Order-isomorphisms, Covering relations, Hasse diagrams, Dual of an ordered set, Duality principle, Bottom and top elements, Maximal and minimal elements, Zorn's lemma, Building new ordered sets, Maps between ordered sets.

Unit – 2 (15 hours)

Lattices

Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products, Lattice isomorphism; Definitions, examples and properties of modular and distributive lattices; The $M_3 - N_5$ theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice.

Unit – 3 (15 hours)

Boolean Algebras and Applications

Boolean algebras, De Morgan's laws, Boolean homomorphism, Representation theorem, Boolean polynomials, Boolean polynomial functions, Equivalence of Boolean polynomials, Disjunctive normal form and conjunctive normal form of Boolean polynomials; Minimal forms

of Boolean polynomials, Quine-McCluskey method, Karnaugh diagrams, Switching circuits and applications, Applications of Boolean algebras to logic, set theory and probability theory.

Practical (30 hours):

Practical/Lab work to be performed in a computer Lab using any of the Computer Algebra System Software such as Mathematica/MATLAB /Maple/Maxima/Scilab/SageMath etc., for the following problems based on:

- 1) Expressing relations as ordered pairs and creating relations.
- 2) Finding whether or not, a given relation is:
 - i. Reflexive
 - ii. Antisymmetric
 - iii. Transitive
 - iv. Partial order
- 3) Finding the following for a given partially ordered set
 - i. Covering relations.
 - ii. The corresponding Hasse diagram representation.
 - iii. Minimal and maximal elements.
- 4) Finding the following for a subset S of a given partially ordered set P
 - i. Whether a given element in P is an upper bound (lower bound) of S or not.
 - ii. Set of all upper bounds (lower bounds) of S .
 - iii. The least upper bound (greatest lower bound) of S , if it exists.
- 5) Creating lattices and determining whether or not, a given partially ordered set is a lattice.
- 6) Finding the following for a given Boolean polynomial function:
 - i. Representation of Boolean polynomial function and finding its value when the Boolean variables in it take particular values over the Boolean algebra $\{0,1\}$.
 - ii. Display in table form of all possible values of Boolean polynomial function over the Boolean algebra $\{0,1\}$.
- 7) Finding the following:
 - i. Dual of a given Boolean polynomial/expression.
 - ii. Whether or not two given Boolean polynomials are equivalent.
 - iii. Disjunctive normal form (Conjunctive normal form) from a given Boolean expression.
 - iv. Disjunctive normal form (Conjunctive normal form) when the given Boolean polynomial function is expressed by a table of values.
- 8) Representing a given circuit diagram (expressed using gates) in the form of Boolean expression.
- 9) Minimizing a given Boolean expression to find minimal expressions.

Essential Readings

1. Davey, B. A., & Priestley, H. A. (2002). Introduction to Lattices and Order (2nd ed.). Cambridge University press, Cambridge.
2. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). Applied Abstract Algebra (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

Suggested Readings

- Donnellan, Thomas. (1999). Lattice Theory (1st ed.). Khosla Pub. House. Indian Reprint.
- Rosen, Kenneth H. (2019). Discrete Mathematics and its Applications (8th ed.), Indian adaptation by Kamala Krithivasan. McGraw-Hill Education. Indian Reprint 2021.

- Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion.
- Understand the maximization and minimization of multivariable functions subject to the given constraints on variables.
- Learn about inter-relationship amongst the line integral, double, and triple integral formulations.
- Familiarize with Green's, Stokes' and Gauss divergence theorems, and learn applications.

SYLLABUS OF DSC-11

UNIT – I: Calculus of Functions of Several Variables (18 hours)

Basic concepts, Limits and continuity, Partial derivatives, Tangent planes, Total differential, Differentiability, Chain rules, Directional derivatives and the gradient, Extrema of functions of two variables, Method of Lagrange multipliers with one constraint.

UNIT – II: Double and Triple Integrals (15 hours)

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integrals over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals.

UNIT – III: Green's, Stokes' and Gauss Divergence Theorem (12 hours)

Vector field, Divergence and curl, Line integrals and applications to mass and work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, Gauss divergence theorem.

Essential Reading

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. Pearson Education. Indian Reprint.

Suggestive Reading

- Marsden, J. E., Tromba, A., & Weinstein, A. (2004). Basic Multivariable Calculus. Springer (SIE). Indian Reprint.

DISCIPLINE SPECIFIC CORE COURSE – 12: NUMERICAL ANALYSIS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Numerical Analysis	4	3	0	1	Class XII pass with Mathematics	DSC-2: Real Analysis DSC-3: Vector Calculus Sri Venkateswara College दिल्ली विश्वविद्यालय वीसा कुआं, नई दिल्ली / Dhula Kuan, New Delhi-21

Learning Objectives: The main objective of this course is to introduce:

- Various computational techniques to find approximate value for possible root(s) of algebraic and non-algebraic equations.
- Methods to solve system of linear equations and ordinary differential equations.
- The use of computer algebra system (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem-solving skills.

Learning Outcomes: This course will enable the students to:

- Learn some numerical methods to find the zeroes of nonlinear functions of a single variable, up to a certain given level of precision.
- Learn Gauss–Jacobi, Gauss–Seidel methods to solve system of linear equations.
- Get aware of using interpolation techniques, for example in finding values of a tabulated function at points which are not part of the table.
- Learn finding numerical solutions of difference equations which are obtained converting differential equations using techniques from calculus.

SYLLABUS OF DSC-12

UNIT – I: Methods for Solving Algebraic and Transcendental Equations (12 hours)

Rate and order of convergence; Bisection method, Method of false position, Fixed point iteration method, Newton's method, and Secant method, their order of convergence and convergence analysis.

UNIT – II: Techniques to Solve Linear Systems and Interpolation (15 hours)

LU decomposition and its applications; Iterative methods: Gauss–Jacobi, Gauss–Seidel methods; Lagrange and Newton interpolation, Piecewise linear interpolation.

UNIT – III: Numerical Differentiation and Integration (18 hours)

First and higher order approximation for the first derivative, Approximation for the second derivative; Numerical integration by closed Newton–Cotes formulae: Trapezoidal rule, Simpson's rule and its error analysis; Euler's method to solve ODE's, Modified Euler method, Runge–Kutta Method (fourth-order).

Essential Reading

1. Bradie, Brian. (2006). A Friendly Introduction to Numerical Analysis. Pearson Education India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.

Suggestive Readings

- Gerald, Curtis F., & Wheatley, Patrick O. (2007). Applied Numerical Analysis (7th ed.). Pearson Education. India.
- Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). Numerical Methods for Scientific and Engineering Computation. (6th ed.). New Age International Publisher, India, 2016.

Note: Non programmable scientific calculator may be allowed in the University examination.

Practical (30 hours)- Practical / Lab work to be performed in Computer Lab: Use of computer algebra system (CAS) software: Python/SageMath/Mathematica/MATLAB/Maple/Maxima/Scilab etc., for developing the following numerical programs:

1. Bisection method.

2. Newton-Raphson method.
3. Secant method.
4. LU decomposition method.
5. Gauss–Jacobi method.
6. Gauss–Seidel method.
7. Lagrange interpolation.
8. Newton interpolation.
9. Trapezoidal rule.
10. Simpson's rule.
11. Euler's method.
12. Runge–Kutta Method (fourth-order).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

3. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). *Elementary Analysis: The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Suggestive Readings

- Apostol, T. M. (2007). *Calculus: One-Variable Calculus with an Introduction to Linear Algebra* (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ghorpade, Sudhir R. & Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*. Undergraduate Texts in Mathematics, Springer (SIE). Indian reprint.

DISCIPLINE SPECIFIC CORE COURSE – 6: ORDINARY DIFFERENTIAL EQUATIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ordinary Differential Equations	4	3	0	1	Class XII pass with Mathematics	NIL

Learning Objectives: The main objective of this course is to introduce the students:

- The exciting world of differential equations.
- Their applications and mathematical modeling.

Learning Outcomes: The course will enable the students to:

- Learn the basics of differential equations and compartmental models.
- Formulate differential equations for various mathematical models.
- Solve first order non-linear differential equations, linear differential equations of higher order and system of linear differential equations using various techniques.
- Apply these techniques to solve and analyze various mathematical models.

SYLLABUS OF DSC-6

UNIT – I: First-Order Differential Equations (12 hours)

Concept of implicit, general and singular solutions for the first order ordinary differential equation; Bernoulli's equation, Exact equations, Integrating factors, Initial value problems, Reducible second order differential equations; Applications of first order differential equations to Newton's law of cooling, exponential growth and decay problems.

UNIT – II: Second and Higher-Order Differential Equations

(18 hours)

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General solution of homogenous equation of second order, Principle of superposition for a homogenous equation, Wronskian and its properties, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Method of variation of parameters, Method of undetermined coefficients, Two-point boundary value problems, Cauchy- Euler's equation, System of linear differential equations, Application of second order differential equation: Simple pendulum problem.

UNIT – III: Formulation and Analysis of Mathematical Models (15 hours)

Introduction to compartmental models, Lake pollution model; Density-dependent growth model, Interacting population models, Epidemic model of influenza and its analysis, Predator-prey model and its analysis, Equilibrium points, Interpretation of phase plane

Practical (30 hours)- Practical / Lab work to be performed in a Computer Lab:

Modeling of the following problems using SageMath/Mathematica/MATLAB/Maple/Maxima/Scilab etc.

1. Solutions of first, second and third order differential equations.
2. Plotting of family of solutions of differential equations of first, second and third order.
3. Solution of differential equations using method of variation of parameters.
4. Growth and decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Density-dependent growth model.
7. Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two prey one predator).
8. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

Essential Readings

1. Barnes, Belinda & Fulford, Glenn R. (2015). *Mathematical Modeling with Case Studies, Using Maple and MATLAB* (3rd ed.). CRC Press. Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equations and Boundary Value Problems: Computing and Modeling* (5th ed.). Pearson Education.
3. Ross, Shepley L. (2014). *Differential Equations* (3rd ed.). Wiley India Pvt. Ltd.

Suggestive Reading

- Simmons, George F. (2017). *Differential Equations with Applications and Historical Notes* (3rd ed.). CRC Press. Taylor & Francis Group.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 3: PROBABILITY AND STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Probability and Statistics	4	3	0	1	Class XII pass with Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness.
- To render the students to several examples and exercises that blend their everyday experiences with their scientific interests to form the basis of data science.

Learning Outcomes

This course will enable the students to:

- Understand some basic concepts and terminology - population, sample, descriptive and inferential statistics including stem-and-leaf plots, dotplots, histograms and boxplots.
- Learn about probability density functions and various univariate distributions such as binomial, hypergeometric, negative binomial, Poisson, normal, exponential and lognormal.
- Understand the remarkable fact that the empirical frequencies of so many natural populations, exhibit bell-shaped (i.e., normal) curves, using the Central Limit Theorem.
- Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.

SYLLABUS OF DSC – 3

Theory

Unit – 1

(15 hours)

Descriptive Statistics, Probability, and Discrete Probability Distributions

Descriptive statistics: Populations, Samples, Stem-and-leaf displays, Dotplots, Histograms, Qualitative data, Measures of location, Measures of variability, Boxplots; Sample spaces and events, Probability axioms and properties, Conditional probability, Bayes' theorem and independent events; Discrete random variables and probability

distributions, Expected values; Probability distributions: Binomial, geometric, hypergeometric, negative binomial, Poisson, and Poisson distribution as a limit.

Unit – 2

(15 hours)

Continuous Probability Distributions

Continuous random variables, Probability density functions, Uniform distribution, Cumulative distribution functions and expected values, The normal, exponential and lognormal distributions.

Unit – 3

(15 hours)

Central Limit Theorem and Regression Analysis

Sampling distribution and standard error of the sample mean, Central Limit Theorem and applications; Scatterplot of bivariate data, Regression line using principle of least squares, Estimation using the regression lines; Sample correlation coefficient and properties.

Practical (30 hours)

Software labs using Microsoft Excel or any other spreadsheet.

- 1) Presentation and analysis of data (univariate and bivariate) by frequency tables, descriptive statistics, stem-and-leaf plots, dotplots, histograms, boxplots, comparative boxplots, and probability plots ([1] Section 4.6).
- 2) Fitting of binomial, Poisson and normal distributions.
- 3) Illustrating the Central Limit Theorem through Excel.
- 4) Fitting of regression line using the principle of least squares.
- 5) Computation of sample correlation coefficient.

Essential Reading

1. Devore, Jay L. (2016). Probability and Statistics for Engineering and the Sciences (9th ed.). Cengage Learning India Private Limited. Delhi. Indian Reprint 2020.

Suggestive Reading

- Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw-Hill Pub. Co. Ltd. Reprinted 2017.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSE-1 (iii): C++ Programming for Mathematics

Total Marks: 150 (Theory: 75 + Internal Assessment: 25 + Practical: 50)

Workload: 4 Lectures (per week), 4 Periods practical (per week per student)

Duration: 14 Weeks (56 Hrs. Theory + 56 Hrs. practical) **Examination:** 3 Hrs.

Course Objectives: This course introduces C++ programming in the idiom and context of mathematics and imparts a starting orientation using available mathematical libraries, and their applications.

Course Learning Outcomes: After completion of this paper, student will be able to:

- i) Understand and apply the programming concepts of C++ which is important to mathematical investigation and problem solving.
- ii) Use mathematical libraries for computational objectives.
- iii) Represent the outputs of programs visually in terms of well formatted text and plots.

Course Contents:

Unit 1: C++ Essentials

(Lectures: 16)

Fundamentals of programming, Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types, Variables and literals in C++, Operators, Expressions, Evaluation precedence, and Type compatibility. Outline of program development in C++, Debugging and testing.

Applications: Greatest common divisor, and Random number generation.

Unit 2: Working with Structured Data

(Lectures: 12)

Structured data-types in C++, Arrays and manipulating data in arrays with applications in factorization of an integer and finding Euler's totient; Objects and classes: Information hiding, Modularity, Constructors and Destructors, Methods and Polymorphism.

Applications: Cartesian geometry using points (2 & 3-dimensional), and Pythagorean triples.

Unit 3: Working with Containers and Templates

(Lectures: 16)

Containers and Template Libraries: Sets, Iterators, Multisets, Vectors, Maps, Lists, Stacks and Queues. Applications: Basic set algebra, Modulo arithmetic, Permutations, and Polynomials.

Unit 4: Using Mathematical Libraries and Packages

(Lectures: 12)

Arbitrary precision arithmetic using the GMP package; Linear algebra: Two-dimensional arrays in C++ with applications in finding Eigenvalues, Eigenvectors, Rank, Nullity, and Solving system of linear equations in matrices. Features of C++ for input/output and visualization: Strings, Streams, Formatting methods, Processing files in a batch, Command-line arguments, Visualization packages and their use in plots.

Reference:

1. Scheinerman, Edward (2006). *C++ for Mathematicians: An Introduction for Students and Professionals*. Chapman & Hall/CRC. Taylor & Francis Group, LLC.

Additional Readings:

1. Dale, Nell & Weems, Chip (2013). *Programming and Problem Solving with C++* (6th ed.). Comprehensive Edition. Jones & Bartlett Learning.
2. Gottschling, Peter (2016). *Discovering Modern C++: An Intensive Course for Scientists, Engineers, and Programmers*. Addison-Wesley. Pearson Education, Inc.
3. Josuttis, Nicolai M. (2012). *The C++ Standard Library: A Tutorial and Reference* (2nd ed.). Addison-Wesley. Pearson Education, Inc.
4. Lippman, Stanley B. (2000). *Essential C++*. Addison-Wesley.
5. Stroustrup, Bjarne (2013). *The C++ Programming Language* (4th ed.). Addison-Wesley.

Practical / Lab work to be performed in Computer Lab:

A: Preparatory (Practical Sessions: 8 Hrs.)

1. Setting up of C++ programming environment on Linux/Windows/Mac-OS; gcc/g++/mingw/cc, Program-development methodology and use IDE's or other tools.
2. Demonstration of sample programs for
 - a. "Hello World"
 - b. Sum of an arithmetic progression.
 - c. Value of $\sin x$ using series expansion.
3. Finding/demonstrating:
 - a. Machine epsilon.
 - b. Integer and float overflow/underflow.
 - c. Iteration and selection based logic.(provide a list of 8-10 problems suitable to learners needs)

B: Evaluative:

Set-I: (Practical Sessions: 8 Hrs.)

1. Greatest common divisor (including Euclid's Method).
2. Random number generation (including a Monte Carlo Program).

Set-II: (Practical Sessions: 12 Hrs.)

1. Factorization of an integer, and Euler's totient.
2. Cartesian geometry using points (2 & 3-dimensional).
3. Pythagorean triples.

Set-III: (Practical Sessions: 16 Hrs.)

1. Basic set algebra.
2. Modulo arithmetic.
3. Permutations.
4. Polynomials.

Set-IV: (Practical Sessions: 12 Hrs.)

1. Arbitrary precision arithmetic using the GMP package.
2. Finding Eigenvalues, Eigenvectors, Rank, Nullity, and Solving system of linear equations in matrices.
3. Plots (using the GNU plotutils package).

Note. *Exception handling in lab-exercises (SET-I to IV), Comments/Documentation using Doxygen may be emphasized.*

Teaching Plan (Theory of DSE-1 (iii) C++ Programming for Mathematics):

Week 1: Fundamentals of programming, Organization of logic flow in stored program model of computation, C++ as a general purpose programming language, Structure of a C++ program, Common compilers and IDE's, Basic data-types.

[1] Chapter 1, and Chapter 2 (Sections 2.1 to 2.3)

Week 2: Variables and literals in C++, Operators, Expressions, Evaluation precedence, and Type compatibility. Outline of program development in C++, Debugging and testing.

[1] Chapter 2 (Sections 2.4 to 2.9)

Weeks 3 and 4: Applications: Greatest common divisor, and Random number generation.

[1] Chapter 3, and Chapter 4

Week 5: Structured data-types in C++, Arrays and manipulating data in arrays.

Applications: Factorization of an integer, and Euler's totient.

[1] Chapter 5 (Sections 5.1 to 5.4)

Weeks 6 and 7: Objects and classes: Information hiding, Modularity, Constructors and Destructors, Methods and Polymorphism. Applications: Cartesian geometry using points (two and three dimensional), and Pythagorean triples.

[1] Chapter 6, and Chapter 7

Weeks 8 and 9: Containers and Template Libraries: Sets, Iterators, Multisets, Vectors, Maps, Lists, Stacks and Queues with applications in basic set algebra.

[1] Chapter 8 [Sections 8.1 to 8.7 (8.7.1 – 8.7.3)]

Weeks 10 and 11: Applications: Modulo arithmetic, Permutations, and Polynomials.

[1] Chapter 9, Chapter 11 (Sections 11.1, and 11.2), and Chapter 12 (Sections 12.1 to 12.3)

Week 12: Arbitrary precision arithmetic using the GMP package; Linear algebra: Two-dimensional arrays in C++ with applications in finding Eigenvalues, Eigenvectors, Rank, Nullity, and Solving system of linear equations in matrices.

[1] Chapter 13 [Sections 13.1, and 13.2 (13.2.1, 13.2.2)]

Weeks 13 and 14: Features of C++ for input/output & visualization: Strings, Streams, Formatting methods, Processing files in a batch, Command-line arguments, Visualization packages and their use in plots.

[1] Chapter 14 [Sections 14.1 to 14.6, and 14.8 (14.8.1-14.8.3)]

- Learn about normal, self-adjoint, and unitary operators and their properties, including the spectral decomposition of a linear operator.
- Find the singular value decomposition of a matrix.

SYLLABUS OF DSC-17

UNIT-I: Dual Spaces, Diagonalizable Operators and Canonical Forms (18 hours)

The change of coordinate matrix; Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Annihilators; Eigenvalues, eigenvectors, eigenspaces and the characteristic polynomial of a linear operator; Diagonalizability, Direct sum of subspaces, Invariant subspaces and the Cayley-Hamilton theorem; The Jordan canonical form and the minimal polynomial of a linear operator.

UNIT-II: Inner Product Spaces and the Adjoint of a Linear Operator (12 hours)

Inner products and norms, Orthonormal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality; Adjoint of a linear operator with applications to least squares approximation and minimal solutions to systems of linear equations.

UNIT-III: Class of Operators and Their Properties (15 hours)

Normal, self-adjoint, unitary and orthogonal operators and their properties; Orthogonal projections and the spectral theorem; Singular value decomposition for matrices.

Essential Reading

1. Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2019). Linear Algebra (5th ed.). Pearson Education India Reprint.

Suggestive Readings

- Hoffman, Kenneth, & Kunze, Ray Alden (1978). Linear Algebra (2nd ed.). Prentice Hall of India Pvt. Limited. Delhi. Pearson Education India Reprint, 2015.
- Lang, Serge (1987). Linear Algebra (3rd ed.). Springer.

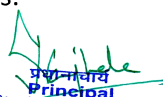
DISCIPLINE SPECIFIC CORE COURSE – 18: COMPLEX ANALYSIS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Complex Analysis	4	3	0	1	Class XII pass with Mathematics	DSC-2 & 11: Real Analysis, Multivariate Calculus

Learning Objectives: The main objective of this course is to:

- Acquaint with the basic ideas of complex analysis.
- Learn complex-valued functions with visualization through relevant practicals.


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 धौला कुआँ, नई दिल्ली / Dhaula Kuan, New Delhi-21

- Emphasize on Cauchy's theorems, series expansions and calculation of residues.

Learning Outcomes: The accomplishment of the course will enable the students to:

- Grasp the significance of differentiability of complex-valued functions leading to the understanding of Cauchy-Riemann equations.
- Study some elementary functions and evaluate the contour integrals.
- Learn the role of Cauchy-Goursat theorem and the Cauchy integral formula.
- Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues, and apply Cauchy Residue theorem to evaluate integrals.

SYLLABUS OF DSC-18

UNIT – I: Analytic and Elementary Functions (15 hours)

Functions of a complex variable and mappings, Limits, Theorems on limits, Limits involving the point at infinity, Continuity and differentiation, Cauchy-Riemann equations and examples, Sufficient conditions for differentiability, Analytic functions and their examples; Exponential, logarithmic, and trigonometric functions.

UNIT – II: Complex Integration (15 hours)

Derivatives of functions, Definite integrals of functions; Contours, Contour integrals and examples, Upper bounds for moduli of contour integrals; Antiderivatives; Cauchy-Goursat theorem; Cauchy integral formula and its extension with consequences; Liouville's theorem and the fundamental theorem of algebra.

UNIT – III: Series and Residues (15 hours)

Taylor and Laurent series with examples; Absolute and uniform convergence of power series, Integration, differentiation and uniqueness of power series; Isolated singular points, Residues, Cauchy's residue theorem, Residue at infinity; Types of isolated singular points, Residues at poles and its examples, An application to evaluate definite integrals involving sines and cosines.

Essential Reading

1. Brown, James Ward, & Churchill, Ruel V. (2014). Complex Variables and Applications (9th ed.). McGraw-Hill Education. Indian Reprint.

Suggestive Readings

- Bak, Joseph & Newman, Donald J. (2010). Complex Analysis (3rd ed.). Undergraduate Texts in Mathematics, Springer.
- Mathews, John H., & Howell, Russell W. (2012). Complex Analysis for Mathematics and Engineering (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition.
- Zills, Dennis G., & Shanahan, Patrick D. (2003). A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers.

Practical (30 hours)- Practical / Lab work to be performed in Computer Lab:

Modeling of the following similar problems using SageMath/Python/Mathematica/Maple/MATLAB/Maxima/ Scilab etc.

Essential Readings

1. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint.
2. Chartrand, Gary, & Zhang, Ping (2012). A First Course in Graph Theory. Dover Publications.

Suggestive Readings

- Bondy, J. A., and Murty, U.S.R. (2008). Graph Theory. Graduate Texts in Mathematics, Springer.
- Diestel, Reinhard (2017). Graph Theory (5th ed.). Graduate Texts in Mathematics, Springer.
- West, Douglas B. (2001). Introduction to Graph Theory (2nd ed.). Prentice Hall. Indian Reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE– 1(ii): MATHEMATICAL PYTHON

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Python	4	3	0	1	Class XII pass with Mathematics	Basic knowledge of Python

Learning Objectives

The Learning Objectives of this course are as follows:

- To be able to model and solve mathematical problems using Python Programs.
- To experience utility of open-source resources for numerical and symbolic mathematical software systems.

Learning Outcomes

This course will enable the students to use Python:

- For numerical and symbolic computation in mathematical problems from calculus, algebra, and geometry.
- To tabulate and plot diverse graphs of functions and understand tracing of shapes, geometries, and fractals.
- To prepare smart documents with LaTeX interface.

SYLLABUS OF DSE - 1(ii)

Theory

Unit – 1

(15 hours)

Drawing Shapes, Graphing and Visualization

Drawing diverse shapes using code and Turtle; Using matplotlib and NumPy for data organization, Structuring and plotting lines, bars, markers, contours and fields, managing subplots and axes; Pyplot and subplots, Animations of decay, Bayes update, Random walk.

Unit – 2

(18 hours)

Numerical and Symbolic Solutions of Mathematical Problems

NumPy for scalars and linear algebra on n -dimensional arrays; Computing eigenspace, Solving dynamical systems on coupled ordinary differential equations, Functional programming fundamentals using NumPy; Symbolic computation and SymPy: Differentiation and integration of functions, Limits, Solution of ordinary differential equations, Computation of eigenvalues, Solution of expressions at multiple points (lambdify), Simplification of expressions, Factorization, Collecting and canceling terms, Partial fraction decomposition, Trigonometric simplification, Exponential and logarithms, Series expansion and finite differences, Solvers, Recursive equations.

Unit – 3

(12 hours)

Document Generation with Python and LaTeX

Pretty printing using SymPy; Pandas API for IO tools: interfacing Python with text/csv, HTML, LaTeX, XML, MSEXcel, OpenDocument, and other such formats; Pylatex and writing document files from Python with auto-computed values, Plots and visualizations.

Practical (30 hours): Software labs using IDE such as Spyder and Python Libraries.

- Installation, update, and maintenance of code, troubleshooting.
- Implementation of all methods learned in theory.
- Explore and explain API level integration and working of two problems with standard Python code.

Essential Readings

1. Farrell, Peter (2019). Math Adventures with Python. No Starch Press. ISBN Number: 978-1-59327-867-0.
2. Farrell, Peter and et al. (2020). The Statistics and Calculus with Python Workshop. Packet Publishing Ltd. ISBN: 978-1-80020-976-3.
3. Saha, Amit (2015). Doing Math with Python. No Starch Press. ISBN: 978-1-59327-640-9

Suggested Readings

- Morley, Sam (2022). Applying Math with Python (2nd ed.). Packet Publishing Ltd. ISBN: 978-1-80461-837-0
- Online resources and documentation on the libraries, such as:
 - <https://matplotlib.org>
 - <https://sympy.org>
 - <https://pandas.pydata.org>
 - <https://numpy.org>
 - <https://pypi.org>
 - <https://patrickwalls.github.io/mathematicalpython/>

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Semester-VI
Skill Enhancement Paper
SEC-4: Statistical Software: R

Total Marks: 100 (Theory: 38, Internal Assessment: 12, and Practical: 50)

Workload: 2 Lectures, 4 Practicals (per week) **Credits:** 4 (2+2)

Duration: 14 Weeks (28 Hrs. Theory + 56 Hrs. Practical) **Examination:** 2 Hrs.

Course Objectives: The purpose of this course is to help you begin using **R**, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes: This course will enable the students to:

- i) Be familiar with **R** syntax and use **R** as a calculator.
- ii) Understand the concepts of objects, vectors and data types.
- iii) Know about summary commands and summary table in **R**.
- iv) Visualize distribution of data in **R** and learn about normality test.
- v) Plot various graphs and charts using **R**.

Unit 1: Getting Started with R - The Statistical Programming Language

Introducing **R**, using **R** as a calculator; Explore data and relationships in **R**; Reading and getting data into **R**: combine and scan commands, viewing named objects and removing objects from **R**, Types and structures of data items with their properties, Working with history commands, Saving work in **R**; Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions.

Unit 2: Descriptive Statistics and Tabulation

Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables.

Unit 3: Distribution of Data

Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro–Wilk test for normality, The Kolmogorov–Smirnov test.

Unit 4: Graphical Analysis with R

Plotting in **R**: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.

References:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Gardener, M. (2012). *Beginning R: The Statistical Programming Language*, Wiley Publications.

Additional Reading:

- i. Verzani, John (2014). *Using R for Introductory Statistics* (2nd ed.). CRC Press, Taylor & Francis Group.

Practicals to be done in the Computer Lab using Statistical Software R:

[1] Chapter 14 (Exercises 1 to 3). [2] Relevant exercises of Chapters 2 to 5, and 7.

Note: The practical may be done on the database to be downloaded from <https://data.gov.in/>

Teaching Plan (Theory of SEC-4: Statistical Software: R):

Weeks 1 to 3: Introducing R, using R as a calculator; Explore data and relationships in R, Reading and getting data into R: Combine and scan commands, viewing named objects and removing objects from R, Types and structures of data items with their properties, Working with history commands, Saving work in R.

[1] Chapter 14 (Sections 14.1 to 14.4).

[2] Chapter 2.

Weeks 4 and 5: Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions.

[2] Chapter 3.

Weeks 6 to 8: Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables.

[2] Chapter 4.

Weeks 9 to 11: Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro–Wilk test for normality, The Kolmogorov-Smirnov test.

[2] Chapter 5.

Weeks 12 to 14: Plotting in R: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.

[1] Chapter 14 (Section 14.7).

[2] Chapter 7.

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Be familiar with R syntax and use R as a calculator. Understand the concepts of objects, vectors and data types.	(i) Topics to be explained with illustrations using R software. (ii) Students to be given homework/assignments. (iii) Students to be encouraged to look for new applications.	• Presentations and participation in discussions. • Assignments and class tests. • Mid-term examinations. • Practical examinations. • End-term examinations.
2.	Know about summary commands and summary table in R.		
3.	Visualize distribution of data in R and learn about normality test.		
4.	Plot various graphs and charts using R.		

Keywords: Objects, Vectors, Data types, Summary commands, Shapiro–Wilk test, Bar charts.

VAC 1: FIT INDIA

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fit India	02	0	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Encourage physical activity through engaging the students in sports and yoga.
- Understand the importance of a balanced diet .
- Build skills for self-discipline, self-confidence, cooperation and teamwork.
- Promote fitness as a joyful activity

Learning outcomes

The Learning Outcomes of this course are as follows:

- Adopting a healthy lifestyle.
- Knowledge of nutrition, diet and psycho-physiological aspects of fitness.
- Develop Self-esteem, Self-confidence, Self-discipline and team spirit as indicators of fitness.

SYLLABUS OF FIT INDIA

ONLY PRACTICAL

Note: Concepts are to be taken up during the practical/practice hours.

Practical component (if any) –

(15 Weeks)

UNIT – I Participation in Physical Activity

(4 Weeks)

- Fit India Protocol

- Physical Activity, Health and Fitness
- Indicators of Fitness

Practical/Practice

- Aerobic Work Out / Physical Activity (Walking)
- Yoga – Asanas (Lying, Sitting and Standing positions) and Pranayama
- Cardiovascular Testing by 12min/9 min Cooper Run/Walk test

UNIT – II Health Related Fitness and their Components

(4 Weeks)

- Muscular Strength and Endurance
- Body Composition and Flexibility

Practical/Practice

- Flexibility Training: Back Saver Sit and Reach test
- Muscular Strength Training: Curl Ups / Standing Broad Jump/ Vertical Jump/ Plyometric
- Endurance Training: 1 Mile RockPort Test or 12 /9 minute Cooper run/walk test.
- Ideal Body Weight, Body Mass Index (BMI), Waist-Hip Ratio, Waist-Height Ratio (Data of at least 10 persons to be collected)

UNIT – III Nutrition and Fitness

(4 Weeks)

- Healthy Eating Plate
- Balanced Diet
- Caloric Content of Food

Practical/Practice

- Preparing Daily Diet and Calorie Chart
- Aerobic Work Out / Physical Activity (Walking)
- Assessment of Physical Activity with the Calorie intake.
- Asanas for digestive system excretory system

UNIT – IV Sports Physiology and Psychology

(3 Weeks)

- Depression, Anxiety and Stress Scale (DASS)
- Rosenberg Self Esteem Scale

Practical/Practice

- Skills learning and Participation in sports
- Group Games / Relays/ Minor Games
- Meditative Asanas and Pranayama
- Fitness component testing (as per Fit India Protocol and Norms) and Analysis of Results
- Data of at least 10 persons to be collected on DASS and self-esteem scale

Essential/recommended readings

- Fit India Website: <https://fitindia.gov.in>
- Wener W.K. Hoeger, Sharon
- A. Hoeger - Fitness and Wellness-Cengage Learning (2014).

Suggested readings

- Charles B. Corbin, Gregory J Welk, William R Corbin, Karen A Welk - Concepts of Fitness And Wellness_ A Comprehensive Lifestyle Approach-McGraw-Hill (2015)
- W.Larry Kenney, Jack H. Wilmore, Devid L.Costil(2015). Physiology of Sports and Exercise, Second Edition. USA. Human Kinetics.
- Websites of International Sports Federations
- Website of Ministry of Youth Affairs and Sports

 **Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time**

LaTeX TYPESETTING FOR BEGINNERS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LaTeX Typesetting for Beginners	2	0	0	2	Class XII	NIL

Learning Objectives: The objective of this course is to introduce:

- LaTeX, a high-quality open-source typesetting software that produces professional prints and PDF files for research articles and books in all subjects, and languages.
- Typesetting in Indian languages using LaTeX by transliteration and ITRANS packages.

Learning Outcomes: After completion of the course the learner will be able to:

- Prepare a LaTeX document with title page including contents, references, and index.
- Understand the Indian language transliteration package (ITRANS-processor) for typesetting Sanskrit, Hindi, Punjabi, Malayalam, etc. using LaTeX.

UNIT-I: Getting Started with LaTeX

(24 hours)

Installing and using LaTeX for creating a first LaTeX document; Formatting text and understanding LaTeX commands and environments; Designing pages, Creating a book with chapters and table of contents, Creating and customizing lists, Including images, and creating tables with captions.

UNIT-II: Cross-References, Index, Bibliography and Large Documents

(16 hours)

Setting labels and references, Hyperlinks; Customizing the table of contents, Generating an index, Creating a bibliography; Writing basic math formulas and equations; Developing large documents by splitting the input and creating front/back matter.

UNIT-III: Typesetting in Indian Languages using LaTeX

(20 hours)

Transliteration symbols with illustrative examples of the Indian languages, such as Sanskrit, Hindi (Devanagari), Punjabi, and Malayalam; Creation of the transliterated document for typesetting in Devanagari (for Sanskrit, Hindi, and Marathi), Gurumukhi (for Punjabi), and Rachana (for Malayalam); ITRANS pre-processor package to convert English-encoded text into various Indian language script such as Gujarati, Bengali, Kannada, Tamil, Telugu, etc.

Essential Readings

1. Kottwitz, Stefan (2021). LaTeX Beginner's Guide (2nd ed.). Packet Publishing Ltd.
2. Nambudiripad, K.B.M. (2014). LaTeX for Beginners. Narosa Publishing House, Delhi.
3. <https://ctan.org/pkg/devanagari>; <https://www.ctan.org/pkg/gurmukhi-singh>
4. <https://ctan.org/tex-archive/language/indian/itrans>

Suggested Reading

- Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

Practical Exercises: Getting started with free open-source software LaTeX for typesetting documents from chapter 1 of the text book [1]: LaTeX Beginner's Guide (2nd ed.) by Stefan Kottwitz for installing and using LaTeX. Learners are required to:

- Design a LaTeX document by choosing title, author, date, address, page dimensions, margins, adjust line spacing, add footnotes, and orientation.
- Create a document with bulleted lists, numbered lists, and definition lists. Furthermore, modify the document with compact and customized versions of such lists, including spacing adjustments and interrupting and resuming.
- Create tables, adding captions to tables, putting text into columns, spanning columns and rows, using LaTeX packages to auto-fit columns.
- Generate a document by customizing the table of contents, lists of figures and tables, producing an index pointing to relevant information for keywords and phrases.
- Typesetting fine-tune math expressions, align and number equations, and use various math symbols from the amsmath package in LaTeX.
- Generate a list of five books related to your field of interest under an automatically generated title 'Bibliography', using thebibliography command in LaTeX. Illustrate how these references are cited in the body of a document.
- Create a LaTeX file to manage large documents consisting of several LaTeX files by splitting the input, including front and back matter and a separate title page.
- Transliterate these six names: Aryabhata, Arthashastra, Bhaskaracharya, Chanakya, Ganita Bharati, and Shankaracharya, and write them in itemize form using Devanagari package in LaTeX. Also use the verbatim environment to display the LaTeX code.
- Typeset ten words of your choice using ITRANS pre-processor package in LaTeX to convert English-encoded text into any one Indian language script.

Teaching Plan (SEC Paper: LaTeX Typesetting for Beginners)

Week 1: Installing and using LaTeX for creating a first LaTeX document. [1]: **Chapter 1.**

Week 2: Formatting text and understanding LaTeX commands and environments. [1]: **Chapter 2.**

Week 3: Designing pages, Creating a book with chapters and table of contents. [1]: **Chapter 3.**

Week 4: Creating and customizing lists. [1]: **Chapter 4.**

Week 5: Including images. [1]: **Chapter 5.**

Week 6: Creating tables with captions. [1]: **Chapter 6.**

Week 7: Setting labels and references, Hyperlinks. [1]: **Chapter 7.**

Week 8: Customizing the table of contents, Generating an index, Creating a bibliography. [1]: **Chapter 8.**

Week 9: Writing basic math formulas and equations. [1]: **Chapter 9.**

Week 10: Developing large documents by splitting the input and creating front/back matter. [1]: **Chapter 11.**

Weeks 11, and 12: Transliteration symbols with illustrative examples of the Indian languages, such as Sanskrit, Hindi (Devanagari), Punjabi, and Malayalam. [2]: **Chapter 9; and gurmukhi**

Weeks 13, and 14: Creation of transliterated document for typesetting in Devanagari (Sanskrit, Hindi and Marathi), Gurumukhi (Punjabi), and Rachana (Malayalam). [2]: **Chapter 10; [3]: Devanagari, and Gurmukhi.**

Week 15: ITRANS pre-processor package to convert English-encoded text into various Indian language script such as Gujarati, Bengali, Kannada, Tamil, Telugu, etc. [4]: **Itrans: Indian languages**

UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/

Dated: 21.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Value Addition Course (VACs)

**Under UGCF-2022 listed under Appendix-II -A to the Ordinance V (2-A) of the Ordinances of the University
(With effect from academic year 2022-23)**

The following two courses are being added under the Pool of Value Addition Courses, which are in progression of the courses (i) Vedic Mathematics-I and (ii) National Cadet Corps-I respectively :

1. Vedic Mathematics-II
2. National Cadet Corps-II

VAC :Vedic Mathematics - II

Course Title and Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the Course
		Lecture	Tutorial	Practical/Practise		
Vedic Mathematics- II	02	1	0	1	Pass in Class 12 th	VAC-Vedic Mathematics -I

Course Objectives:

- Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics
- Help students appreciate ancient Indian Mathematics and its contribution to the world.
- Enhance computational proficiency by involving procedures in Linear and Matrix Algebra


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- Improve geometrical thinking by understanding the basic tenets of geometry such as construction of line segments, angles, triangles and circles as used in Ancient India
- Develop conceptual knowledge of mathematical concepts
- Appreciate the need of conceptual knowledge over procedural processes

Learning Outcomes:

After completion of the course, students shall be able to

- think critically
- Find mathematical solution of algebraic expressions
- Solve system of linear equations and matrices faster and with ease.
- Appreciate the Mathematical advancements of Ancient India.

Syllabus of Vedic Mathematics - II

Unit I: Contribution of Indian Mathematicians	Sessions/Lectures
● Varahmihir ● Brahmagupta ● Srinivasa Ramanujan ● Neelkanth Somayya ● Bharti Krishna Tirtha	3
Unit II: Easy Solution of linear equations	
● Introduction of simple equation ● Solutions of simple equations ● Solutions of linear equations in two variables ● Practical application of linear equations in two variables	4
Unit III: High Speed Matrix Algebra	
● Introduction and history of Matrices and Determinants ● Matrices and Determinants of third order ● Inverse of Matrices	4
Unit IV: Vedic Geometry	
● Different forms of straight lines ● The Triangle ● The Cyclic Quadrilateral, Squares, and the Circle ● Geometrical constructions (such as <i>Altars</i>) ● Transformation of simple shapes ● Kalpa Sutras-Srautha Sutras and Sulbha Sutras	4

Note: Some of the theoretical concepts would be dealt with during practice hours.

Practical/ Practice Component

(15 sessions of 2 hours each= 30 hours)

The students are expected to demonstrate the application of Vedic Maths through various *Sutras*

- Conduct workshops under the supervision of the course teacher to spread awareness on the utility of Vedic Mathematics.
- Students may share their experience with the class teacher in the form of audio-video presentations of 15 minutes.
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- Vedic Mathematics, Swami Bharati Krishna Trithaji, *Motilal Banarsidas, New Delhi.*
- The Essential of Vedic Mathematics, Rajesh Kumar Thakur, *Rupa Publications, New Delhi*
- Vedic Mathematics For All Ages, Vandana Singhal, *Motilal Banarsidas Publishers.*
- Elements of Vedic Mathematics, Udayan S. Patankar, Sunil M. Patankar, *TTU Press.*
- Vedic Mathematics: The Problem Solver, Ronak Bajaj, *Black Rose Publications.*
- Vedic Geometry Course, S. K. Kapoor, *Lotus Press*
- Gardner, Robert and J.F. Staal. *Altar of Fire*. Documentary. The Film Study Center at Harvard University, 1976

Suggested Readings

- A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, *Wiley Eastern Limited, New Delhi*
- Magical World of Mathematics, VG Unkalkar, *Vandana publishers, Bangalore*
- Vedic Mathematics - Modern Research Methods, Tiwari P., *Campus Books International*
- Learning Vedic Mathematics, S. K. Kapoor, *Lotus Press Publications*
- Vedic Mathematics Made Easy, DahavalBathia, *Jaico Publishing, New Delhi*
- Vedic Mathematics New Horizons Advance Lessons, S. K. Kapoor, *Lotus Press*

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time.

VAC 1: VEDIC MATHEMATICS - I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Vedic Mathematics - I	02	1	0	1	12 TH Pass	NIL

Learning Objectives

The Learning Objectives of the course are:

- Foster love for maths and remove its fear through Vedic Mathematics
- Enhance computation skills in students through Vedic Mathematics
- Develop logical and analytical thinking
- Promote joyful learning of mathematics
- Discuss the rich heritage of mathematical temper of Ancient India

Learning outcomes

The Learning Outcomes of the course are

- Overcome the fear of maths
- Improved critical thinking
- Familiarity with the mathematical underpinnings and techniques
- Ability to do basic maths faster and with ease.
- Appreciate the Mathematical advancements of Ancient India.

SYLLABUS OF VEDIC MATHEMATICS - I

UNIT – I Vedic Maths- High Speed Addition and Subtraction Sessions/Lectures (5 Weeks)

- Vedic Maths: History of Vedic Maths and its Features
- Vedic Maths formulae: Sutras and Upsutras
- Addition in Vedic Maths: Without carrying, Dot Method

- Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah (All from 9 last from 10)
- Fraction –Addition and Subtraction

UNIT – II Vedic Maths- Miracle Multiplication and Excellent Division (4 Weeks)

- Multiplication in Vedic Maths: Base Method (any two numbers upto three digits)
- Multiplication by Urdhva Tiryak Sutra
- Miracle multiplication: Any three-digit number by series of 1's and 9's
- Division by Urdhva Tiryak Sutra (Vinculum method)

UNIT – III Vedic Maths-Lightening Squares and Rapid Cubes (3 Weeks)

- Squares of any two-digit numbers: Base method
- Square of numbers ending in 5: Ekadhikena Purvena Sutra
- Easy square roots: Dwandwa Yoga (duplex) Sutra
- Square root of 2: Baudhayana Shulbasutra
- Cubing: Yavadunam Sutra

UNIT – IV Vedic Maths-Enlighten Algebra and Geometry (3 Weeks)

- Factoring Quadratic equation: Anurupyena, Adyamadyenantyamanty Sutra
- Concept of Baudhayana (Pythagoras) Theorem
- Circling a square: Baudhayana Shulbasutra
- Concept of pi: Baudhayana Shulbasutra
- Concept angle (θ) 0o, 30o, 45o, 60o and 90o: Baudhayana number

Practical component : (If any) (15 Weeks)

The students are expected to demonstrate the application of Vedic Maths: Sutra and Upsutra

- Conduct workshops under the supervision of the course teacher to spread awareness on the utility of Vedic Mathematics.
- Students are required to visit nearby retail shops/local vendors to purchase stationery/vegetables/bread and butter and use tricks of Vedic maths of addition and subtraction to calculate the amount to pay and receive the difference.
- Students may share their experience with the class teacher in the form of audio-video presentations of 15 minutes.
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi 2019.
- Vedic Mathematics Made Easy, Dahaval Bathia, Jaico Publishing, New Delhi 2011
- Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
- Learn Vedic Speed Mathematics Systematically, Chaitnaya A. Patil 2018.

Suggested Readings

- A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, Wiley Eastern Limited, New Delhi.
- Enjoy Vedic Mathematics, S M Chauthaiwale, R Kollaru, The Art of Living, Bangalore.
- Magical World of Mathematics, VG Unkalkar, Vandana publishers, Bangalore.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

SEC – 20: Back-End Web Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
	2			2		

Learning Objectives

The Learning Objective of this course is as follows:

- To introduce the basic concepts and techniques of server side web programming.
- To enable the students to apply the basic concepts and techniques of server side web programming.

Learning outcomes

The Learning Outcomes of this course are as follows:

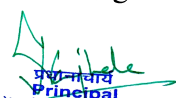
- After studying this course, students will be able to build interactive and dynamic websites.
- After studying this course, students will be able to write the server side programming techniques with Django for accessing the contents to/from the server
- After studying this course, students will be able to learn to validate server-side/backend data
- After studying this course, students will be able to use GET and POST methods for sending data within client and server.

SYLLABUS OF SEC-20

Unit 1

(7 weeks)

Installation of Django ,Introduction to Django;;Model–view–controller(MVC) model; Django structure; HTML templates; URL dispatcher ,Django Template System, Interacting with a Database


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श्री वेंकटेश्वर महाविद्यालय
Sri Venkateswara College
दिल्ली विश्वविद्यालय / University of Delhi
घौला कुआँ, नई दिल्ली / Dhoola Kuan, New Delhi-21

Unit 2

(7 weeks)

The Django Administration Site , Wrapper Functions, Custom Views GET and POST methods ;Deployment of Django; Automating tasks with Django; Building Web APIs using Django REST

Project work

Build a website for student admission in a college/university.

Essential/recommended readings

- <https://docs.djangoproject.com/>

Examination scheme and mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

SEC – 21: Front End Web Design and Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
	2			2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the basic concepts and techniques of client-side web programming.
- To enable the students to develop simple, interactive, and stylish websites using HTML, CSS and JavaScript.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to build websites using the elements of HTML.
- After studying this course, students will be able to build interactive and stylish websites using the client side programming techniques with CSS and Javascript.
- After studying this course, students will be able to learn to validate client-side data.
- After studying this course, students will be able to define the structure and contents of the website using different features of CSS.

SYLLABUS OF SEC-21

Unit 1 (4 weeks)

Introduction: Introduction to internet and web design. Basic concepts of webarchitecture.

Unit 2 (4 weeks)

HTML: Introduction to hypertext mark-up language (html), creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames.

Unit 3 (4 weeks)

Cascading style sheet (CSS): Concept of CSS, creating style sheet, Importing style sheets, CSS properties, CSS styling (background, text format, controlling fonts), CSS rules.

Types, CSS Selectors, CSS cascade, working with block elements and objects, working with lists and tables, CSS id and class, box model (introduction, border properties, padding properties, margin properties).

Unit 4

(4 weeks)

Basics of Javascript: Document object model, data types and variables, functions, methods and events, controlling program flow, built-in objects and operators, validations.

Practical Exercises

HTML

- Create an HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.
- Create an HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking
- Create an HTML document for displaying the current semester's timetable.
- Create a website with horizontal and vertical frames. Top horizontal frame needs to show your college's name and logo. Bottom horizontal frame is to be split into two vertical frames. The left frame has hyperlinks to pages related to faculty, courses, student activities, etc. The right frame shows the corresponding webpage based on the link clicked on the left frame.
- Create a student registration form using HTML which has the following controls and make an interactive content presentation using CSS.:
 - I. Text Box II. Dropdown box III. Option/radio buttons
 - IV. Check boxes V. Reset and Submit button
- Create a webpage for your department with a drop-down navigation menu for faculty, courses, activities, etc.. Implement the webpage using styles, rules, selectors etc. learned in CSS
- Write event-driven programs in JavaScript for the following:
 - Enter a number and on click of a button print its multiplication table.
 - Print the largest of three numbers entered by the user.
 - Find the factorial of a number entered by the user.
 - Enter a list of positive numbers using the prompt terminated by a zero. Find the sum and average of these numbers.
- Create a student registration form using text, radio button, check box, drop down box, text field and all other required HTML elements. Customize the CSS and javascript to input and validate all data. Create functions to perform validation of each element, example:
 - a. Roll number is a 7-digit numeric value
 - b. Name should be an alphabetical value (String)
 - c. Non-empty and valid fields like DOB

Essential/recommended readings

- Nixon, R., Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5, O'Reilly, 2018.
- Powell, T.A. HTML & CSS: The Complete Reference, 5th edition, Tata McGrawHill, 2017.
- Duckett, J., JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.

Suggested Readings

- Boehm, A., & Ruvalcaba, Z., Murach's HTML5 and CCS, 4th edition, Mike Murach & Associates, 2018.
- Ivan Bayross, Web Enabled Commercial Application Development Using Html, Dhtml, Javascript, Perl CGI, BPB Publications, 2010.

Examination scheme and mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Programming using Python

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Programming using Python	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide exposure to basic problem-solving techniques with computers
- To develop logical thinking abilities and to propose novel solutions for real-world problems through programming language constructs.
- To deepen the empirical knowledge on applying programming in business domains.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to interpret the basic representation of the data structures and sequential programming
- After studying this course, students will be able to gain knowledge of, and ability to use control framework terminologies.
- After studying this course, students will be able to work out using the core data structures as lists, dictionaries, tuples, and sets.
- After studying this course, students will be able to choose appropriate programming paradigms, interrupt and handle data using files to propose solutions through reusable modules
- After studying this course, students will be able to propose possible error-handling constructs for unanticipated states/inputs.
- After studying this course, students will be able to implements exemplary applications on real-world problems.

Syllabus

Unit-1: Introduction

(8 hours)

Relationship between computers and programs, Basic principles of computers, File systems, Using the Python interpreter, Introduction to binary computation, Input / Output

Unit-2: Data types and control structures

(8 hours)

Operators (unary, arithmetic, etc.), Data types, variables, expressions, and statements, Assignment statements, Strings and string operations, Control Structures: loops and decision

Unit-3: Modularization and Classes

(8 hours)

Standard modules, Packages, Defining Classes, Defining functions, Functions and arguments (signature)

Unit-4: Data structures and Object-oriented design

(8 hours)

Data Structures (array, List, Dictionary), Error processing, Exception Raising and Handling Programming types, Object Oriented Programming, Object Oriented Design, Inheritance and Polymorphism

Practical Exercises

(28 hours)

- Running instructions in Interactive interpreter and a Python Script
- Write a program to purposefully raise Indentation Error and Correct it
- Write a program to compute distance between two points taking input from the user. (Pythagorean Theorem)
- Write a program add.py that takes 2 numbers as command line arguments and prints its sum.
- Write a Program for checking whether the given number is an even number or not.
- Using a for loop, write a program that prints out the decimal equivalents of $1/2$, $1/3$, $1/4$, $1/10$
- Write a program using a for loop that loops over a sequence. What is the sequence?
- Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero.
- Find the sum of all the primes below two million. Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10 terms will be: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89,
- By considering the terms in the Fibonacci sequence whose values do not exceed four million, find the sum of the even-valued terms.
- Write a program to count the numbers of characters in the string and store them in a dictionary data structure.

- Write a program to use split and join methods in the string and trace a birthday with a dictionary data structure.
- Write a program combining lists that combines these lists into a dictionary.
- Write a program to count the frequency of characters in a given file. Can you use character frequency to tell whether the given file is a Python program file, C program file or a text file?
- Write a program to print each line of a file in reverse order.
- Write a program to compute the number of characters, words and lines in a file.
- Write a function ball collide that takes two balls as parameters and computes if they are colliding. Your function should return a Boolean representing whether or not the balls are colliding. Hint: Represent a ball on a plane as a tuple of (x, y, r), r being the radius. If (distance between two balls centers) $\leq$ (sum of their radii) then (they are colliding)
- Find mean, median, mode for the given set of numbers in a list.
- Write a function nearly equal to test whether two strings are nearly equal. Two strings a and b are nearly equal when a can be generated by a single mutation on b.
- Write a function dups to find all duplicates in the list.

Essential/recommended readings

- "Starting Out with Python plus My Programming Lab with Pearson eText --Access Card Package (3rd Edition) Tony Gaddis ISBN-13: 978-0133862256".
- Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition).
- Head-First Python: A Brain-Friendly Guide (2nd Edition) by Paul Barry.
- Learn Python the Hard Way: 3rd Edition by Zed A. Shaw.
- Python Programming: An Introduction to Computer Science (3rd Edition) by John M. Zelle.
- Python Cookbook: Recipes for Mastering Python 3 (3rd Edition) by Brian Jones and David Beazley.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Hague, R. and Harrop, M. McCormick J. (2016) *Comparative Government and Politics: An Introduction* (Tenth Edition). London: Palgrave MacMillan.

Ishiyama, J.T. and Breuning, M. (eds.). (2011) *21st Century Political Science: A Reference Book*. Los Angeles: Sage.

Newton, K. and Deth, Jan W. V. (2010) *Foundations of Comparative Politics: Democracies of the Modern World*. Cambridge: Cambridge University Press.

O'Neil, P. (2009) *Essentials of Comparative Politics* (3rd Edition). New York: WW. Norton & Company, Inc.

Roy Macridis (1966) *The Study of Comparative Government*, Random House.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 12: Global Politics

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Global Politics DSC 12	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This course aims to familiarize the students with key concepts and issues of global politics by providing an overall frame that de-centres the Eurocentric notion of the origins and development of global politics and introduces students to the alternative locations of global politics through history as well as in the contemporary contexts. Through the conceptual frames of geo-politics, geo-economics and geo-strategy, students will learn about various dimensions of the contemporary dynamics of global politics. Students will debate questions of dominance, control, and identity by examining the cultural frames of global politics. The course also offers insights into key and pressing contemporary global issues ranging from climate change, nuclear proliferation and migration to the rise and impact of global terrorism and, human security. It also discusses politics at the grassroots level through the lens of global social movements in an interconnected world. Throughout, the course attempts to foreground the perspectives from the Global South in order to pluralize and truly globalize the domain of global politics.

Learning outcomes

At the end of the course, students would acquire

- a basic clarity on the meaning, nature and significance of global politics.
- ability to analyse global politics beyond its conventional Eurocentric accounts.
- conceptual tools to understand its dynamics in the contemporary context.
- an understanding of the debates on the changing nature of global politics in terms of de-globalization and post-globalization along with territorialization and deterritorialization.
- the ability to understand the operational aspects of geo-politics, geo-economics, and geo-strategy in the context of global politics.
- the skills to analyze discourses on cultural frames of global politics

- an enhanced understanding of contemporary global issues like- ecology, environment, proliferation of nuclear weapons, global terrorism, human security, and migration.

SYLLABUS OF DSC-12

UNIT – I (10 Hours)

Locating Global Politics

UNIT – II (12 Hours)

Changing Nature of Global Politics

- Globalization to de-globalization, and post-globalization
- Geo-politics, Geo-economics, and Geo-strategy
- Territorialisation and De-territorialisation
- Cultural Frames of Global Politics

UNIT – III (12 Hours)

Contemporary Global Issues

- Ecological Issues: Climate Change, and International Environmental Agreements
- Proliferation of Nuclear Weapons in Post- Cold War Era
- Global Terrorism and Its Impact
- Migration
- Human Security

UNIT – IV (11 Hours)

Global Social Movements

- Environment Movements
- Women Movements
- Peace Movements

Essential/recommended readings

Unit 1 Locating Global Politics

Essential readings:

Hobson, J.M. (2004). *The Eastern origins of Western civilization* (pp. 1-26). Cambridge: Cambridge University Press.

Acharya, Amitav (2014), "Who Are the Norm Makers? The Asian-African Conference in Bandung and the Evolution of Norms" in Special Section on "Principles from the Periphery: The Neglected Southern Sources of Global Norms", *Global Governance*, 20 (3): 405- 417.

Additional readings:

Hobson, J.M. (2020), "Globalization" in A. B. Tickner, & K. Smith (eds.), *International Relations from the Global South: Worlds of difference* (pp. 221-239). Routledge.

Pieterse, Jan Nederveen (2017), "Oriental Globalization: Past and Present", in Delanty, Gerard (eds.), *Europe and Asia Beyond East and West*, New York: Routledge, pp. 61-73.

Getachew, A. (2019), *Worldmaking after Empire: The rise and fall of self-determination, 1919-1933*. Princeton: Princeton University Press.

Unit 2 Changing Nature of Global Politics

a. Globalization to de-globalization, and post-globalization

Essential readings:

Ritzer, G. (2010), *Globalization: A Basic Text*, West Sussex: Wiley-Blackwell, pp. 33-62.

Stager, M. (2009). *Globalization: A Very Short Introduction*, London: Oxford University Press, pp. 1-16.

Kornprobst, M. & Paul, T.V. (2021), "Globalization, deglobalization and the liberal international order", *International Affairs*, 97 (5): 1305-1316.

Flew, T. (2020). "Globalization, neo-globalization and post-globalization: The challenge of populism and the return of the national", *Global Media and Communication*, 16 (1): 19-39.

Additional Readings:

Held, D., & McGrew A. (2003), "The Great Globalization Debate: An introduction" in D. Held, & A. McGrew. (eds.), *Global Transformations Reader: Politics, Economics and Culture*. Cambridge: Polity Press, pp. 1-50.

Paul, T.V. (2021). "Globalization, deglobalization and reglobalization: Adapting liberal international order". *International Affairs*, 97 (5): 1599-1620.

James, Harold (2017), "Deglobalization as a Global Challenge", *Centre for International Governance Innovation (CIGI) Papers No. 135*, URL: https://www.cigionline.org/sites/default/files/documents/Paper%20no.135WEB_1.pdf

b. Geo-politics, Geo-economics, and Geo-strategy

Essential Readings:

Chaturvedi, S. (2012), "Geopolitics" in B.S. Chimni, & S. Mallavarapu (eds.), *International Relations: Perspectives for the Global South*, New Delhi: Pearson, pp: 149-166.

Wigell, Mikael et al. (2019) (eds.), *Geo-economics and Power Politics in the 21st Century: The Revival of Economic Statecraft*, London: Routledge, pp: 1-24.

Hobson, John M. (2021), *Multicultural Origins of the Global Economy: Beyond the Western-Centric Frontier*, Cambridge: Cambridge University Press, pp. 433-455.

Blouet, Brian W. (2005) (eds.), *Global Geostrategy: Mackinder and the defence of the West*, New York: Frank Cass, pp. 1-16; 137-141; 165-171.

Additional Readings:

Flint, C. (2022). *Introduction to Geopolitics* (4th Edition), London: Routledge, pp: 1-44.

Dodds, K. (2019), *Geopolitics: A Very Short Introduction* (3rd Edition), Oxford: Oxford University Press, pp. 1-14.

Luttwak, Edward N. (1998), "From Geopolitics to Geo-Economics: Logic of Conflict, Grammar of Commerce" in Tuathail, Gearoid O et al. (eds.), *The Geopolitics Reader*, London: Routledge, pp. 125-130.

Dorsman, Andre B et al. (2018) (eds.), *Energy economy, Finance and Geostrategy*, Cham (Switzerland): Springer, pp. 1-10.

c. Territorialisation and De-territorialisation

Essential Readings:

Sassen, Saskia (1996), "The State and the new geography of power", in *Losing Control? Sovereignty in an Age of Globalisation*, New York: Columbia University Press, pp. 1-32.

Elden, S. (2005), "Missing the Point: Globalization, Deterritorialization and the Space of the World", *Transactions of the Institute of British Geographers*, 30(1), 8–19.

Additional Readings:

Scholte, J. A. (2003), "What is 'Global' about Globalization?" In D. Held & A. McGrew. (eds.), *Global Transformations: Politics, Economics and Culture*, Cambridge: Polity Press, pp. 84-91.

Appadurai, A. (1990), "Disjuncture and Difference in the Global Cultural Economy", *Theory Culture and Society*, 7 (2-3): 295-310.

d. Cultural Frames of Global Politics (3 Lectures)

Essential Readings:

Harshe, R. (2006), "Culture, Identity and International Relations", *Economic and Political Weekly*, 41(37), 3945–3951.

Lapid, Yosef (1996), "Culture's Ship: Returns and Departures in International Relations Theory", in Lapid, Yosef and Friedrich Kratochwil (eds.), *The Return of Culture and Identity in IR Theory*, London: Lynne Rienner Publishers, Inc., pp. 3-20.

Additional Readings:

Holton, Robert (2000), "Globalization's Cultural Consequences", *The Annals of the American Academy of Political and Social Science (ANNALS, AAPSS)*, 570: 140-152.

Gusterson, Hugh (2005), "The Seven Deadly Sins of Samuel Huntington", in Besteman, Catherine and Hugh Gusterson (eds.), *Why America's Top Pundits are Wrong*, Berkeley: University of California Press, pp. 24-42.

Chirico, JoAnn (2014), "Globalizing Culture: Change and Continuity", in *Globalization: Prospects and Problems*, Washington D.C.: Sage Publications, pp. 254-284.

Unit 3 Contemporary Global Issues

a. Ecological Issues: Climate Change, and International Environmental Agreements

Essential Readings:

Heywood, A. (2011), "Global Environmental Issues" in *Global Politics*, New York: Palgrave, pp. 383-411.

Volger, J. (2011), 'Environmental Issues', in J. Baylis, S. Smith and P. Owens (eds.), *Globalization of World Politics*, New York: Oxford University Press, pp. 348-362.

Additional Readings:

Kreienkamp, J. (2019), "The Long Road to Paris: The History of the Global Climate Change Regime", *Global Governance Institute Policy Brief Series* (pp. 1-24), London: University College.
[https://www.ucl.ac.uk/global-governance/sites/global-governance/files/the long road to paris the history of the global climate change regime.pdf](https://www.ucl.ac.uk/global-governance/sites/global-governance/files/the%20long%20road%20to%20paris%20the%20history%20of%20the%20global%20climate%20change%20regime.pdf)

Death, Carl (2019), 'Can We Save the Planet?', in Edkins, Jenny & Maja Zehfuss (eds.), *Global Politics: A New Introduction (3rd edition)*, New York: Routledge, pp. 61-84.

Falkner, Robert (2012), "Global environmentalism and the greening of international society", *International Affairs*, 88 (3): 503-522.

b. Proliferation of Nuclear Weapons in Post- Cold War Era

Essential Readings:

D. Howlett (2011), "Nuclear Proliferation" in J. Baylis, S. Smith and P. Owens (eds.), *The Globalization of World Politics: An Introduction to International Relations*, New York: Oxford University Press, pp. 384-397.

Narang, Vipin (2017), "Strategies of Nuclear Proliferation: How States Pursue the Bomb", *International Security*, 41(3): 110-150.

Additional Readings:

Heywood, A. (2011), Nuclear Proliferation and Disarmament. In *Global Politics*, New York: Palgrave, pp. 263-281.

Chacko, Priya & Alexander E Davis (2018), "Resignifying 'responsibility': India, exceptionalism and nuclear non-proliferation", *Asian Journal of Political Science*, pp. 1-19. URL: <https://doi.org/10.1080/02185377.2018.1486218>

c. Global Terrorism and Its Impact

Essential Readings:

Bajpai, K.P. (2012), "Terrorism" in B.S. Chimni and Siddharth Mallavarapu (eds.), *Handbook on International Relations: Essays from the Global South*. New Delhi: Pearson Education, pp. 312-327.

Gerges, F.A. (2005), *The Far Enemy: Why Jihad Went Global*, Cambridge: Cambridge University Press, pp. 119-150.

Additional Readings:

Heywood, A. (2011), "Terrorism" in *Global Politics*, New York: Palgrave, pp. 282-302.

Vanaik, A. (2007), *Masks of Empire*, New Delhi: Tulika, pp. 103-128.

Hoffman, Bruce (2002), "Rethinking Terrorism and Counterterrorism Since 9/11", *Studies in Conflict and Terrorism*, 25 (5): 303-316.

Barber, Benjamin (2010), "On Terrorism and New Democratic Realism", in Ritzer, George & Zenep Atalay (eds.), *Readings in Globalization: Key Concepts and Major Debates*, West Sussex: Wiley-Blackwell, pp. 305-306.

d. Migration

Essential Readings:

Castells, S. (2012), "Global Migration" In B.S. Chimni, & S. Mallavarapu (eds.), *International Relations: Perspectives for the Global South*, New Delhi: Pearson India Education, pp. 272-285.

Chirico, JoAnn (2014), "Transborder Threats to Human Well-Being: Inequality and Migration", in *Globalization: Prospects and Problems*, Washington D.C.: Sage Publications, pp. 368-382.

Additional Readings:

Aneesh, A. (2006), *Virtual Migration: The Programming of Globalization*, London: Duke University Press, pp. 67-99.

Ritzer, G. (2010), "Global Flows of People: Vagabonds and Tourists", in *Globalization: A Basic Text*, West Sussex: Wiley-Blackwell, pp. 297-321.

Moses, J. (2006), *International Migration: Globalization's Last Frontier*, London: Zed Books, pp. 1-17.

e. Human Security

Essential Readings:

Acharya, Amitav (2014), "Human Security" in Baylis, J. et al. (eds.), *The Globalization of World Politics: An Introduction to International Relations (6th edition)*, Oxford: Oxford University Press, pp. 448-462.

Tadjbakhsh, S. & Chenoy, Anuradha (2007), *Human Security*, London: Routledge, pp. 13-19; 123-127; 236-243.

Additional Readings:

Acharya, Amitav (2001), "Human Security: East versus West", *International Journal*, 56 (3): 442-460.

Cook, Alistair D.B. (2017), "Non-traditional Security and World Politics", in Beeson, Mark & Nick Bisley (eds.), *Issues in 21st Century World Politics (3rd edition)*, New York: Palgrave-Macmillan, pp. 38-51.

UNDP (1994), "Human Development Report: New Dimensions of Human Security", <https://www.hdr.undp.org/en/content/human-development-report-1994>.

Unit 4 Global Social Movements

Essential Readings:

Fominaya, C. (2014), *Social Movements and Globalization- How Protests, Occupation and Uprisings are Changing the World* (Chapter 3), pp: 27-49, New York: Palgrave Macmillan.

Guidry, John A. et al. (2000) (eds.), *Globalizations and Social Movements: Culture, Power, and the Transnational Public Sphere*, Ann Arbor: University of Michigan Press, pp. 1-32.

Eschle, Catherine & Neil Stammers (2004), "Taking Part: Social Movements, INGOs, and Global Change", *Alternatives*, 29 (3): 333-372.

Additional Readings:

Moola, Sarifa (2004), "Contemporary Activism: Shifting Movements, Changing Actors", *Agenda: Empowering Women for Gender Equity*, 60: 39-46.

Maiba, Hermann (2005), "Grassroots Transnational Social Movement Activism: The Case of Peoples' Global Action", *Sociological Focus*: 38 (1): 41-63.

Laxer, Gordon & Sandra Halperin (2003) (eds.), *Global Civil Society and Its Limits*, New York: Palgrave Macmillan, pp: 1-21.

Additional References:

Tickner, Arlene B. & Karen Smith (2020) (eds.), *International Relations from the Global South: Worlds of Difference*, New York: Routledge.

Acharya, A. (2018), *Constructing Global Order: Agency and Change in World Politics*, Cambridge: Cambridge University Press.

Lechner, Frank J. & John Boli (2015) (eds.), *The Globalization Reader (5th edition)*, Oxford: Wiley Blackwell.

Schaeffer, Robert K. (2021), *After Globalization: Crisis and Disintegration*, New York: Routledge.

Stiglitz, Joseph E. (2018), *Globalization and Its Discontents Revisited: Anti- Globalization in the Era of Trump*, New York: W.W. Norton & Company.

Stuenkel, Oliver (2016), *Post Western World: How Emerging Powers are Remaking Global Order*, Cambridge: Polity.

Chari, Chandra (2008) (eds.), *War, Peace and Hegemony in a Globalized World: The Changing Balance of Power in the Twenty-first Century*, New York: Routledge.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Kumar, Sanjeev (ed) (2020). 'Understanding Gandhi: Why Gandhi Matters Today' in Gandhi and the Contemporary World. Oxon & New York: Routledge. PP-1-23.

Unit 5

Gandhi, Mahatma. (1994). What is Hinduism. National Book Trust, New Delhi,

Ragi, Sangit K. (2022), RSS and Gandhi: The Idea of India, New Delhi: Sage [On Hinduism: pp. 42-74; On Religious Conversion: pp. 75-114; On Cow Protection: 193-220; On Language Questions: pp. 160-192]

Mehta, Sandhya. (2002). Gandhiji On Religious Conversion Selected and Compiled, 1st Edition. Mumbai. Mani Bhavan Gandhi Sangrahalaya.

Gandhi (M.K.) . (1955), My Religion. Ahmedabad: Navajivan Trust.

Bilgrami, Akeel (2011), Gandhi's Religion and Its relation to his Politics. In: Brown, Judith M. and Parel, Anthony (ed.): The Cambridge Companion to Gandhi. Cambridge University Press, 93–116

S Radhakrishnan (2007): "Gandhi's Religion and Politics," in S Radhakrishnan (ed), Mahatma Gandhi: Essays and Reflections, Mumbai: Jaico Publication House.

D. Hardiman (2003) 'Fighting Religious Hatreds', in Gandhi in His Time and Ours. Delhi: Oxford University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2b: India's National Security: Major Challenges and Strategic Thinking

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
India's National Security: Major Challenges and Strategic Thinking DSE-2b	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This course aims to link India's internal and external security challenges with its long term strategic thinking, approach and responses to the same. It introduces the historical dimensions of India's security challenges and the policy responses to students before equipping them with tools to conceptually analysing these. The course then discusses intellectual foundations of India's strategic thinking drawn from both classical texts and past

practices. Students will also learn about the major contemporary debates on India's strategic culture. The course will engage students in understanding both internal and external dimensions of India's major security challenges. Some of the key external challenges, it focuses on, include India's securitized borders, maritime security threats, nuclearization, and terrorism. In the internal realm, issues pertaining to Jammu & Kashmir, the North-east, Naxalism, along with cyber and information warfare have been discussed. The final component of the course introduces the students to an array of India's strategic responses ranging from non-alignment, forging strategic partnerships and military responses to pursuing multilateral strategies in the contemporary world.

Learning outcomes

At the end of the course, students would acquire the ability to:

- Understand the ways in which, the security threats to India have evolved historically and how have these been met.
- Appreciate the intellectual and historical foundations of Indian strategic thinking.
- Develop a nuanced understanding of India's strategic culture.
- Learn about India's internal and external security threats in its multifarious dimensions.
- Understand how has India evolved a whole array of strategic responses such as nonalignment, forging strategic partnerships and bilateral as well as multilateral partnerships to address diverse challenges it faces.

SYLLABUS OF DSE-2b

UNIT – I (7 Hours)

Understanding India's National Security

- 1.1 India's Security Policy: A Historical Perspective
- 1.2 Contemporary Dimensions of India's National Security Framework
- 1.3 Conceptualizing India's National Security

UNIT – II (9 Hours)

Intellectual Foundations of India's Strategic Thinking

- 2.1 Textual Traditions: Ramayana & Mahabharata
- 2.2 Kautilya
- 2.3 Non-Textual Conceptualizations: Swaraj, Martial Culture

UNIT – III (7 Hours)

India's strategic culture

- 3.1 Evolution and conceptualization
- 3.2 Contemporary Trends

UNIT – IV (13 Hours)

India's National Security Challenges

4.1 External Challenges

- 4.1.1 India's Neighbourhood (Cross-border terrorism, securitised borders, water sharing conflicts and nuclearization)
- 4.1.2 Maritime Security

4.2 Internal Challenges

- 4.2.1 Maoism/Naxalist Challenge
- 4.2.2 Separatist Movements (J&K and the Northeast)
- 4.2.3 Cyber Warfare

UNIT – V (9 Hours)

India's Strategic Responses

- 5.1 Non-Alignment
- 5.2 Strategic Partnerships
- 5.3 Military Responses
- 5.4 Multilateral Alliances

Essential/recommended readings

Unit wise reading list

Unit 1: Understanding India's National Security

1.1 India's Security Policy: A Historical Perspective

Essential Readings

Raju G C Thomas, "The Strategic Environment and Defence Policies" in *Indian Security Policy* (Princeton: Princeton University Press, 1986) pp. 10-49

Sanjay Chaturvedi, "Indian Geopolitics: 'Nation-State' and the Colonial Legacy" in Kanti Bajpai and Siddharth Mallavarapu (eds.) *International Relations in India: Theorising the Region and Nation* (Orient Longman, 2005) pp. 238-281

Additional Readings

David Malone, "History: A Vital Foundation of India's International Relations" in *Does the Elephant Dance: Contemporary Indian Foreign Policy* (Oxford University Press, 2011) pp. 19-46

Shyam Saran, "Sources of India's World View" in *How India Sees the World: Kautilya to the 21st Century* (Juggernaut, 2018) pp. 9-24

Shivshankar Menon, "The Stage and Inheritance" in *India and Asian Geopolitics: The Past, Present* (The Brookings Institutions, 2021) pp. 11-36

Sumit Ganguly, "India's National Security" in David M. Malone, C. Raja Mohan, and Srinath Raghavan (eds.) *The Oxford Handbook of Indian Foreign Policy* (Oxford University Press, 2015) pp. 145-159

L.P. Singh, "Learning the Lessons of History" in Brahma Chellaney (eds.) *Securing India's Future in the New Millennium* (Orient Longman, 1999) pp. 1-22

Harsh Pant and Kartik Bommakanti, "India's national security: challenges and dilemmas", *International Affairs*, 95 (4) (2019):835-857.

1.2 Contemporary Dimensions of India's National Security Framework

Essential Readings

Kanti Bajpai "India: Modified Structuralism" in Muthaiah Alagappa (eds.) *Asian Security Practice* (Stanford University Press, 1998) pp. 157-197

Additional Readings

Arvind Gupta, "National Security Environment" and "Non-traditional Security Issues in National Security" in *How India Manages its National Security* (Penguin Random House, 2018).

Rohan Mukherjee & David M. Malone, "Indian Foreign policy and Contemporary Security Challenges", *International Affairs*, Volume 87 (1), pp. 87–104 (2011)

1.3 Conceptualizing India's National Security

Essential Readings

Anshuman Behera and Areeba Ahsanat Moazzam, "India's National Security Discourse: A Conceptual Introduction", in Anshuman Behera & Sitakanta Mishra (eds.), *Varying Dimensions of India's National Security* (Springer 2022) pp. 3-18

P. S. Raghavan, "National Security Determinants of Foreign Policy", in Arvind Gupta and Anil Wadhwa (Ed.), *India's Foreign Policy: Surviving in a Turbulent World*, New Delhi: (Sage Publications, 2020) pp. 34-44

Additional Readings

Arvind Gupta, "How Good is India's National Security System?" in *How India Manages its National Security* (Penguin Random House, 2018)

David M. Malone, "India's Contemporary Security Challenges: More Internal than External?" in *Does the Elephant Dance? Contemporary Indian Foreign Policy* (Oxford University Press, 2011) pp. 47-74

Unit 2: Intellectual Foundations of India's Strategic Thinking

2.1 Textual Traditions: Ramayana and Mahabharata

Essential Readings

Swarna Rajagopalan, "Grand Strategic Thought in the Ramayana and Mahabharata" in Kanti Bajpai, Saira Basit and V. Krishnappa (eds) *India's Grand Strategy: History, Theory, Cases* (New Delhi: Rutledge, 2014) pp. 31-62

Additional Readings

Amrita Narlikar and Aruna Narlikar, "India's Negotiation Strategy: The Heroism of Haed Bargaining?" in *Bargaining with a Rising India: Lessons from the Mahabharata* (Oxford: Oxford University Press, 2014) pp. 24-71.

Sharad Patil, "Myth and Reality of Ramayana and Mahabharata", *Social Scientist*, Vol.4, No. 8 (1976): 68-72.

2.2 Kautilya

Essential Readings

Subrata K. Mitra, "Kautilya and the Strategic Culture of India" in Subrata K. Mitra and Michael Liebig (eds.) *Kautilya's Arthashastra: An Intellectual Portrait* (Nomos, 2016) pp. 288-316

Additional Readings

Rashed Uz Zaman, "Kautilya: The Indian Strategic Thinker and Indian Strategic Culture", *Comparative Strategy*, Volume 25, No. 3 (2006) 231-247

George Modelski, "Kautilya: Foreign Policy and International System in the Ancient Hindu World", *The American Political Science Review*, Vol-58, No-3 (Sept., 1964). pp. 549-560.

2.3 Non-Textual Conceptualizations: Swaraj, Martial Culture

Essential Readings

Arpita Anand, 'A 'Regional' Intervention in the Debate on India's Strategic Culture: Maratha Statecraft in *Agyapatra*,' *Journal of Defence Studies*, 15:3, July-September 2021. Available at: <https://idsa.in/jds/a-regional-intervention-in-the-debate-on-indias-strategic-culture-aanant>

Jayashree Vivekanandan, "Strategy, Legitimacy and the Imperium: Framing the Mughal Strategic Discourse," in Kanti Bajpai, Saira Basit and V. Krishnappa (eds.) *India's Grand Strategy: History, Theory, Cases* (New Delhi: Rutledge, 2014) pp. 63-85.

Unit 3: India's strategic culture (4 Lectures)

3.1. Evolution and conceptualization

Essential Readings

Kanti Bajpai and Amitabh Mattoo "Introduction" in *Kanti Bajpai, Amitabh Mattoo and George Tanham (eds.) Securing India: Strategic Thought and Practice* (New Delhi: Manohar, 1996) pp. 15-27

Jaswant Singh, "Strategic Culture" in *Defending India* (New Delhi: Palgrave Macmillan, 1999) pp. 1-60

3.2 Contemporary Trends

Essential Readings

Michael Liebig, 'Interrogating 'Hyphenated Cultures': India's Strategic Culture and Intelligence Culture', *Journal of Defence Studies*, 15:3, July-September 2021. Available at: <https://idsa.in/jds/interrogating-hyphenated-cultures-mliebig>

Amrita Narlikar, "Peculiar Chauvinism or Strategic Calculation? Explaining the Negotiating Strategy of a Rising India", in *International Affairs*, Vol. 82 (1) (2006): 59-76

Additional Readings

George K. Tanham, "Indian Strategic Thought: An Interpretive Essay" in *Kanti Bajpai, Amitabh Mattoo and George Tanham (eds.) Securing India: Strategic Thought and Practice* (New Delhi: Manohar, 1996) pp. 28-111

George K. Tanham, "Indian Strategy in Flux?" in *Kanti Bajpai, Amitabh Mattoo and George Tanham (eds.) Securing India: Strategic Thought and Practice* (New Delhi: Manohar, 1996) pp. 112-139

Unit 4: India's National Security Challenges

4.1 External Challenges:

4.1.1 India's Neighborhood

S. Muni, 'Problem Areas in India's Neighbourhood Policy', *South Asian Survey*, Vol. 10 (2) (2003): 185-196.

i. Cross-Border terrorism:

Essential Readings

Sanjeev Kumar HM, Chp 3 in *The India-Pakistan Sub-conventional War: Democracy and Peace in South Asia* (New Delhi: Sage, 2022), pp. 162-192.

Additional Readings

K. Santhanam, "Sources of Terror: India" in *South Asia Post-9/11: Searching for stability* (Observer Research Foundation, 2003), pp. 31-35

S.D. Muni "Introduction" in *Responding to Terrorism in South Asia* (Manohar, 2006) pp. 11-29

ii. Securitised Borders

Essential Readings

Shyam Saran, "The Pakistan Puzzle" in *How India Sees the World: Kautilya to the 21st Century* (Juggernaut, 2018) pp. 77-106

Alka Acharya, "China" in Kanti Bajpai and Harsh Pant (eds.) *India's Foreign Policy* (Oxford University Press, 2013) pp. 356-369

Additional Readings

Shyam Saran, "The India-China Border Dispute and After" in *How India Sees the World: Kautilya to the 21st Century* (Juggernaut, 2018) pp. 123-149

Shiv Shankar Menon, "India and China" in *India and Asian Geopolitics: The Past, Present* (The Brookings Institution, 2021) pp. 317-339

Tanvi Madan, "China in Three Avatars in Kanti Bajpai, Saira Basit and V. Krishnappa (eds.) *India's Grand Strategy: History, Theory, Cases* (New Delhi: Routledge, 2014) pp. 308-359

Bharat Karnad, "An Elephant with a Small Footprint: The Realist Roots of India's Strategic Thought and Policies" in Kanti Bajpai, Saira Basit and V. Krishnappa (eds.) *India's Grand Strategy: History, Theory, Cases* (New Delhi: Routledge, 2014) pp. 200-233

iii. Water Sharing

Essential Readings

Brahma Chellaney, "Water: The latest India-Pak Battle Line" in *Water: Asia's New Battleground* (Georgetown University Press, 2011) pp. 286-296.

Medha Bisht, "From the edges of borders: reflections on water diplomacy in South Asia" *Water Policy* 21 (2019): 1123–1138

Jonathan Holslag, "Assessing the Sino-Indian Water Dispute," *Journal of International Affairs*, 64:2, Spring/Summer 2011, pp. 19-35.

Additional Readings

K. Warikoo, "Perspectives of Indus Waters treaty" in Ranabir Samaddar and Helmut Reifeld (eds.) *Peace as Process: Reconciliation and conflict Resolution in South Asia* (Konrad Adenauer Foundation, 2001) pp. 281-298

Brahma Chellaney, "Nepal and Bhutan as Subregional Energy Hub" in *Water: Asia's New Battleground* (Georgetown University Press, 2011) pp. 281-286

Brahma Chellaney, "Exploiting the Riparian Advantage: A key test case" in *Water: Asia's New Battleground* (Georgetown University Press, 2011) pp. 141-197 (Includes Bangladesh)

iv. Nuclearization

Essential Readings

Ashley J. Tellis, *India's Emerging Nuclear Doctrine: Exemplifying the Lessons of Nuclear revolution*, *NBR Analysis*, 12:2, May 2001, pp. 1-16; 103-110.

Sundaram, K. and MV Ramana. "India and the policy of no first use of nuclear weapons." *Journal of Peace and Nuclear Disarmament* 1, no. 1 (2018). Taylor & Francis: 152-68.

Additional Readings

Bharat Karnad, "New Attractions of the Bomb: The Nuclearized Twenty-First Century World" in *India's Nuclear Policy* (Praeger Security International, 2008) pp. 5-34

Rajesh Basrur, "India and China: A managed nuclear rivalry?" *Washington Quarterly*, 42, no. 3 (2019). Taylor & Francis: 151-70.

Harsh V. Pant and Yogesh Joshi, *Indian Nuclear Policy*, New Delhi, Oxford University Press, 2018.

Vipin Narang, "Introduction" in *Seeking the Bomb: Strategies of Nuclear Proliferation* (Princeton University Press, 2022) pp. 1-14

4.1.2 Maritime Security

Essential Readings

S. Jaishankar, Chapter 8, "The Pacific Indian: A Re-Emerging Maritime Outlook," in *The India Way: Strategies for an Uncertain World* (New Delhi: Harper Collins, 2020), pp. 179-200.

Rajeswari Pillai Rajagopalan, "India's maritime strategy", in Anit Mukherjee and C. Raja Mohan (eds.) *India's Naval Strategy and Asian Security* (London: Routledge, 2016) pp. 13-36.

Additional Readings

Rahul Roy Chaudhary "India's Maritime Security" *India International Centre Quarterly*, Vol. 26, no. 1 (1999): 129-139

Vijay Sakhuja, "Maritime security order in Asia: a perspective from India" in Joachim Krause and Sebastian Bruns (eds.) *Routledge Handbook of Naval Strategy and Security* (London: Routledge, 2016) pp. 315-327

4.2 Internal Challenges

4.2.1 Naxalism/ Maoism

Essential Readings

P.V Ramana, "State Response to the Maoist Challenge: An Overview," in V.R. Raghavan (ed.), *The Naxal Threat: Causes, State Responses and Consequences* (New Delhi: Vij Books, 2011), pp. 71-94.

Additional Readings

E. N. Rammohan, "Rise of Naxalism, its implications for National Security and the way Forward," in V.R. Raghavan (ed.), *The Naxal Threat: Causes, State Responses and Consequences* (New Delhi: Vij Books, 2011), pp. 95-112.

Ramachandra Guha, "Adivasis, Naxalites and Indian Democracy" *Economic and Political Weekly* 42(32) (2007): 3305-3312

4.2.2 Separatist Movements (J&K/ Northeast)

Kashmir

Essential Readings

Navnita C. Behera, "India's Political Gambit" in *Demystifying Kashmir* (Brookings, 2006) pp. 30-72

Additional Readings

Rekha Chowdhry, "India's responses to the Kashmir Insurgency: A Holistic Perspective", in Moeed Yusuf (eds.) *Insurgency and counter-Insurgency in India: Through a Peacebuilding Lens* (United States Institutes of Peace, 2014) pp. 45-76.

V.G. Patankar, "Insurgency, Proxy War and Insurgency in Kashmir," in Sumit Ganguly and David P. Fidler (eds.), *India and Counterinsurgency: Lessons Learned* (New Delhi: Routledge, 2009), pp. 65-78.

Northeast

Essential Readings

Sanjib Baruah, "Regionalism and secessionism" in Niraja Gopal Jayal and Pratap Bhanu Mehta (eds.) *The Oxford Companion to Politics in India* (Oxford University Press, 2011) pp. 181-191

Additional Readings

Walter Ledweig, "Insights from the Northeast: Counterinsurgency in Nagaland and Mizoram", in Sumit Ganguly and David P. Fidler (eds.) *India and Counterinsurgency: Lessons Learned* (USA, Canada: Routledge, 2009) pp. 45-62

4.2.3 Cyber Security and Information Warfare

Essential Readings

Whagre Prateek & Shibani Mehta, "India's National Cybersecurity Policy Must Acknowledge Modern Realities" (Diplomat, 2019). <https://thedi diplomat.com/2019/12/indias-national-cybersecurity-policy-must-acknowledge-modern-realities/>

Martin C. Libicki, "The Convergence of Information Warfare". *Strategic Studies Quarterly*. 11(1), 49-65. https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-11_Issue-1/Libicki.pdf

Additional Readings

S, Datta, Cybersecurity, Internet governance and India's foreign policy: Historical antecedents (Internet Democracy Project 2016)
<https://internetdemocracy.in/reports/cybersecurity-ig-ifp-saikat-datta>.

Mukerji, Amb (Retd) A. International Cooperation on Cyber Space: India's role. (Ministry of External Affairs, 2018). <https://www.mea.gov.in/distinguished-lectures-detail.htm?743>

Unit 5: India's Strategic Responses

5.1 Non-Alignment

Essential Readings

Rajen Harshe, "India's Non-Alignment: An Attempt at Conceptual Reconstruction," *Economic and Political Weekly*, 25:7-8, February 17-24, 1990, pp. 399-405.

Khilnani, S., Rajiv Kumar and Pratap Bhanu Mehta (eds.) (2013). *Nonalignment 2.0: A Foreign & Strategic Policy for India in the 21st Century*. Penguin.

Additional Readings

P. Srivastava, "From Non-Alignment to Strategic Partnerships" *Non-Alignment Movement: Extending Frontiers* (New Delhi: Kanishka Publishers, 2001) pp. 177-182.

C Rajamohan, "Beyond Non-Alignment" in *Crossing the Rubicon: The Shaping of India's new Foreign Policy* (Viking, 2003) pp. 29-56

Pant, H.V., & Super, J.M. (2015). India's 'non-alignment' conundrum: a twentieth- century policy in a changing world. *International Affairs*, 91(4), 747-764.

5.2 Strategic Partnerships

Essential Readings

Rajiv Sikri, "India's Strategic Choices" in *Challenge & Strategy in Rethinking India's Foreign Policy* (Sage Publications, 2009) pp. 277-290

Ashley J. Tellis, "US-India Relations: The Struggle for an Enduring Partnership" in David M. Malone, C. Raja Mohan, and Srinath Raghavan (eds.) *The Oxford Handbook of Indian Foreign Policy* (Oxford University Press, 2015) pp. 481-494

Additional Readings

Teresita C. Schaffer & Howard B. Schaffer, "Indian Strategic Visions" *India at the Global High Table: The Quest for Regional Primacy & Strategic Autonomy* (Harper Collins India, 2016) pp. 60-81

C. Rajamohan, Chapter 6 on "Embracing America," in *Modi's World: Expanding India's Sphere of Influence*, New Delhi: Harper Collins, 2015.

5.3 Military Responses

Essential Readings

Dasgupta, Sunil and Stephen P. Cohen. "Is India ending its strategic restraint doctrine?", *Washington Quarterly* 34, no. 2 (2011). Taylor & Francis: 163-77.

Tarapore, Arzan. *The Army in Indian Military Strategy: Rethink Doctrine or Risk Irrelevance*. New Delhi: Carnegie India Working Paper, 2020: 1-22.

Additional Readings

Rajpal Budania, "India's Threat Perception and Policy Response" in *India's National Security Dilemmas: Pakistan Factor* (Indus Publishing Company, 2001) pp. 216-269

Singh, Sushant K. "Military as an instrument of India's foreign policy: An expanding footprint". In *The Routledge Handbook of Indian Defence Policy* (second edition) edited by Harsh V. Pant. New Delhi: Routledge, 2020.

Sumit Ganguly, "India's Defence Policy" in Niraja Gopal Jayal & Pratap Bhanu Mehta *The Oxford Companion to Politics in India* (Oxford University Press, 2011, pp. 542-554.

5.4 Multilateral Alliances:

Essential Readings

David Malone "The evolution of Indian Multilateralism" in *Does the Elephant Dance: Contemporary Indian Foreign Policy* (Oxford University Press, 2011) pp. 249-273

Saran, Shyam (2013), India and Multilateralism: A Practitioner's Perspective in Waheguru Pal Singh Sidhu, Pratap Bhanu Mehta, Bruce D. Jones (eds.), *Shaping the Emerging World: India and the Multilateral Order*, Washington DC: Brookings Institution Press, pp. 43-56

Additional Readings

Teresita C. Schaffer & Howard B. Schaffer, "Multilateral Negotiations," *India at the Global High Table: The Quest for Regional Primacy & Strategic Autonomy* (Harper Collins India, 2016) pp. 213-247.

Sanjaya Baru, "The Economic Imperative for India's Multilateralism" in Waheguru Pal Singh Sidhu, Pratap Bhanu Mehta, Bruce D. Jones (eds.) *Shaping the Emerging World: India and the Multilateral Order* (Washington DC: Brookings Institution Press, 2013) pp. 75-92

Navroz K. Dubash and Lavanya Rajamani, "Multilateral Diplomacy on Climate Change," in David M. Malone, C. Raja Mohan, and Srinath Raghavan (eds.) *The Oxford Handbook of Indian Foreign Policy* (Oxford University Press, 2015) pp. 663-680.

Rajesh Rajagopalan, "Multilateralism in India's Nuclear Policy: A Questionable Default Option," in David M. Malone, C. Raja Mohan, and Srinath Raghavan (eds.) *The Oxford Handbook of Indian Foreign Policy* (Oxford University Press, 2015) pp. 650-662.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Common Pool of GE courses for Sem-IV is at the end of the document

Suggestive readings

B.Chakrabarty and R. Pandey (2010) *Modern Indian Political Thought*, New Delhi: Sage Publications.

P. Chatterjee (1993) *The Nation and its Fragments: Colonial and Postcolonial Histories*, New Delhi: Oxford University Press.

R. Pradhan (2008) *Raj to Swaraj*, New Delhi: Macmillan (Available in Hindi).

S. Islam (2006) *Bharat Mein Algaovadaur Dharm*, New Delhi: Vani Prakashan.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-4): Understanding International Relations

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Understanding International Relations GE-4	4	3	1	-	Passed Class XII	NIL

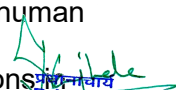
Learning Objectives

This course aims to make students understand the intersections between politics, economics, culture and nature that shape human life in the contemporary world. These intersectional relations foreground the multiple interactions that constitute the reality of the group life of humans. The issues around which the course is designed consists of the role of state in international politics, cultural identities such as the nation and, issues such as global poverty and global inequalities. Additionally, the course dwells on the psycho-cultural and politico-economic causes of violence, oppression and injustices that make the world a contested space. It examines the ways in which information technology shapes the course of human life in the age of globalization and how the phenomenon of the international manifests both in the virtual and the material world. Going beyond the Westphalian conception of territoriality, the course looks at the ways in which International Relations manifests in the realm of art/cinema/museums.

Learning outcomes

On successful completion of the course, students would be able to:

- Understand the nature of the contemporary world in which we live through connected histories, economies and societies.
- Analyze the ways in which our world is shaped in both territorial and non-territorial forms leading to basic planetary understandings of both human and non-human relations.
- Enhance cognitive abilities to map out the multiple and complex interactions international relations between peoples, histories and civilisations.


Principal
श्री वेंकटेश्वर महाविद्यालय
Sri Venkateswara College
दिल्ली विश्वविद्यालय / University of Delhi
घोला कुर्छो, नई दिल्ली / Dhola Kuan, New Delhi-21

- To understand the role of the state and its interface with the market, probe into the cultural identities of a nation, analyse global poverty and climate change politics.
- To critically analyse the politics of 'common yet differentiated responsibilities.'
- Think critically about issues of global inequalities, violence, and injustices in the age of globalization.
- Appreciate the ways in which aesthetic articulation(s) problematize and interrogate the international and our ways of being therein.

SYLLABUS OF GE-4

UNIT – I (7 Hours)

Making Sense of the World

- 1.1 What is International Relations?
- 1.2 Understanding Space: How do we sense our planet
- 1.3 Ways of knowing and being: - Peoples, Histories and Civilisations

UNIT – II (12 Hours)

States, Nations and Markets

- 2.1 State and Diffusion of authority/power
- 2.2 Nations and Nationalism
- 2.3 States and Markets

UNIT – III (12 Hours)

Inequalities

- 3.1 Politico-military inequalities: big states, small states
- 3.2 Economic inequalities: rich states, poor states
- 3.3 Climate Change: Global commons and differentiated responsibilities

UNIT – IV (7 Hours)

Sites of Conflict and Forms of Violence

- 4.1 Changing Landscape/ Nature of Conflict
- 4.2 Forms of Violence

UNIT – V (7 Hours)

Knowing our Virtual and Creative World: The Visual Turn in International Relations

- 5.1 Internet
- 5.2 Museums
- 5.3 Cinemas

Essential/recommended readings

1.1. What is International Relations?

David Blaney, "Where, When and What is IR?" in Arlene B. Tickner and Karen Smith (eds.), *International Relations from the Global South: World of Difference*, New York: Routledge, 2020, pp. 38-55.

1.2. Understanding Space: How can we understand our planet.

Simon Dalby, "What happens if we don't take nature for granted," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 39-60.

Dipesh Chakrabarty, 'The Climate of History in a Planetary Age,' London: University of Chicago Press, 2021, pp. 1-20.

1.3. Ways of knowing and being: - Peoples, Histories and Civilisations

Veronique Pin-Fat, "How do we begin to think about the world," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 20-38.
Tamara A. Trownsell, Amaya Querejazu, Giorgio Shani, Navnita Chadha Behera, Jarrad Reddekop and Arlene B. Tickner Recrafting International Relations through Relationality," *E-International Relations*, January 2019. <https://www.e-ir.info/2019/01/08/recrafting-international-relations-through-relationality/>.

Tamara A. Trownsell, Arlene B. Tickner, Amaya Querejazu, Jarrad Reddekop, Giorgio Shani, Kosuke Shimizu, Navnita Chadha Behera and Anahita Arian, 'Differing about difference: relational IR from around the world,' *International Studies Perspectives*, 22:1, February 2021, pp. 25-64.

Giorgio Shani, 'IR as inter-cosmological relations?' *International Politics Review*, 9 (2021) 306–312. <https://doi.org/10.1057/s41312-021-00120-2>.

Additional Readings:

Milja Kurki, "International Relations in a Relational Universe," *Oxford University Press* (2020) 1-16.

Arturo Escobar, 'Introduction: Another possible is possible,' and 'Theory and the un/real: Tools for rethinking "Reality" and the possible,' in *Pluriversal Politics: The Real and the Possible*, Durham: Duke University Press, 2020, pp. 1-30.

Ashish Kothari, Ariel Salleh, Arturo Escobar, Federico Demaria, Albert Acosta, 'Introduction: Finding Pluriversal Paths', in Ariel Salleh, Arturo Escobar, Federico Demaria, Albert Acosta (eds.), *Pluriverse: a post-development dictionary*, New Delhi: Tulika Books, 2019, pp. xxii-xl. Also, see, <https://kalpavriksh.org/ourteam/ashish-kothari/>

2.1 State and Diffusion of authority/power

Shibashish Chatterjee, 'Reconsidering the State in International Relations,' in Kanti and Siddharth Mallavarapu (eds.), *International Relations in India: Bringing Theory back home*, New Delhi: Orient Longman, 2005, pp. 451-489.

David Held, "The territorial State and Global Politics," in *Global Transformations: Politics, Economics and Culture*, USA: Stanford University Press, 1999, pp. 32-48.

Susan Strange, "The State of the State," in *The Retreat of the State: The Diffusion of Power in the World Economy*, Cambridge: Cambridge University Press, 1996, pp. 66- 88.

2.2 Nations and Nationalism

Andrew Heywood, "Nations and Nationalism" in *Politics*, China: Palgrave Macmillian, 2013, pp. 108-127.

Michael J. Shapiro, "Does the nation-state work?" in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 269- 287.

Elena Barabantseva, "How do people come to identify with nations?" in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 245-268.

Sanjay Chaturvedi, 'Indian Geo-politics: 'Nation-State and the Colonial Legacy' in Kanti Bajpai and Siddharth Mallavarapu (eds.), *International Relations in India: Theorising the Region and Nation*, New Delhi: Orient Longman, 2005, pp. 238-283.

2.3 States and Markets

Lavanya Rajamani, "The principle of common but differentiated responsibilities and respective capabilities in the international climate change regime" in Ludwig Kramer and Emanuela Orlando (eds.), *Principles of Environmental Law*, Sussex: Edward Elgar publishing, 2018, pp. 46-60.

David Held, Chapter five on "Corporate Power and Global Production Networks," in *Global Transformations: Politics, Economics and Culture*, Stanford: Stanford University Press, 1999, pp. 236-282.

Matthew Watson, 'Understanding the State within Modern Society' and 'Understanding the Market within Modern Society' in *Foundations of International Political Economy*, New York: Palgrave, 2005, pp. 161-196.

Additional Readings:

Thomas L. Friedman, *The World is Flat: A Brief History of the Twenty-First Century*, New York: Picador Publication, 2005, pp. 1-50.

Yuval Noah Harari, "Nationalism," in *21 Lessons for the 21st Century*, USA: Spiegel & Grau, Jonathan Cape, 2018, pp. 104-117.

Dr V. Basil Hans, 'State and the Market- Debate and Developments,' January 2014, <http://dx.doi.org/10.2139/ssrn.2373827>

Andrew Heywood, "Sovereignty, the Nation and Supranationalism," in *Political Ideas and Concept*, New York: St. Martin's Press, 1994, pp. 48-77.

Stuart Elden, "Why the World Divided Territorially," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, , pp. 220-244.

Robert Gilpin, "Nature of political economy," in *Global Political Economy: Understanding the International Economic Order*, Princeton: Princeton University Press, 2001, pp- 25-45.

Stephen D. Krasner, 'Sharing Sovereignty: New Institutions for Collapsed and Failing States,' *International Security*, 29: 2, 2004, pp. 85-120.

Susan Strange, Chapters 3-6, on 'The Security Structure', 'The Production Structure', 'The Financial Structure', 'The Knowledge Structure', in *States and Markets*, London: Bloomsbury, 2015,

Unit 3. Inequalities

Mohammad Ayoob, 'Inequality and Theorizing in International Relations: The Case for Subaltern Realism,' *International Studies review*, 4:3, 2002, pp. 27-48.

3.1 Mapping inequalities in IR

Joao Pontes Nogueira, "Inequality," in Arlene B. Tickner and Karen Smith (eds.), *International Relations from the Global South: World of Difference*, New York: Routledge, 2020, pp. 240-255.

Paul Cammack, "Why are Some People Better off than Others," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 405-428.

3.2 Climate Change: Global commons and differentiated responsibilities

A. Damodaran, 'Encircling the Seamless- India, Climate Change, and the Global Commons,' Oxford University Press, 2010, India. Chapters 1 and 2.

Additional Readings:

Amartya Sen, "Capabilities and Resources," in *The Idea of Justice*, New York: Penguin Books, 2009, pp. 253-268.

Amartya Sen, "Measures of Inequality," in *On Economic Inequality*, New York: Press Oxford, 1997, pp. 24-46.

Dipesh Chakrabarty, Chapter 7 on 'Anthropocene Time,' in *The Climate of History in a Planetary Age*, University of Chicago Press London, 2021, pp. 155-181.

Graham Thompson, "Global Inequality, Economic Globalization and Technological Change," Chapter Eleven in 'A World of Whose Making- Ordering the International: History, Change and Transformation' by William Brown, Simon Bromley, and Suma Athreye. Pluto Press, 2004, pp. 377-415.

Unit 4. Sites of Conflict and Forms of Violence

Arlene B. Tickner, "War and Conflict," in Arlene B. Tickner and Karen Smith (eds.), *International Relations from the Global South: World of Difference*, New York: Routledge, 2020, pp. 115-138.

4.1 Changing Landscape/ Nature of Conflict

Michael Dillon, "What makes the world dangerous," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 519-538

Mary Kaldor, 'In Defense of New Wars', *Stability: International Journal of Security and Development*, 2:1, 2013, 1-16. <http://dx.doi.org/10.5334/sta.at>.

4.2 Forms of Violence

Joanna Bourke, "Why Does Politics Turns into Violence?" in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 472-495.

Anuradha M. Chenoy, "Militarization, Conflict and Women in South Asia," in Lois Ann Lorentzen and Jennifer Turpin (eds.), *The Women and War Reader*, New York: New York University Press, 1998, pp. 101-110.

Additional Readings:

Roland Bleiker, "Can we move beyond Conflict," in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 564- 589.

David Held, "Expanding reach of organized violence," in *Global Transformations: Politics, Economics and Culture*, Stanford: Stanford University Press, 1999, pp. 87- 92.

5.1 Internet

M. I. Franklin, "How does the way we use the Internet make a difference?" in Jenny Edkins and Maja Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, 2008, pp. 176-199.

Jr. Harry M. Cleaver, 'The Zapatista Effect: The Internet and the Rise of an Alternative Political Fabric,' *Journal of International Affairs*, 51:2, 1998, pp. 621- 640.

5.2 Museums

Christine Sylvester, "Can International Relations and Art/Museums Come Together," in *Art/Museums: International Relations Where We Least Expect it*, New York: Routledge, 2016, pp. 1-24.

<https://www.ushmm.org/teach/teaching-materials/holocaust>

<https://www.partitionmuseum.org/event/remembering-the-jallianwala-bagh-massacre-100-years-later/>

5.3 Cinemas

Cynthia Weber, "Culture, Ideology, and the Myth Function in IR Theory," in *International Relations Theory: A Critical Introduction*, London: Routledge, 2013, pp. 1-12.

Cynthia Weber, "Case Study: Modernization and Development theory: is there a clash of civilizations? Movie analysis of East is East," in *International Relations Theory: A Critical Introduction*, London: Routledge, 2013, pp. 173-202.

Additional Readings:

Maria Elena Martinez- Torres, 'Civil Society, the Internet, and the Zapatistas,' *Journal of Social Justice*, 13:3, 2001, pp. 347-355.

Lene Hansen, Rebecca Adler-Nissen and Katrine Emelie Andersen, 'The visual international politics of the European refugee crisis: Tragedy, humanitarianism, borders,' *Cooperation and Conflict*, 56:44, 2021, pp. 367-393.

Mirzoeff, Nicholas, "Global Visual Cultures" in *An Introduction to Visual Culture* 2nd Edition, London: Routledge, 2009, pp. 1-16.

Azmat Rasul and Mudassir Mukhtar, 'Bollywoodization of foreign policy: How film discourse portrays tensions between states' *Journal of Media Critiques*, 1:1, June 2015, pp. 11-27.

Roland Bleiker, *Visual Global Politics*, London and New York: Routledge, 2018, pp.1-29.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-5): Governance: Issues and Challenges

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Governance: Issues and Challenges GE-5	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This paper deals with concepts and different dimensions of governance highlighting the major debates in the contemporary times. There is a need to understand the importance of the concept of governance in the context of a globalising world, environment, administration, development. The essence of governance is explored through the various good governance initiatives introduced in India.

Learning outcomes

On successful completion of the course, the students will be

- acquainted with the changing nature of governance in the era of globalization.
- introduced to the most contemporary ideas of sustainable development and green governance.
- familiarised with a rigorous introduction to the best practices in India on good governance.

SYLLABUS OF GE-5

J. Barnes (ed.), *The Cambridge Companion to Aristotle*. Cambridge: Cambridge University Press.

Q. Skinner (2000) *Machiavelli: A Very Short Introduction*, Oxford: Oxford University Press, pp. 23-53

Unit 2

C. Macpherson (1962) *The Political Theory of Possessive Individualism: Hobbes to Locke*. Oxford University Press.

D. Boucher and P. Kelly (eds) *Political Thinkers: From Socrates to the Present*. Oxford: Oxford University Press, pp. 207-224

J. Coleman (2000) 'Introduction', in *A History of Political Thought: From Ancient Greece to Early Christianity*, Oxford: Blackwell Publishers.

I. Hampsher-Monk (2001) *A History of Modern Political Thought: Major Political Thinkers from Hobbes to Marx*, Oxford: Blackwell Publishers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-7): Politics of Globalisation

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Politics of Globalisation GE-7	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This course examines the paradoxes of contemporary globalisation. It has been crafted in a manner as to introduce to the students from diverse disciplinary backgrounds the complex multifaceted nature of the contemporary phenomenon of globalization. Students will learn about the evolution of globalization by examining whether globalization is a mere historical process, or, it is also a socio-cultural, politico-economic and, psychological phenomenon and, understand these through different conceptual frames. It then makes the students understand the debates that have been put forth for and against globalization. The course introduces the discourse regarding the Eurocentric formulations of globalization and the ways in which the non-European voices have historically been marginalized in the shaping of Western modernity. Students will also learn about the political, economic and cultural facets of globalization. As a political phenomenon, the course seeks to understand as to how globalization has impacted upon the functioning of the sovereignty of nation-states. In the realm of economy, it introduces the impact of time/space compression upon the macroeconomic structures of trade and finance as well as the structural transformation that information and communications technology has brought in the working of the global political economy. As a cultural phenomenon, the course also discusses the new global mobilizations in the form of global social movements, movements of people across borders and the political and economic impact of global epidemics.

Learning outcomes

Upon successful completion of this course, students will have the knowledge and skills to:

- Understand the nature, significance, and principal debates in the literature on globalisation and the concept of globalization as both a historical process and, a socio-cultural phenomenon.
- Study various approaches which will augment student's knowledge on international political economy.
- Demonstrate basic knowledge of the interconnectedness of global issues, processes, and dynamics.
- Develop insight into the alternative understanding of globalisation and various critical aspects related to it like who are the beneficiaries in this process.
- Understand diverse global challenges like global migration and epidemics.
- Learn the ways in which globalization holds promise for a better world and a developed world and, at the same time, understand how it is laden with deep-seated tendencies to engender strands of inequalities and spur erosion of local cultures.

SYLLABUS OF GE-7

UNIT – I (9 Hours)

Conceptualizing Globalisation

- 1.1 Is Globalisation New? Historical Perspectives
- 1.2 Approaches to Understand globalisation
- 1.3 The Globalisation Debate

UNIT – II (9 Hours)

Globalization: A Eurocentric Project?

- 2.1 The Question of Post-Coloniality
- 2.2 Making Sense of Globalization for the People at the Margins

UNIT – III (9 Hours)

Sovereign State in a Globalised World

- 3.1 Political Dimensions
- 3.2 Shift from State to Market?

UNIT – IV (9 Hours)

Role of International Institutions: Multi-dimensionality of Globalisation

- 4.1 World Bank, International Monetary Fund, World Trade Organisation and, G-20
- 4.2 The Globalisation of Trade
- 4.3 Global Epidemics and Working of World Health Organization

UNIT – V (9 Hours)

Responses and Resistances to Globalization

- 5.1 Global Social Movements
- 5.2 International Migration

Essential/recommended readings

Unit 1. Conceptualizing Globalisation

Essential Readings

1.1 Is Globalisation New? Historical Perspectives

Hirst, Paul and Thompson, G. “*Globalisation in Question*” (Third Edition), UK: Polity Press, 2009, pp. 25-52.

Ritzer, George and Paul D. Paul, *Globalization: A Basic Text* (Second Edition), UK: Wiley Blackwell, 2015, pp. 14-53.

1.2 Approaches to Understand Globalisation

Held, D and et. al. "Rethinking Globalisation" in Held, David and Anthony McGrew (eds.) *The Global Transformations Reader: An Introduction to the Globalisation Debate*, (Second Edition). Cambridge: Polity Press, Blackwell Publishing, 2003, pp. 60-67.

Ritzer, G and Dean, P. *Globalisation: The Essentials*, UK: Wiley-Blackwell, 2019, pp. 55-92.

1.3 The Globalisation Debate

Bishop, Matthew Louis & Anthony, "The political economies of different Globalizations: Theorising Reglobalization", *Globalizations*, Vol. 18, June 2020, pp. 1-21.

Keohane, Robert O. and Nye Jr, Joseph S., "What's New? What's Not? (And So What?)" in Held, D and McGrew, A (ed.), *The Global Transformations Reader: An Introduction to the Globalisation Debate* (2nd edition). Cambridge: Polity Press, Blackwell Publishing, 2003, pp. 75-84.

Additional Readings

Held, David and Anthony McGrew (eds.) *The Global Transformations Reader: An Introduction to the Globalisation Debate* (Second Edition). Cambridge: Polity Press, Blackwell Publishing, 2000, pp 1-42.

Bhagwati, J. "*In Defence of Globalisation*", UK: Oxford University Press, 2007, pp. 3-36, 199-220.

Dwivedi, Sangit S., "Localisation vs Globalisation: A Conscious Vision of India" in Tyagi, R., S. Mangla and Giri (eds.), *Glocalization and Federal Governance in India*, Bloomsbury. 2019, pp. 141-154.

Michie, Jonathan. (eds.), "Globalisation in Questions?", *Handbook of Globalisation*, UK, Edward Elgar, 2003, pp: 17-79.

McGrew, A. "Globalisation and Global Politics" in Baylis J., Smith and Owens (eds.), *The Globalisation of World Politics: An Introduction to International Relations*, New York: Oxford University Press. 2017, pp. 15-31.

Unit 2. Globalization: A Eurocentric Project?

Essential Readings

2.1 The Question of Post-Coloniality

Chatterjee, P. *Our Modernity* (SEPHIS) and (CODESRIA), Rotterdam/Dakar. 1997 pp. 3-20.

Sanjeev Kumar H.M., "Contesting Modernity: Crisis of Democratization in South Asia," *India Quarterly*, LXIV (4), October-December 2008, pp. 124-155.

2.2 Making Sense of Globalization for the People at the Margins

Vandana Shiva, "Ecological Balance in an Era of Globalisation," in Frank J. Lechner and John Boli (eds.), *The Globalization Reader*, Oxford: Blackwell, 2004: pp. 422-429.

Kirsten Foot, "Actors and Activities in the Anti-Human Trafficking Movement," in Jorge Heine and Ramesh Thakur (eds.), *The Dark Side of Globalization*, Tokyo: UN University Press, 2011, pp. 249-265.

Additional Readings

Sen, A. "Introduction" and "The Perspective of Freedom" *Development as freedom* (2nd ed.). New York: Oxford University Press. 2001 pp.1- 34.

Hirst, P. and Thompson, G. "The Future of Globalization", *Cooperation and Conflict*, Vol. 37, No. 3, Special Issue on Globalization, *Cooperation and Conflict*, September 2002, pp. 247-265.

Appadurai, Arjun. *Modernity at Large: Cultural Dimensions of Globalisation*. Minneapolis: University of Minnesota Press, 1996, pp. 66-88.

Ashcroft, Bill, Gareth Griffiths, and Helen Tiffins, eds. *The Empire Writes Back: Theory and Practice in Post-Colonial Literature*. London: Routledge, 1989, pp.1-32; 193-220.

Gustava Esteva and Madhu Suri Prakash, "From Global to Local: Beyond Neo-liberalism to International Hope," in Frank J. Lechner and John Boli (eds.), *The Globalization Reader*, Oxford: Blackwell, 2004: pp. 410-416.

Research Foundation for Science, Technology and Diversity, "Jaiv Panchayat: Biodiversity Protection at the Village Level," in Robin Broad (ed.), *Global Backlash: Citizen Initiatives for a Just World Economy*, Boulder: Rowman and Littlefield, 2002, pp. 269-272.

Unit 3. Sovereign State in a Globalised World

Essential Readings

3.1 Political Dimensions

Bull, Hedley. "Beyond the state system?" in Held, David and Anthony McGrew (eds.) *The Global Transformations Reader: An Introduction to the Globalisation Debate* (Second Edition). Cambridge: Polity Press, Blackwell Publishing, 2000, pp 577-582.

Elizabeth, A. and Ozioko, M. V, *Effect of Globalisation on Sovereignty of States*, UN Document, 2000, pp. 256-270.

3.2 Shift from State to Market?

Susan Strange, "The Declining Authority of States," in in Frank J. Lechner and John Boli (eds.), *The Globalization Reader*, Oxford: Blackwell, 2004: pp. 219-224.

Jessica T. Mathews, "Power Shift," in David Held and Anthony McGrew (eds.), *The Global Transformations Reader: An Introduction to the Globalisation Debate* (Second Edition). Cambridge: Polity Press, Blackwell Publishing, 2003, pp. 204-212.

Unit 4. Role of International Institutions: Multi-dimensionality of Globalisation

Essential Readings

4.1 World Bank, International Monetary Fund, World Trade Organisation and, G-20

Coffey Peter, Riley, Robert, *Reform of the International Institutions - The IMF, World Bank and the WTO*, Part-2, Edward Elgar Publishing, 2006, pp. 12-84.

Dash, P., Shaw, Khandelwal, "Evolution of G20 Process: From Crisis Management to Development Cooperation", *G 20 Digest*, pp. 5-12. Available at: <https://www.g20-insights.org/wp-content/uploads/2020/01/Dash Shaw Khandelwal Evolution G20.pdf>

4.2 The Globalisation of Trade

Woods, N. "International Political Economy in an Age of Globalisation", and Watson, M. "Global Trade and Global Finance", in Baylis J., Smith and Owens (eds.) *The Globalisation of World Politics: An Introduction to International Relations*, New York: Oxford University Press. 2017, pp. 243-257, 417-428.

4.3. Global Epidemics and Working of World Health Organization

Editors, CFR. "What does the World Health Organisation do?" *Council on Foreign Relations*, 29 Jan. 2021, New York: 1-14. <https://www.cfr.org/backgrounder/what-does-world-health-organization-do>

Lee, Kelley and Julliane Piper, "The WHO and Covid-19 Pandemic", *Global Governance and Review of Multilateral Organizations*, 2020. <https://brill.com/view/journals/gg/gg-overview.xml>

Additional Readings

Stiglitz, J. "The Promise of Global Institutions", *Globalisation and its Discontents*, New York: Norton, 2002, pp. 3-22.

Cypher, J. and Dietz, J. "The International Monetary Fund, the World Bank and Foreign Aid", *The Process of Economic Development*. New York: Routledge, 2009, pp. 555-591.

Oatley, Thomas, "Trade and Development: Import Substitution Industrialization", *International Political Economy: Interests and Institutions in the Global Economy*, 2011. 5th ed, pp. 111-132.

Hoekman, B. and Kostecki, M, "The Trading System in Perspective", *The Political Economy of the World Trading System: From GATT to WTO*, 3rd Ed, 2009, New York: OUP, pp. 7-57.

Friedman, T., *Lexus and the Olive Tree: Understanding Globalization*, 2000, New York: Anchor, pp. 101-142.

Gilpin, Robert, *The Challenge of Global Capitalism: The World Economy in the 21st Century*, USA: Princeton University Press, 2000, pp. 15-52, 293-324.

Charles, Cliff. *The Role of the World Health Organisation in the International System*. London: Chatham House, 2013: 1-51.

Lorena, Barberia et.al. "The Political Science of Covid-19: An Introduction", *Social Science Quarterly*, 2021. pp. 2045-2054.

Lebni Javed Y. and Abbas Jaffar et al., "How the COVID-19 pandemic affected economic, social, political, and cultural factors: A lesson from Iran", *Journal of Social Psychiatry*, 2021, 63 (7). pp: 298-300

Unit 5. Responses and Resistances to Globalization

Essential Readings

5.1 Global Social Movements

Donatella della Porta, et al, "The Study of Social Movements: Recurring Questions" and "Social Movements and Democracy", *Social Movements in a Globalising World*, UK: Macmillan, 1999, pp. 3-23; 223-248.

5.2 International Migration

Keeley, B. "International Migration: The Human Face of Globalisation", OECD, 2009, pp: 9-40

Inglis Christine et al (edited), "Introduction," in *The Handbook of International Migration*, New Delhi: Sage Publication, 2020, pp. 1-17

Additional Readings

Khagram, Sanjeev et al (ed.) "Women's Rights are Human Rights", and "Globalisation, Global Alliances, and the Narmada Movement", *Restructuring World Politics: Transnational Social Movements: Social Movements, Protest, and Contention, Volume 14*, MN: University of Minnesota Press. 2002. pp. 96-122; pp. 231-244

Berger, S., "Globalisation and Politics", *Annual Review of Political Science*, 2000, vol- 3, pp. 43-62.

Schaeffer, Robert K. *Social Movement and Global Social Change: The Rising Tide*, UK: Rowman & Littlefield, 2014, pp. 1-18.

Tarrow, S. "The Global in the Local: Global Framing", *The New Transnational Activism*, New York: Cambridge University Press, 2005, pp 35-59.

Suggestive readings

Gottlieb, G. "*Nation against State: New Approach to Ethnic Conflicts and The Decline of Sovereignty*", New York: Council on Foreign Press, 1993, pp: 6-47

Smith, G. and Naim, M. *Altered States: Globalization, Sovereignty and Governance*, IDRC, 2000. pp. 5-20.

Hardt, M. and Negri, A., "Passages of Sovereignty", *Empire*, England: Harvard University Press, 2000 pp. 67-183.

Stiglitz, J. E., *Globalization and Its Discontents Revisited: Anti-Globalization in the Era of Trump*, New York: W.W. Norton & Company, 2018. pp. 89-132

कोर्स से सम्बन्धित हिंदी माध्यम की पुस्तकें

दुबे, अभय कुमार (संपादक), *भारत का भूमंडलीकरण, लोक चिंतन ग्रंथमाला*, नई दिल्ली: वाणी प्रकाशन, २००३

पंत, पुष्पेश, *भूमंडलीकरण एवं भारत*, नई दिल्ली: एक्सेसपब्लिशिंग, २०१६

खन्ना, वीएन, *अंतराष्ट्रीय सम्बन्ध*, नॉएडा (उप्र): विकास पब्लिशिंग हाउस, २०२०

चक्रवर्ती, बिद्युत एवं प्रकाश चंद कंडपाल, *वैश्वीकृत दुनिया में लोक प्रशासन: सिद्धांत और पद्धतियाँ*, २०१८

भार्गव, नरेश, *वैश्वीकरण: समाज शास्त्रीय परिप्रेक्ष्य*, २०१४

पांडेय, ब्रज कुमार, *भूमंडलीकरण की समझ*, महावीर प्रकाशन दिल्ली

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-8): Introduction to Public Policy

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introduction to Public Policy GE-8	4	3	1	-	Passed Class XII	NIL

Learning Objectives

The paper seeks to provide an understanding to the concept of Public Policy. Public Policy is a proposed course of action of a government to realize its socio-economic objectives. The essence of public policy lies in its effectiveness in translating the governing philosophy into programmes and policies and making it a part of community living. This course will help to understand the complexities of public policy and its interaction with the socio-economic structure.

Learning outcomes

By the end of this course a student will acquire the following knowledge and skills.

- Contextualization of knowledge;
- Praxis and technique;
- Critical Thinking;
- Research and Communication

SYLLABUS OF GE-8

UNIT – I (10 Hours)

Public Policy

- Concept, Characteristics and Significance

Discipline Specific Elective (DSE) Courses for Sem – V

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3a: International Political Economy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
International Political Economy DSE-3a	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This course introduces to the students the significant linkages that exist between politics and economics in the domain of International Relations by apprising them about the meaning, nature and conceptual foundations of the field of International Political Economy. In doing this the course examines the structural functional linkages that exist between the macro-economic global structure and the systemic contours of global politics. Students will learn about the traditional as well as critical theoretical frameworks employed to examine the nature and functioning of international political economy. These theories include economic nationalism, liberalism and neo-Marxism on the one hand and historical sociology, feminism and postcolonialism on the other. Based on these conceptual and theoretical foundations, the course then attempts at delineating the major issues pertaining to the nature and functioning of the global political economy specially focusing on international trade, development and finance. The course also looks at the key constitutive elements of global economic governance including multilateral and regional institutions, regimes and multinational corporations. Further, the course introduces the students to key concerns pertaining to global economic crises, and the indicators of information communications technology (ICT), cyber economy and the global civil society.

Learning outcomes

By the completion of the course the students would be able to:

- Develop a basic understanding of the structural functional linkages that connect the realms of politics and economics.
- Learn to use the conceptual tools and theoretical frameworks for understanding the nature and basic functioning of the international political economy.
- Understand the structural drivers that determine the contours of international trade and finance.
- Develop an understanding about the Global South's contribution to this field both in the domain of ideas and working of the global political economy.
- Understand how our economic life is getting transformed on account of the information and communication technology, the cyber economy and interventions of the global civil society.

SYLLABUS OF DSE-3a

UNIT – I (2 Hours)

Introduction: Understanding the intersectionality between politics and economy

UNIT – II (14 Hours)

Theoretical Perspectives

- a. Economic Nationalism, Liberalism and Structuralism
- b. Historical Sociology, Feminism and Postcolonialism

UNIT – III (12 Hours)

International Trade and Development

- a. International trade
- b. Multinational corporations
- c. Perspectives from the Global South and the Indian Story

UNIT – IV (8 Hours)

International Finance

- a. International finance and monetary structure
- b. International and regional financial institutions

UNIT – V (9 Hours)

New Directions and New Challenges

- a. ICT and Cyber economy
- b. Economic Crises
- c. Global Civil Society

Essential/recommended readings

Unit 1. Introduction: Understanding the intersectionality between politics and economy

Essential Readings

Gilpin, Robert (2001), "The Nature of Political Economy", in *Global Political Economy: Understanding the International Economic Order*, Princeton, N.J.: Princeton University Press, pp. 25-45.

Balaam, David N. and Bradford Dillman (2014), "What Is International Political Economy?", in *Introduction to International Political Economy*, 6th edition, Boston: Pearson, pp. 2-24.

Additional Readings

Gilpin, Robert (2001), "Introduction: The Fragile Global Economy" and "The Second Great Age of Capitalism", in *The Challenge of Global Capitalism: The World Economy in the 21st Century*, Princeton, N.J.: Princeton University Press, pp. 3-51.

Frieden, Jeffrey and Lisa Martin (2002), "International Political Economy: Global and Domestic Interactions," in Ira Katznelson and Helen Milner, eds., *Political Science: The State of the Discipline*, New York & London: W. W. Norton & Co., pp. 118-146.

Hirst, Paul, Grahame Thompson and Simon Bromley (2009), "Globalization and the History of the International Economy", in *Globalization in Question*, third edition, Cambridge: Polity Press, pp.54-107.

Strange, Susan (1970), "International Economics and International Relations: A Case of Mutual Neglect", *International Affairs*, 46 (2): 304- 315.

Unit 2.a. Economic Nationalism, Liberalism and Structuralism

Essential Readings

Balaam, David N. and Bradford Dillman (2014), "Laissez-Faire: The Economic Liberal Perspective", "Wealth and Power: The Mercantilist Perspective", and "Economic Determinism

and Exploitation: The Structuralist Perspective”, in *Introduction to International Political Economy*, 6th edition, Boston: Pearson, pp. 25-52; 53-77; 78-100.

Martinussen, John (1997), “Neo-Marxist Theories of Underdevelopment and Dependency”, in *Society, State and Market: A guide to competing theories of development*, London: Zed Books Ltd., pp. 85-100.

Gilpin, Robert (1987), “Three Ideologies of Political Economy”, in *The Political Economy of International Relations*, Princeton: Princeton University Press, pp. 25-64.

Strange, Susan (2003), “States, Firms, and Diplomacy”, in Jeffrey A. Frieden and David A. Lake (ed.) *International Political Economy: Perspectives on Global Power and Wealth*, Fourth Edition, London and New York: Routledge, pp. 60-68.

Additional Readings

O'Brien, Robert and Marc Williams (2016), “Theories of Global Political Economy”, in *Global Political Economy: Evolution and Dynamics*, Fifth Edition, London: Palgrave, pp. 6-21.

Frank, Andre Gunder (1966) “The Development of Underdevelopment,” *Monthly Review*, 18 (4): 17-31.

Wallerstein, Immanuel (1974), “The Rise and Future Demise of the World-Capitalist System: Concepts for Comparative Analysis”, *Comparative Studies in Society and History*, 16 (4): 387-415.

Gilpin, Robert (2001), “The Neoclassical Conception of Economy”, “The Study of International Political Economy”, and “New Economic Theories”, in *Global Political Economy: Understanding the International Economic Order*, Princeton, N.J.: Princeton University Press, pp. 46-128.

Shaikh, Anwar (2005), “The Economic Mythology of Neoliberalism”, in Alfredo Saad-Filho and Deborah Johnston (eds.) *Neoliberalism: A Critical Reader*, London: Pluto Press, pp. 41-49.

Lenin, V.I. (1997), “The Export of Capital”, and “Imperialism as a Special Stage of Capitalism”, reproduced in George T. Crane and Abba Amawi (eds.) *The Theoretical Evolution of International Political Economy: A Reader*, New York: Oxford University Press, pp. 98-101.

Unit 2.b. Historical Sociology, Feminism and Postcolonialism

Essential Readings

Hobson, John M. (1997), “A sociology of international relations and an international relations of sociology”, in *The Wealth of States: A Comparative Sociology of International Economic and Political Change*, Cambridge: Cambridge University Press, pp. 1-22.

Griffin, Penny (2017), “Gender and the Global Political Economy”, *Oxford Research Encyclopedia of International Studies*, URL: <https://doi.org/10.1093/acrefore/9780190846626.013.187>

Bhambra, Gurinder K. (2020) “Colonial global economy: towards a theoretical reorientation of political economy”, *Review of International Political Economy*, 28 (2): 3017-322.

Additional Readings

Escobar, Arturo (1984), “Discourse and Power in Development: Michel Foucault and the Relevance of his Work to the Third World”, *Alternatives: Global, Local, Political*, 10 (3): 377-400.

Gill, Stephen and David Law (1993), “Global hegemony and the structural power of capital”, in Stephen Gill (ed.) *Gramsci, Historical Materialism and International Relations*, Cambridge: Cambridge University Press, pp. 93-124.

Steans, Jill (1999), "The Private is Global: Feminist Politics and Global Political Economy," *New Political Economy*, Vol. 4, No. 1, pp.113-128.

Griffin, Penny (2007), "Refashioning IPE: and How Gender Analysis Teaches International (Global) Political Economy", *Review of International Political Economy*, Vol. 14, No. 4, pp. 719-736.

Rai, Shirin M. (2002), "Gender and Development: Theoretical Perspectives in Context", *Gender and the political economy of development: from nationalism to globalization*, Oxford: Polity, pp. 44-83.

Unit 3.a. International Trade

Essential Readings

O'Brien, Robert and Marc Williams (2016), "International Trade", in *Global Political Economy: Evolution and Dynamics*, Fifth Edition, London: Palgrave, pp. 102-124.

Krasner, Stephen D. (2003), "State Power and the Structure of International Trade", in Jeffrey A. Frieden and David A. Lake (ed.) *International Political Economy: Perspectives on Global Power and Wealth*, Fourth Edition, London and New York: Routledge, pp. 19-36.

Additional Readings

Archer, Candace and Stefan Fritsch (2010) "Global fair trade: Humanizing globalization and reintroducing the normative to international political economy", *Review of International Political Economy*, 17: 103-128.

Gilpin, Robert (1987), "The Politics of International Trade", in *The Political Economy of International Relations*, Princeton: Princeton University Press, pp. 171-230.

Ruggie, John Gerard (1982) "International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order", *International Organization*, 36 (2): 379-415.

Baracuh, Braz (2012), "The Geopolitics of Multilateralism: The WTO Doha Round Deadlock, the BRICs, and the Challenges of Institutionalised Power Transitions," *CRP Working Paper Series*, No. 4, January. URL: <https://documents.net/document/the-geopolitics-of-multilateralism-the-wto-doha-round-deadlock.html>

Unit 3.b. Multinational corporations

Essential Readings

Hirst, Paul, Grahame Thompson and Simon Bromley (2009), "Multinational Companies and the Internationalization of Business Activity", in *Globalization in Question*, third edition, Cambridge: Polity Press, pp. 109-149.

Balaam, David N. and Bradford Dillman (2014), "Transnational Corporations: The Governance of Foreign Investment", in *Introduction to International Political Economy*, 6th edition, Boston: Pearson, pp. 432-457

Additional Readings

Gilpin, Robert (1987), "Multinational Corporations and International Production", *The Political Economy of International Relations*, Princeton: Princeton University Press, pp. 231-26.

Fieldhouse, David (2003) "A New Imperial System'? The Role of the Multinational Corporations Reconsidered", in Jeffrey A. Frieden and David A. Lake (ed.) *International Political Economy: Perspectives on Global Power and Wealth*, Fourth Edition, London and New York: Routledge.

Unit 3.c. Perspectives from Global South and the Indian Story

Essential Readings

Buzan, Barry and George Lawson (2016), "The Impact of the 'Global Transformation' on Uneven and Combined Development", in Alexander Anievas and Kamran Matin (eds.) *Historical Sociology and World History Uneven and Combined Development over the Longue Durée*, London: Rowman & Littlefield International, pp. 171-184.

David L. Blaney and Naeem Inayatullah (2016), "The Stakes of Uneven and Combined Development" in Alexander Anievas and Kamran Matin (eds.) *Historical Sociology and World History Uneven and Combined Development over the Longue Durée*, London: Rowman & Littlefield International, pp. 239-250.

Mukherjee, Aditya (2010) "Empire: How colonial India made modern Britain", *Economic and Political Weekly*, 45(50), 73– 82.

Dadabhai Naoroji (1901), "Deficit of Imports Compared with the exports of India"; "The Drain to England"; "Increase of the Drain"; "Small Amount of Imports from England"; "India's Tribute"; and "The Elements of the Drain", in *Poverty and Unbritish Rule in India*, London: Swan Sonnenschein & Co., Ltd, pp.28-34.

Subrahmanyam, Sanjay (1988) "Commerce and State Power in Eighteenth-Century India: Some Reflections", *South Asia Research* 8 (2): 97-110.

Additional Readings

Dutt, Romesh (1902), "External Trade", and "Finance And The Economic Drain, 1793-1837", in *The Economic History of India: Under Early British Rule, Vol. 1: From The Rise Of The British Power In 1757 To The Accession Of Queen Victoria In 1837*, Great Britain: Kegan Paul, Trench, Trübner, pp. 291-302; 398-420.

Chaudhuri, K.N. (1983), "Foreign Trade and Balance of Payments (1757-1947)", in Dharma Kumar (ed.) *The Cambridge Economic History Of India, Volume 2: c. 1757-c. 1970*, Cambridge: Cambridge University Press, 804-877.

Shaikh, Anwar (2006), "Globalization and the myth of free trade", in Anwar Shaikh (ed.) *Globalization and the Myths of Free Trade*, London and New York: Routledge, pp. 50-68.

Acemoglu, Daron and James A. Robinson (2013), "Reversing Development" and "The Virtuous Circle", in *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. London: Profile Books, pp. 245-273, 302-334.

Chibber, Vivek (2003), "Late Development and State-Building", *Locked in Place: State-Building and Late Industrialization in India*, Princeton: Princeton University Press, pp. 13-48.

Daron Acemoglu and James A. Robinson (2017), "The economic impact of colonialism", in Stelios Michalopoulos and Elias Papaioannou (eds.) *The Long Economic and Political Shadow of History: Volume I. A Global View*, London: CEPR Press, pp. 81-88.

Unit 4.a. International finance and monetary structure

Essential Readings

Balaam, David N. and Bradford Dillman (2014), "The International Monetary and Finance Structure", in *Introduction to International Political Economy*, 6th edition, Boston: Pearson, pp. 151-177

Eric Helleiner (2017), "The Evolution of the International Monetary and Financial System", in John Ravenhill (ed.) *Global Political Economy*, fifth edition, Oxford: Oxford University Press, 119-224.

Additional Readings

Setser, Brad (2008), "A Neo-Westphalian International Financial System?", *Journal of International Affairs*, Vol. 62, No. 1, pp. 17-34.

Wade, Robert (2006), "Choking the South", *New Left Review*, Vol. 38, March/April, pp. 115-127.

Unit 4.b. International and regional financial institutions

Essential Readings

Williams, Marc (2012), "Global Economic Institutions" in Richard Devetak, Anthony Burke and Jim George (eds.) *An Introduction to International Relations*, second edition, Cambridge: Cambridge University Press, pp. 336-347.

Rana, Pradumna B. and Ramon Pacheco Pardo (2018), "Rise of Complementarity between Global and Regional Financial Institutions: Perspectives from Asia", *Global Policy*, 9 (2): 231-243.

Wihtol, Robert (1988), "The Asian Development Bank", in *The Asian Development Bank and Rural Development: Policy and Practice*, London: Macmillan Press, pp. 16-30.

Additional Readings

Vetterlein, Antje (2012), "Seeing Like the World Bank on Poverty," *New Political Economy*, Vol. 17, No. 1, pp. 35-58.

Picciotto, Robert (2003), "A New World Bank for a New Century", in C. Roe Goddard, Patrick Cronin and Kishore C. Dash (eds.) *International Political Economy: State-Market Relations in a Changing Global Order*, Boulder, Colo. : Lynne Rienner, pp. 341-352.

Cooper, Andrew F. (2017), "The BRICS' New Development Bank: Shifting from Material Leverage to Innovative Capacity", *Global Policy*, 8 (3): 275-284.

Lisa L. Martin (2006), "Distribution, Information, and Delegation to International Organizations: The Case of IMF Conditionality," in Darren G. Hawkins et al. (eds.) *Delegation and Agency in International Organizations*, Cambridge: Cambridge University Press, pp. 140-164.

Oatley, Thomas (2019), "Developing Countries and International Finance II: The Global Capital Flow Cycle", in *International Political Economy*, Sixth Edition, New York and London: Routledge, pp. 428-453.

Sinha, Aseema (2021) "Understanding the 'crisis of the institution' in the liberal trade order at the WTO", *International Affairs*, 97 (5): 1521–1540.

Nel, Philip (2010), "Redistribution and Recognition: What Emerging Regional Powers Want", *Review of International Studies*, Vol. 36, No. 4, pp. 951-974.

Unit 5.a. ICT and Cyber economy

Essential Readings

Brass, Irina and David J. Hornsby (2019), "Digital Technological Innovation and the International Political Economy", in T. M. Shaw et al. (eds.), *The Palgrave Handbook of Contemporary International Political Economy*, London: Palgrave Macmillan.

O'Brien, Robert and Marc Williams (2016) *Global Political Economy: Evolution and Dynamics*, Fifth Edition, London: Palgrave, pp. 266-268.

Additional Readings

Castells, Manuel (2010), "The New Economy: Informationalism, Globalization, Networking", in *The Rise of the Network Society*, 2nd edition, Malden, M.A.: Wiley Blackwell, pp. 77-162.

Dicken, Peter (2015), "Technological Change: 'Gales of Creative Destruction'", in *Global Shift: Mapping the Changing Contours of the World Economy*, 7th Edition, London: The Guilford Press, pp. 74-113.

Fidler, David (2021), "Cybersecurity, Global Commerce, and International Organizations", in Paul Cornish (ed.) *The Oxford Handbook of Cyber Security*, Oxford: Oxford University Press, pp. 497-513.

Wittel, Andreas (2013), "Counter-commodification: The economy of contribution in the digital commons", *Culture and Organization*, 19:4, 314-331.

Unit 5.b. Economic Crises

Essential Readings

Hale, Thomas, David Held, Kevin Young (2013), "Economy", in *Gridlock: Why Global Cooperation is Failing when We Need It Most*, London: Polity Press, 113-188.

Luis W. Pauly (2017), "The Political Economy of Global Financial Crises", in John Ravenhill (ed.) *Global Political Economy*, fifth edition, Oxford: Oxford University Press, pp. 225-252.

Stiglitz, Joseph E. (2017), "The Burden of Debt", in *Making Globalization Work: The Next Steps to Global Justice*, London: Allen Lane, pp. 211-244.

Wade, Robert and Frank Veneroso (1998), "The Asian Crisis: The High Debt Model Versus the Wall Street-Treasury-IMF Complex," *New Left Review*, 1/228, pp. 3-22.

Helleiner, Eric (2011) "Understanding the 2007-2008 Global Financial Crisis: Lessons for Scholars of International Political Economy?" *Annual Review of Political Science*, Vol. 14, pp. 67-87.

Additional Readings

O'Brien, Robert and Marc Williams (2016) *Global Political Economy: Evolution and Dynamics*, Fifth Edition, London: Palgrave, pp. 153-178.

Ferguson, Niall (2008), "Afterword: The Decent of Money", in *The Ascent of Money: A Financial History of the World*, New York: The Penguin Press, pp. 341-358.

Lipson, Charles (1981), "The International Organization of Third World Debt", *International Organization*, 35 (4): 603-631.

Unit 5.c. Global Civil Society

Essential Readings

Scholte, Jan Aart (2000), "Global Civil Society", in Ngaire Woods (ed.) *The Political Economy of Globalization*, New York: St. Martin's Press, pp. 173-201.

Cerny, Philip G. (2003), "Globalization and the Changing Logic of Collective Action", in Jeffrey A. Frieden and David A. Lake (ed.) *International Political Economy: Perspectives on Global Power and Wealth*, Fourth Edition, London and New York: Routledge, pp. 446-460.

Additional Readings

Nathan, Dev, D. Narasimha Reddy and Govind Kelkar (2008), "Addressing Crises and Change", in *International Trade and Global Civil Society*, London and New York: Routledge, pp. 247-264.

Sen, Amartya (2009), "Human Rights and Global Imperatives", and "Justice and the World", in *The Idea of Justice*, Cambridge: The Belknap Press of Harvard University Press, pp. 355-416.

Reference Literature:

Gilpin, Robert (2001), *Global Political Economy: Understanding the International Economic Order*, Princeton, N.J.: Princeton University Press.

Grieco, Joseph M. and G. John Ikenberry (2003), *State, Power and World Markets: The International Political Economy*, New York: W.W. Norton & Co.

Hulsemeyer, Axel (2010), *International Political Economy: A Reader*, Oxford: Oxford University Press.

Oatley, Thomas (2019) *International Political Economy*, Sixth Edition, New York and London: Routledge.

Ravenhill, John (ed.) (2017) *Global Political Economy*, fifth edition, Oxford: Oxford University Press.

Strange, Susan (1994) *State and the Markets*, Second Edition, London and New York: Continuum.

Strange, Susan (1996) *The Retreat of the State: The Diffusion of Power in the World Economy*, Cambridge: Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3b: Understanding Ambedkar

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Understanding Ambedkar DSE-3b	4	3	1	-	Passed Class XII	NIL

Learning Objectives

This course is broadly intended to introduce Ambedkar's ideas and their relevance in contemporary India, by looking beyond caste. Ambedkar's philosophical contributions towards Indian economy and class question, sociological interpretations on religion, gender, caste and cultural issues; ideas on politics such as concepts of nation, state, democracy, law and constitutionalism are to be pedagogically interrogated and interpreted. This will help students to critically engage themselves with the existing social concerns, state and economic structures and other institutional mechanisms. This also will facilitate them to strengthen their creative thinking with a collective approach to understand ongoing social, political, cultural and economic issues of the society.

Learning outcomes

The course is designed to provide students the original writings and ideas of Ambedkar on diverse issues beyond caste and equip them to critically engage with the ideas, interpretations. By engaging with the original sources as well as secondary writings on Ambedkar's ideas that cover, caste, class, gender, religion, state, democracy and constitution the students will be able to understand a thinker in the context and contemporaneity. At the end of the course, students shall be equipped with the method of understanding the ideas, philosophy and relevance of a particular thinker. Students shall also be able to reflect on the method of the thinker's engagement with the then context, issues and concepts. Finally, the students shall be equipped in understanding the conceptual and philosophical diversity, situatedness and significance of Ambedkar beyond his contribution in the sphere of social justice and drafting the Indian constitution. The Course thus

Paul E. Johnson, Gary J. Miller, John H. Aldrich (1994), *American Government: People, Institutions and Policies*, Cengage Learning: Boston, MA.

Vicki L. Hesli (2007), *Governments and Politics in Russia and the Post-Soviet Region*, Houghton Mifflin Company: Boston.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 18: India's Foreign Policy: Challenges and Strategies

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
India's Foreign Policy: Challenges and Strategies DSC 18	4	3	1	-	Passed Class XII	Nil

Learning Objectives

This course seeks to equip students to engage with the key sources, theoretical underpinnings, and the structural/functional dimensions of the foreign policymaking processes in India. Theoretical grounding will apprise students about the shift in India's identity as a postcolonial state to an 'emerging power' in the contemporary multipolar world. It will familiarize the students with the domestic, regional and international drivers and constraints; how these intersect and have shaped the evolution and practice of India's foreign policy. Students will learn about critical issues and developments of its foreign policy at the bilateral, regional, and global levels with a special focus on India's bargaining strategies and positioning in international climate change negotiations, international economic governance and international security regimes. It will develop analytical skills among the students to comprehend the impending foreign policy conundrums and give students a basic yet nuanced understanding of India's opportunities and challenges in its foreign policymaking in the contemporary world.

Learning outcomes

At the end of this course, the students would have acquired:

- ☞ basic knowledge of the sources, theoretical perspectives and key drivers of India's foreign policy.
- ☞ analyse the opportunities and challenges India faces in securing its interests as an emerging global power.
- ☞ an insight about India's position in changing global power equations particularly its bilateral ties with powerful nations like the US and Russia along with India's largest neighbour, China.
- ☞ an enhanced understanding of India's sub-regional, regional, and global issues of concern.

- ☞ grasp of India's negotiation strategies in dealing with global trade, environment, and security regimes.
- ☞ recognise the ways in which India deploys its soft power in the world.

SYLLABUS OF DSC-18

UNIT – I (10 Hours)

India's Foreign Policy: As a postcolonial state

- a. Sources of India's Foreign Policy
- b. Theorizing India's Foreign Policy
- c. Dimensions of India's Foreign Policy: Domestic and International
- d. From Non-Alignment to Strategic Engagements in a Multipolar World

UNIT – II (9 Hours)

India and the Changing Global Power Equations

- a. India and the USA
- b. India and Russia
- c. India and China

UNIT – III (9 Hours)

India in South Asia: Issues and Challenges

- a. Issues: Land and boundary, Migration, and Refugee crisis
- b. Debating Regional Strategies: SAARC and BIMSTEC

UNIT – IV (10 Hours)

Challenges of India's Foreign Policy in the Global Domain

- a. Negotiating Styles and Strategies: Trade, Security and Climate Change
- b. India's Engagements in Multilateral Forums: BRICS

UNIT – V (7 Hours)

India as an Emerging Power

- a. India in the Changing International Order
- b. Soft power diplomacy

Essential/recommended readings

Unit 1: India's Foreign Policy: As a postcolonial state

1.a. Sources of India's Foreign Policy

Essential Readings

Shahi, D. (2019). *Kautilya and Non-Western IR Theory*. Switzerland: Palgrave Pivot, pp. 95-126.

Rajagopalan, S. (2014). "Grand Strategic Thought" in the Ramayana and Mahabharata. In Kanti Bajpai, Saira Basit and V. Krishnappa (eds.), *India's Grand Strategy: History, Theory, Cases* (1st ed.), (pp. 31-62). New Delhi: Routledge.

Additional Readings

Jaishankar, S. (2021). *The India Way: Strategies for an Uncertain World*. New Delhi: Harper Collins India, pp. 45-68.

Narlikar, A., & Narlikar, A. (2014). *Bargaining with a Rising India: Lessons from the Mahabharata*. Oxford: OUP, pp. 1-23.

Dixit, J.N. (1998). *Across Borders: Fifty Years of India's Foreign Policy*. New Delhi: Thomson Press, pp. 1-13.

Menon, S. (2021). *India and Asian Geopolitics: The Past, Present*. Penguin Random House. pp. 11-36.

1.b. Theorizing India's Foreign Policy

Essential Readings

Thakur, V. (2012). Indian Foreign Policy. In Bhupinder S. Chimni & Siddharth Mallavarapu (eds.), *International Relations: Perspectives for the Global South* (1st ed., pp. 39-53). New Delhi: Pearson.

Bajpai, K. (2015). Five Approaches to the Study of Indian Foreign Policy. In David M. Malone, C. Raja Mohan, & S. Raghavan (eds.), *The Oxford Handbook of Indian Foreign Policy* (pp. 21-34). Oxford: Oxford University Press.

Additional Readings

Mallavarapu, Siddharth. (2015). Theorizing India's Foreign Relations, in David M. Malone and C. Raja Mohan and S. Raghavan (eds.), *The Oxford Handbook of Indian Foreign Policy*. United Kingdom: Oxford University Press, pp. 35-48.

Chacko, Priya. 2019. Constructivism and Indian Foreign Policy. In Harsh Pant (ed.), *New Directions in India's Foreign Policy: Theory and Praxis* (pp. 48-66). Cambridge University Press.

1.c. Dimensions of India's Foreign Policy: Domestic and International

Essential Readings

Raghavan, P.S. (2020). National Security Determinants of Foreign Policy. In Arvind Gupta & Anil Wadhwa (eds.), *India's Foreign Policy: Surviving in a Turbulent World* (pp. 34-44). New Delhi: Sage Publications.

Bandyopadhyay, J. (2003) *Making of India's Foreign Policy*. New Delhi: Allied Publishers, pp. 29-80.

Additional Readings

Appadorai, A. (1981). *The Domestic Roots of India's Foreign Policy*. New Delhi: OUP, pp. 1-26.

Zajackowski, J. (2014). India's Foreign Policy Following the Cold War Year. In Jacob Zajackowski, Jivanta Schottli, & Manish Thapa (eds.), *India in the Contemporary World: Polity, Economy, and International Relations* (pp.265-308). New Delhi: Routledge.

Sahni, Varun. (2007). India's Foreign Policy: Key drivers. *The South African Journal of International Affairs*, 14 (2), 21-35.

1.d. From Non-Alignment to Strategic Engagements in a Multipolar World

Essential Readings

Mishra, K.P. (1981). Towards Understanding Non-alignment. *International Studies*, 20 (1-2), 23-37.

Pant, H.V., & Super, J.M. (2015). India's 'non-alignment' conundrum: a twentieth- century policy in a changing world. *International Affairs*, 91(4), 747-764.

Hall, Ian (2019). *Modi and the Reinvention of Indian Foreign Policy*. Bristol: Bristol University Press, pp. 21-40.

Additional Readings

Kaura, V. (2021). Debating the Relevance of Non-alignment in Indian Diplomacy. *India Quarterly*, 77 (3), 501-506.

Tripathi, S. (2020). *India's Foreign Policy Dilemma over Non-Alignment 2.0*. Mathura Road: Sage Publications, pp. 99-145.

Saran, S. (2015). India's Contemporary Plurilateralism. In David M. Malone, C. Raja Mohan, & S. Raghavan (eds.), *The Oxford Handbook of Indian Foreign Policy* (pp.623-635), Oxford: OUP.

Roy, G. S. (2021). ASEAN in India's Act East Policy. In M. Mayilvaganan (ed.), *ASEAN and India–ASEAN Relations Navigating Shifting Geopolitics*. London: Routledge, pp. 91-106.

Panda, J. P. (2021). India's Indo-Pacific Prism Finding Strategic Autonomy in the Face of Chinese Adventurism. In Brendon J. Cannon & Kei Hakata (eds.), *Indo-Pacific Strategies Navigating Geopolitics at the Dawn of a New Age* (pp.62-80). London: Routledge.

Unit 2: India and the Changing Global Power Equations

2.a. India and the USA

Essential Readings

Tellis, Ashley J. (2013). The Transforming US-Indian Relationship and Its Significance for American Interests. In Kanti P. Bajpai and Harsh V. Pant (eds.), *India's Foreign Policy: A Reader* (pp. 303-320). New Delhi: Oxford University Press.

Pande, Aparna. (2021). Natural Allies. In Shweta Dhaliwal (ed.), *Indo-US Relations: Steering through the Changing World Order* (pp. 10-35). New York: Routledge.

Additional Readings

Hagerty, D. T. (2016). The Indo-US Entente: Committed Relationship or 'Friends with Benefits'? in Ganguly, Sumit (ed.), *Engaging the World: Indian Foreign Policy Since 1947* (pp. 133-155), New Delhi: Oxford University Press.

Madan, T. (2020). *Fateful Triangle: How China Shaped US-India Relations During the Cold War*. Washington D. C.: Brookings, pp. 1-13; 291-300.

Dhaliwal, S. (2021). Introduction. In Shweta Dhaliwal (ed.), *Indo-US Relations: Steering through the Changing World Order* (pp. 1-9). New York: Routledge.

2.b. India and Russia

Essential Readings

Malhotra, A. (2020). India–Russia Ties: Exploring Convergences and Divergences. In Arvind Gupta & Anil Wadhwa (eds.), *India's Foreign Policy: Surviving in a Turbulent World* (pp. 266-280). New Delhi: Sage Publications.

Upadhyay, A. (2015). India and Russia in Changing World. *Economic and Political Weekly*, 50 (33). <https://www.epw.in/journal/2015/33/commentary/india-and-russia-changing-world.html>

Tellis, A.J. (2022). "What is in Our Interest": India and the Ukraine War. *Carnegie Endowment for International Peace*. <https://carnegieendowment.org/2022/04/25/what-is-in-our-interest-india-and-ukraine-war-pub-86961>

Additional Readings

Menon, R. (2015). India and Russia: The anatomy and Evolution of a Relationship. In David M. Malone, C. Raja Mohan, & S. Raghavan (eds.), *The Oxford Handbook of Indian Foreign Policy* (pp.509-523). Oxford: OUP.

Kapoor, N. (2019). India-Russia ties in a changing world order: In pursuit of a Special Strategic Partnership. *ORF Occasional Paper*. <https://www.orfonline.org/research/india-russia-ties-in-a-changing-world-order-in-pursuit-of-a-special-strategic-partnership-56877/>

Ollapally, Deepa M. (2010). The Evolution of India's Relations with Russia, In Sumit Ganguly (ed.), *India's Foreign Policy: Retrospect and Prospect* (pp. 226-247). New Delhi: Oxford University Press.

Singh, A.I. (1995). India's Relations with Russia and Central Asia. *International Affairs*, 71 (1), pp. 69-81.

2.c. India and China

Essential Readings

Tellis A., & Mirski S. (2013). Introduction. In A. Tellis and S. Mirski (eds.), *Crux of Asia: China, India, and the Emerging Global Order*, Washington: Carnegie Endowment for International Peace, pp. 3-44.

Gokhale, V. (2021). The Road from Galwan: The Future of India-China Relations. *Carnegie Endowment for International Peace*. <https://carnegieindia.org/2021/03/10/road-from-galwan-future-of-india-china-relations-pub-84019>

Additional Readings

Mansingh, S. (2016). Rising China and Emergent India in the Twenty-first century Friends or Rivals? In Kanti P. Bajpai & Harsh V Pant (eds.), *India's Foreign Policy: A Reader* (pp. 281-302). New Delhi: Oxford University Press.

Pardesi, M.S. (2016). India's China Policy. In Sumit Ganguly (ed.), *Engaging the World: India's Foreign Policy Since 1947* (pp.167-189). New Delhi: OUP.

Swaran, S. (2021). COVID-19 and India-China Equations: Examining their Interface in the Indian Ocean Region. *Chinese Studies Journal*, 15, 11-132. [https://jnu.ac.in/Faculty/ssingh/Singh Covid19%20and%20India%20China%20Equations C SJ%20Vol%2015-2021.pdf](https://jnu.ac.in/Faculty/ssingh/Singh%20Covid19%20and%20India%20China%20Equations%20C%20SJ%20Vol%2015-2021.pdf)

Unit 3: India in South Asia: Issues and Challenges

3.a. Land and Boundary, Migration, and Refugee crisis

Essential Readings

Muni, S.D. (2003). Problem Areas in India's Neighbourhood Policy. *South Asian Survey*, 10 (2), 185-196.

Tripathi, D. & Chaturvedi, S. (2020) South Asia: Boundaries, Borders and Beyond, *Journal of Borderlands Studies*, 35(2), 173-181. DOI: 10.1080/08865655.2019.1669483.

Shyam Saran, "Role of Border States in India's Foreign Policy," Speech at IIT Guwahati, 29 March 2016.

Chowdhory, N. Citizenship and Membership: Placing Refugees in India. In Nasir Uddin & Nasreen Chowdhory (eds.), *Deterritorialized Identity and Transborder Movements in South Asia* (pp. 37-54). Singapore: Springer.

Ray Chaudhary, A.B., & Ghosh, A.K. (2021, April) *Trans-Border Migration: Bridging the Gap between State and Human Security*. Observer Research Foundation. <https://www.orfonline.org/research/trans-border-migration-bridging-the-gap-between-state-and-human-security/>

Additional Readings

Dubey, Muchkund. (2016). *Dealing with Neighbours in India's Foreign Policy: Coping with the Changing World*. Hyderabad: Orient Blackswan, pp.64-86.

Das, P. (2014). Issues in the Management of the Indo-Pakistan International border. *Strategic Analysis*, 38 (3), pp.307-324.

Ranjan, A. (2018) *India-Bangladesh Border Dispute: History and LBA Dynamics*. Singapore: Springer, pp. 65-88.

Sekhon, J.S., & Sharma, S. (2019). Involuntary Migration in the Border Belt of Indian Punjab. In Nasir Uddin & Nasreen Chowdhory (eds.), *Deterritorialized Identity and Transborder Movements in South Asia* (pp. 155-176). Singapore: Springer.

Chari, P.R. (2003). Missing Boundaries: Refugees, Migrants, Stateless and Internally Displaced Persons in South Asia: An Overview. In P.R. Chari, Mallika Joseph, & Suba Chandran (eds.), *Missing Boundaries: Refugees, Migrants, Stateless and Internally Displaced Persons in South Asia* (pp. 17-38). New Delhi: Manohar Publishers.

3.b. Debating Regional Strategies: SAARC and BIMSTEC

Essential Readings

Chatterjee, S. (2019). India and the SAARC: Security, Commerce, and Community. In Shibashis Chatterjee, Sumit Ganguly, & E. Sridharan (eds.), *India's Spatial Imaginations of South Asia: Power, Commerce, and Community*. Oxford Scholarship Online. DOI:10.1093/oso/9780199489886.003.0004

Gul, N. (2015). SAARC and the Regional Integration in South Asia. In Rajiv Bhatia, Swaran Singh, & Reena Marwah (eds.), *Transforming South Asia: Imperatives for Action* (pp. 159-174). New Delhi: KW Publishers & Indian Council of World Affairs.

Chakravarty, P. R. (2021). BIMSTEC: India's Foreign Policy Fulcrum. In Aparna Pande (ed.), *Routledge Handbook on South Asian Foreign Policy* (pp.183-201). New York: Routledge. <https://doi.org/10.4324/9780429054808>

Additional Readings

Parida, S.K. (2020). India, SAARC and the Covid-19 Pandemic. *World Affairs*, 24(4), 112-119.

Muni, S.D., & Jetley, R. (2010). SAARC Prospects: The Changing Dimensions. In S.D. Muni (ed.), *Emerging Dimensions of SAARC* (pp. 1-31). New Delhi: Foundation Books.

Seema Narain (2010), SAARC and South Asia Economic Integration. In S.D. Muni (ed.), *Emerging Dimensions of SAARC* (pp. 32-50). New Delhi: Foundation Books.

Omer, H. (2021). Perspective on BIMSTEC in transforming South Asia. In Adluri Subramanyam Raju & Anasua Basu Ray Chaudhury (eds.), *New Futures for BIMSTEC: Connectivity, Commerce and Security*. New York: Routledge.

Unit 4: Challenges of India's Foreign Policy in the Global Domain (9 Lectures)

4.a. Negotiating Styles and Strategies: Trade, Security and Climate Change

Essential Readings

Trade:

Mehta, S. P., & Chatterjee, B. (2015). India in the International Trading System. In David M. Malone, C. Raja Mohan & S. Raghavan (eds.), *The Oxford Handbook of Indian Foreign Policy* (pp. 636-649). Oxford: Oxford University Press.

Sharma, M. S., & Bhogal, P. (2022). India and Global Trade Governance: A Saga of Missed Opportunities. In Harsh V Pant (ed.), *India and Global Governance: A Rising Power and Its Discontents* (pp. 109-134). New York: Routledge.

Security

Narang, V. (2016). India's Nuclear Weapon Policy. In Sumit Ganguly (ed.), *Engaging the World-India's Foreign Policy Since 1947* (pp. 448-467). New Delhi: OUP.

Biswas, A. (2022). India's Rise in the Global Nuclear Governance Architecture: Principles, Exceptions, and Contradictions. In Harsh V Pant (ed.), *India and Global Governance: A Rising Power and Its Discontents* (pp. 17-27). New York: Routledge.

Climate Change

Dubash, K. N., & Rajamani, L. (2015). Multilateral Diplomacy on Climate Change. In David M. Malone, C. Raja Mohan, & S. Raghavan (eds.) *The Oxford Handbook of Indian Foreign Policy* (pp. 663-677). Oxford: Oxford University Press.

Sengupta, S. (2013). Defending 'Differentiation': India's Foreign Policy on Climate Change from Rio to Copenhagen. In Kanti P. Bajpai & Harsh V Pant (eds.), *India's Foreign Policy: A Reader* (pp. 389-411). New Delhi: Oxford University Press.

Additional Readings

Trade

Narlikar, A. (2021). India's foreign economic policy under Modi: negotiations and narratives in the WTO and beyond. *International Politics*, 59(1), 148-166.

Mukherji, R. (2014). India and Global Economic Governance: From Structural Conflict to Embedded Liberalism. *International Studies Review*, doi: 10.1111/misr.12155

Security

Karnad, B. (2021, October 28). *Nuclear-wise, India is seriously handicapped (by govt!)*. <https://bharatkarnad.com/2021/10/28/nuclear-wise-india-is-seriously-handicapped-by-govt/>

Rajagopalan, R. (2005) *India's Nuclear Doctrine and The Nuclear Danger* New Delhi: Penguin Books India, pp. 67-88.

Sinha, U.K. (2020) Rebalancing Foreign Policy and Non-traditional Security Issues. In Arvind Gupta & Anil Wadhwa (eds.), *India's Foreign Policy: Surviving in a Turbulent World* (pp. 115-130). New Delhi: Sage Publications.

Climate Change

Nachiappan, K. (2019) Agenda-setting from behind: India and the Framework Convention on climate change. *India Review*, 18(5), 552-567.

Negi, A. (2014) India and the Climate Change Regime. In Amitabh Mattoo & Happymon Jacob (eds.), *India and the International System: Theory, Policy and Structure* (pp. 287-307). New Delhi: Australia-India Institute Series in Foreign Policy and International Relations and Manohar Publications.

Raghunandan, D. (2013). Rethinking India's Climate Policy and the Global Negotiations. *Oxfam India*. <https://www.oxfamindia.org/sites/default/files/Raghu%27s%20paper.pdf>

4.b. India's Engagements in Multilateral Forums: BRICS

Essential Readings

Sharma, R. K. (2022). BRICS in India's Vision for Global Governance. In Harsh V Pant (ed.), *India and Global Governance: A Rising Power and Its Discontents* (pp. 135-145). New York: Routledge.

Additional Readings

Sakhuja, V. (2014). BRICS: The Oceanic Connections. *Institute of Peace and Conflict Studies*, available at http://www.ipcs.org/comm_select.php?articleNo=4594

Unit 5: India as an Emerging Power (5 Lectures)

5.a. India in the Changing International Order

Essential Readings

Saran, S. (2017). *How India Sees the World: Kautilya to the 21st Century*. Juggernaut Books. pp. 258-275.

Menon, S. (2021). *India and Asian Geopolitics: The Past, Present*. Penguin Random House. pp.1-10, pp. 340-374.

Additional Readings

Rajgopalan, R., & Sahni, V. (2008). India and the Great Powers: Strategic Imperatives: Normative Necessities. *South Asian Survey*, 15 (1), 5–32.

Kukreja, V. (2017). Dynamics of Change and Continuity in India's Foreign Policy under Modi's Regime in Shantesh K Singh (ed.). *India's Foreign Policy Continuity with Difference Under Modi Government*, pp. 1-16). New Delhi: Manak Publications.

Raja Mohan, C. (2013). Changing Global Order: India's Perspective. In A. Tellis & S. Mirski (Eds.), *Crux of Asia: China, India, and the Emerging Global Order* (pp. 53-62). Washington: Carnegie Endowment for International Peace.

5.b. Soft power diplomacy

Essential Readings

Kugiel, P. (2012). India's Soft Power in South Asia. *International Studies*, 49 (3-4), 351-376.

Paul, T.V. (2014). Indian Soft Power in a Globalizing World. *Current History*, 113(762), 157-162.

Mazumdar, A. (2018). India's Soft Power Diplomacy under the Modi Administration: Buddhism, Diaspora, and Yoga. *Asian Affairs*, 49 (3), 468-49.

Additional Readings

Gupta, A.K. (2008). Commentary on India's Soft Power and Diaspora. *International Journal on World Peace*, 25(3), 61-68.

Sikri, Veena (2020). Strategizing Soft Power Projection. In Arvind Gupta & Anil Wadhwa (ed.), *India's Foreign Policy: Surviving in a Turbulent World* (pp. 45-61). New Delhi: Sage Publications.

Pathak, V. (2018). Indian Diaspora: A Strategic Asset for Indian Foreign Policy in the 21st Century. In Sangit K. Ragi (ed.), *Imagining India as a Global Power: Prospects and Challenges* (pp. 223-226). Oxon and New York: Routledge.

Reference Books/Literature

Malone, D. M. , & Raja Mohan, C. and Raghavan, S. (2015). *The Oxford Handbook of Indian Foreign Policy*. United Kingdom: Oxford University Press.

Ganguly, S. (2016). *Engaging the World-Indian Foreign Policy since 1947*. New Delhi: Oxford University Press.

Ragi, S. K. (2018). *Imagining India as a Global Power: Prospects and Challenges*. New York: Routledge.

Malone, David M. (2011). *Does the Elephant Dance? Contemporary Indian Foreign Policy*, New Delhi: Oxford University Press.

Sikri, R. (2007). *Challenge & Strategy in Rethinking India's Foreign Policy*. Sage Publications.

Khilani, S., Mehta, R.K., Mehta, P. B. (eds.). (2012). *Non-Alignment 2.0*. <https://cprindia.org/wp-content/uploads/2021/12/NonAlignment-2.pdf>.

Dubey, M. (2015). *India's Foreign Policy: Coping with the Changing World*. Hyderabad: Orient BlackSwan.

Ganguly, S. (2019). *Indian Foreign Policy: Oxford India Short Introductions*. Oxford University Press.

Gupta, A. (2018) *How India manages its National Security*. Penguin Random House.

Cohen, S. (2002) *India: Emerging Power*. Brookings Institution Press.

Hall, I.(ed.). (2014). *The Engagement of India: Strategies and Responses*. Washington DC: Georgetown University Press.

Dutt, V.P. (1984) *India's Foreign Policy*. New Delhi: Vikas Publishing House.

Pande, A. (2020) *India's Marathon: Reshaping the Post-Pandemic World Order*. Takshashila Institution.

Pande, A. (2017). *From Chanakya to Modi: Evolution of India's Foreign Policy*. New Delhi: HarperCollins Publishers.

हिंदी में किताबें और लेख

गांगुली, सुमित (2018) भारत की विदेश नीति : पुनरावलोकन एवं संभावनाएं , अनुवादक: अभिषेक चौधरी, नई दिल्ली : ऑक्सफोर्ड यूनिवर्सिटी प्रेस।

सीकरी, राजीव (2009) भारत की विदेश नीति : चुनौती और राजनीति। नई दिल्ली : सेज भाषा।

अरोड़ा, लिपाक्षी, खन्ना, वी.एन., कुमार लेस्ली के. (2019). भारत की विदेश नीति। नई दिल्ली : विकास प्रकाशन।

दीक्षित, जे.एन. (2020) भारतीय विदेश नीति। नई दिल्ली : प्रभात प्रकाशन।

मिश्रा, राजेश (2018) भारतीय विदेश नीति : भुमंडलीकरण के दौर में। नई दिल्ली : ओरिएंट ब्लैकस्वान।

पंत, हर्ष (2022) इस संकट में चीन के हाथों रूस को खो न दें हम!

<https://www.orfonline.org/hindi/research/ukraine-crisis-russia-at-the-hands-of-china-in-this-crisis/>

सरन, समीर (2022) 75 वर्ष का भारत : नैतिकता, अर्थव्यवस्था और मिसाल।

<https://www.orfonline.org/hindi/research/india-75-ethic-economy-and-exemplar/>

आर. एस . यादव (2013), भारत की विदेश नीति। नई दिल्ली : पियर्सन एजुकेशन।

पुष्पेश पन्त (2010), भारत की विदेश नीति। नई दिल्ली : मैकग्राहिल एजुकेशन।

दत्त, वी.पी. (2015), बदलते दुनिया में भारत की विदेश नीति (1987 से 2008 तक)। दिल्ली : हिंदी माध्यम निदेशालय, दिल्ली विश्वविद्यालय।

यादव, आर.एस. (2013) भारत की विदेश नीति। दिल्ली : पियर्सन।

VAC 1: GANDHI AND EDUCATION

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Gandhi and Education	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives:

The Learning Objectives of the course are:

- Seek inspiration from Gandhi's thoughts on education.
- Analyse Gandhian education philosophy for moral and character development.
- Understand Gandhi's Idea on Self-reliant education (Swavalambi Shiksha)
- Relate Gandhi's educational thoughts to NEP 2020

Learning Outcomes

The Learning Outcomes of the course are:

- Value Gandhian perspective on education
- Appreciate the significance of education in Indian languages
- Evaluate the application of Gandhian thoughts in NEP 2020
- Realise the principles of NEP 2020 in vocational and skill oriented education.

SYLLABUS OF GANDHI AND EDUCATION

UNIT – I : Gandhi's Philosophy and education

(Weeks: 5)

- Gandhi's Philosophy on education
- Education for character building and moral development
- Education relating to health, hygiene, heritage, and handicraft

UNIT – II Gandhi's Experiment in Education

(Weeks: 5)

- Gandhi's educational ideas on use of Indian Language as a medium of Instruction, TextBook and Teacher.
- Gandhi's educational thought on Elementary and Adult Education.
- Gandhi's vision on Higher Education

UNIT – III : Gandhi's Educational Thought on Skill and Vocational Education

(Weeks: 5)

- Rural development through Skill and Local Need Based education
- Skill education in NEP 2020 and Gandhi
- Gandhi's Idea on Self-reliance (Swavalambi Shiksha) and its reflection in contemporary educational policy.

Practical component (if any) -

(15 Weeks)

- Regular visits to Gandhi Museum and library to gain insight on Gandhi
- Excursion to Gandhi Ashrams located in different places like Sewagram, Wardha, Sabarmati, Ahmedabad etc.
- Workshops/projects in collaboration with Gandhi Bhawan, Gandhi Smriti and Darshan, Gandhi Peace Center. Ashrams based on innovation in village & cottage industry, Khadi, handicrafts, organic farming etc.
- Adoption of one place for Swachhta Mission or Skill Education
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- महात्मा गांधी. (2014). बुनियादी शिक्षा. वाराणसी : सर्व सेवा संघ प्रकाशन.
- गांधी, मो. क. (2010). मेरे सपनों का भारत. अहमदाबाद : नवजीवन प्रकाशन मंदिर.
- नवजीवन प्रकाशन मंदिर. (1960). शरीर-श्रम. अहमदाबाद: मो. क. गांधी. pp– 196-231
- प्रभु, आर. के. व राव, यू. आर. (1994). महात्मा गांधी के विचार. इंडिया: नेशनल बुक ट्रस्ट.
- Anand T. Hingorani, ed.] Gandhi, M.K. Our Language Problem (Bombay:
- Bharatiya Vidya Bhavan,), pp. 53-55
- TOWARDS NEW EDUCATION written by M. K. Gandhi Edited by Bharatan Kumarappa

Suggestive readings

- गांधी, मो.क. (2012). सत्य के प्रयोग अथवा आत्मकथा (त्रिवेदी, काशीनाथ, अनुवादक)
अहमदाबाद: नवजीवन प्रकाशन मंदिर.
- गांधी, मो.क. (2012). हिंद स्वराज (नणावती, अमृतलाल ठाकोरदास, अनुवादक).
अहमदाबाद: नवजीवन प्रकाशन मंदिर
- Coomaraswamy, Anand K . (1910). Art and Swadeshi . Munshi Ram Manoharalal.
Delhi

Examination scheme and mode: Subject to directions from the Examination
Branch/University of Delhi from time to time

VAC 1: CONSTITUTIONAL VALUES AND FUNDAMENTAL DUTIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Constitutional Values And Fundamental Duties	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Enrich students with knowledge and relevance of the Constitution.
- Develop awareness about Duties and Values.
- Inculcate a sense of Constitutionalism in thought and action.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the Constitution and its relevance
- Appreciate the values and goals embedded in the Constitution.
- Recognise the importance of Fundamental Duties enshrined in the Constitution.
- Apply the spirit of fundamental values and duties in everyday national life.

SYLLABUS OF CONSTITUTIONAL VALUES AND FUNDAMENTAL DUTIES

UNIT – I The Constitution of India – An Introduction

(5 Weeks)

- Federal Republic, Rule of Law, Separation of Powers
- Sovereignty, Socialism, Democracy
- Secularism and Sarva Dharma Sama Bhava

UNIT – II Constitutional Values

(5 Weeks)

- Justice: Social, Political, Economic

- Liberty: Thought, Expression, Belief, Faith, Worship
- Equality: Equality before law & equal application of laws
- Fraternity: Dignity, Unity and Integrity

UNIT – III Fundamental Duties

(5 Weeks)

- Reflecting on the ancient Indian notions of righteousness and duty consciousness
- Fundamental Duties- Article 51A [(a) – (k)]
- Legal status of Fundamental Duties - Judicial approach

Practical component (if any) –

(15 Weeks)

- Reflections on some of the constitutional values/ fundamental duties and its contemporary relevance in day-to-day national life through group discussions and projects.
- Conduct workshops to spread awareness on the Fundamental Duties and Values.
- Students are required to conduct a survey (minimum 25 respondents) on assessing the awareness of the constitutional duties amongst the citizens.
- Students may share their experiences on Fundamental Duties and Values in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

श्री वेङ्कटेश्वर महाविद्यालय
Sri Venkateswara College
रिजली विद्यापीठ / University of Delhi
धौला कुर्मी, नई दिल्ली / Dhola Kurma, New Delhi-21

Essential/recommended readings

- Preamble to the Constitution of India, 1950.
- The Constitution of India, Articles - 14, 19, 21.
- The Constitution of India, Fundamental Duties [Ar. 51 A (a) – (k)].

Suggested readings

- Durga Das Basu, et al., Introduction to the Constitution of India (LexisNexis, 26th edn, 2022).
- Leila Seth, We, the Children of India: The Preamble to Our Constitution (New Delhi, Puffin Books, Penguin Books India, 2010).
- Mahendra Pal Singh, V.N. Shukla's Constitution of India, (Eastern Book Company, Lucknow, 13th revised edn. 2017)
- B.R. Ambedkar Selected Speeches, (Prasar Bharati, New Delhi, 2019) available at: https://prasarbharati.gov.in/whatsnew/whatsnew_653363.pdf.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

Political Leadership and Communication

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Political Leadership and Communication	2	1	0	1	12 th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the cross-cutting multi-disciplinary linkage of the subject.
- To gain a basic understanding of specific concepts and critical review of political communication and election campaign studies.
- To be able to construct a linkage between political communication and leadership.
- To learn conceptual frameworks and qualitative research skills for the analysis of modes and techniques of political communication and leadership.

Learning outcomes

The Learning Outcome of this course is as follows:

- After studying this course, students will be able to have a professional/career-oriented insight by facilitating their journey as Media managers, policy makers, political analysts, Journalists, Public relations officers in government agencies, political parties and higher education.

SYLLABUS

Unit I: Explaining Political Communication

(3 weeks)

- Meaning, Nature and Scope
- Evolution and Transformation

Unit II: Exploring Leadership

(3 weeks)

- Themes, Theories and Typologies
- Participation and Performance

Unit III: Expanding Political Communication and Leadership: Orientation and Action

(3 weeks)

- Developing Communication and Leadership through Research
- Strengthening Techniques of Communication and Leadership

Unit IV: Extending Political Communication and Leadership: Research Issues and Challenges

(3 weeks)

- Researching Communication and Leadership through Survey: Opinion Poll, Exit Poll.
- Examining Contemporary Issues and Challenges in Communication and Leadership

Unit V: Executing Political Communication and Leadership: Empirical and Professional Implications

(3 weeks)

- 
- Psephology as an Art and Vocation
 - Exploring Career Options

Essential/recommended Readings:

- Pole (2009). Blogging the Political: Politics and Participation in a networked Society. New York: Routledge.
- D. A. Graber (2005). 'Political Communication Faces the 21st Century', Journal of Communication, September: 479-507.
- Frank Esser and Barbara Pfetsh (eds.). (2004). Comparing Political Communication-Theories, Cases and Challenges. Cambridge: Cambridge University Press.
- G. Gerbner, L. Gross, M. Morgan and N. Signorielli (1982). 'Charting the Mainstream: Television's Contribution to Political Orientations', Journal of Communication, 32(2): 100-27.
- H. A. Semetko and M. Scammell (eds.) (2012). The SAGE Handbook of Political Communication. London: Sage.
- John C Maxwell (2008). Developing the Leader Within You. New Delhi: Harper Collins.
- Kiran Prasad (ed.) (2003). Political Communication: The Indian Experience. New Delhi: B.R. Publishers.
- Max Depree (2004). Leadership is an Art. RHUS Publications.
- Yogesh Atal (2014). 'Matdataoin Ka Sansar', Pratiman, Vol.2, No.1.
- Yogesh Atal (2018). 'Chunav Shastra Aur Rajniti', Pratiman, No.11.

Web Source

- <http://www.politicalcommunication.org/history.html>

Examination scheme and mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

AECC Course
AE3 - Your Laws, Your Rights
(62323501)
AECC (Electives) - (AECCE) Credit:4

Course Objective

More often than not, when we talk of laws we mean authoritatively sanctioned rules, which are considered essential for a well-ordered society. Yet laws in a democracy are also about constituting a society marked by equality, freedom, and dignity. The rights approach to law has assumed importance in democracies, precisely because of people's struggles to broaden the understanding of law as something which reflects the will of the people. As such law becomes an important source of rights and duties, which develop and strengthen alongside institutions of representative democracy, constitutional norms, and the rule of law. This course aims to help the students understand law as a source of rights, and as a progressively widening sphere of justice, welfare, and dignity. This relationship between laws and rights will be studied through specific values which have come to be seen as integral for a democratic society viz., equality and non-discrimination, empowerment, redistribution and recognition of traditional rights etc.

Course Learning Outcomes

On the successful completion of the course, students would be able to:

- Demonstrate an understanding of law as a source of right.
- Develop an understanding of democratic values such as equality, justice etc. and learn about different laws enacted to uphold these value.
- Demonstrate an awareness of democratic rights guaranteed to Indian citizens and persons
- Develop skills related to using ordinary legal procedures to safeguard the rights guaranteed to citizens and persons
- Show basic awareness of ordinary procedures such as obtaining different kinds of identity documents.
- Show understanding of the structure and principles of the Indian legal system

Unit 1

Rule of law and the Criminal Justice System in India (1 week)

Unit 2

Laws relating to criminal justice administration (2 weeks)

- a) How to file a complaint, First Information Report (FIR)
- b) Detention, arrest and bail

Unit 3

Equality and non-discrimination (4 weeks)

- a) Gender: the protection of women against domestic violence, rape and sexual harassment
- b) Caste: laws abolishing untouchability and providing protection against atrocities
- c) Class: laws concerning minimum wages
- d) Disability and equality of participation and opportunity

Unit 4

Empowerment (2 weeks)

- a) Access to information
- b) Rights of the consumer

Unit 5

Redistribution, recognition and livelihood (2 weeks)

- a) Traditional rights of forest dwellers and the issue of women's property rights
- b) Rural employment guarantee

Unit 6

Access to Identification documents and Social Security Schemes (1 week / exercises only)

Familiarise yourself with the following: Procedure for obtaining an Election Commission of India Identity Card, Driving license, Ration Card, Rashtriya Swasthya Bima Yojna, Old Age Pension Scheme.

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III. Equality and non-discrimination

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S. Durrany, (2006) *The Protection of Women from Domestic Violence Act 2005*, New Delhi: Indian Social Institute.

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K. Saxena, (2011) 'Dalits', in M. Mohanty et al., *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books, Pp.15-38

P. Mathew, (2004) *The Minimum Wages Act, 1948*, New Delhi: Indian Social Institute.

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IV. Empowerment

N. Kurian, (2011) 'Consumers', in M. Mohanty et al., *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books.

Vishnu Konoorayar, (2008), 'Consumer Law', In *Towards Legal Literacy in India*. K. Sankaran and U.K. Singh (eds). New Delhi: Oxford University Press.

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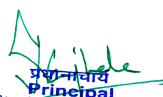
S. M. Laskar (2016), *Importance of Right to Information for Good Governance in India*, *Bharati Law Review*, Oct-Dec, available at <http://docs.manupatra.in/newslines/articles/Upload/AC9CD2C7-B8AD-4C5A-B910-3751BFE5CB28.pdf>

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V. Redistribution, Recognition and livelihood

M. Sarin and O. Baginski, (2010) *India's Forest Rights Act -The Anatomy of a Necessary but Not Sufficient Institutional Reform*, Department for International Development. Available at www.ippg.org.uk (Accessed: 10.04.2013).

J. Dreze, Dey and Khera, (2008) *Employment Guarantee Act, A Primer*, New Delhi: National Book Trust (Also available in Hindi).


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Additional Resources:

Bare Acts:

- o *Consumer Protection Act, 1986*, Available at http://chdsla.gov.in/right_menu/act/pdf/consumer.pdf
- o *Criminal law Amendment Act, 2013*, Available at http://egazette.nic.in/WriteReadData/2013/E_17_2013_212.pdf
- o *Mahatma Gandhi National Rural Employment Guaranty Act, 2005*, Available at <http://nrega.nic.in/rajaswa.pdf>
- o *National Food Security Act 2011*, Available at http://nac.nic.in/foodsecurity/nfsb_final.pdf,
- o *Protection of Women Against Domestic Violence Act, 2005*, Available at <http://wcd.nic.in/wdvact.pdf>,
- o *Right to Information Act, 2005*, Available at <http://righttoinformation.gov.in/rti-act.pdf>
- o *Scheduled Castes and Scheduled Tribes Prevention of Atrocities Act, 1989*, Available at <http://tribal.nic.in/writereaddata/linkimages/poaact989E4227472861.pdf>,
- o *Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006*, Available at <http://tribal.gov.in/writereaddata/mainlinkFile/File1033.pdf>,
- o *The Minimum Wages Act, 1948*, Available at <http://www.ilo.org/dyn/travail/docs/623/Minimum%20Wages%20Act%201948.pdf>,
- o *The Persons with Disabilities (Equal Opportunities, Protection of Rights, Full Participation) Act, 1995*, Available at http://bhind.nic.in/Sparsh_disability%20act%201995.pdf,
- o *The Right of Children to Free and Compulsory Education Act, 2009*, Available at <http://www.delta.org.in/form/rte.pdf>
- o *The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Bill, 2012*, Available at http://164.100.24.219/BillsTexts/LSBillTexts/PassedLoksabha/144C_2010_LS_Eng.pdf,
- o *Criminal Law Amendment Act, 2013*, Available at mha.nic.in/pdfs/TheCrimnalLaw030413.pdf

Additional Readings:

I. Rule of law and the Criminal Justice System in India

K. Sankaran and U. Singh, (2008) 'Introduction', in *Towards Legal Literacy*. New Delhi: Oxford University Press, pp. xi – xv.

III. Equality and non-discrimination

Gender Study Group, (1996) *Sexual Harassment in Delhi University*, A Report, Delhi: University of Delhi.

A. Kidwai, (2013), *Sexual Harassment in the Workplace: the Verma Committee and After*, *Economic and Political Weekly*, Vol. 48, Issue No. 06

D. Srivastva, (2007) 'Sexual Harassment and Violence against Women in India: Constitutional and Legal Perspectives', in C. Kumar and K. Chockalingam (eds) *Human Rights, Justice, and Constitutional Empowerment*, Delhi: Oxford University Press.

IV. Empowerment

Live Law, Highlights Of Consumer Protection Bill-2018, available at <https://www.livelaw.in/highlights-consumer-protection-bill-2018-read-bill/>

A. Roberts, (2010) 'A Great and Revolutionary Law? The First Four Years of India's Right to Information Act', *Public Administration Review*. Volume 70, Issue 6, pp. 925–933.

SAHRDC, (2006) 'Consumer Rights', in *Introducing Human Rights*, Oxford University Press, pp. 118-134.

Other suggested readings:

K. Chaubey, (2013) 'Do Pragatisheel Kanoonon ki Dastan: Rajya, Jan Andolan aur Pratirdoh', *Pratiman: Samaj, Samaj, Sanskriti*, CSDS- Vani Prakashn, pp. 149-177.

S. Dahiwal, (2009) 'Khairlanji: Insensitivity of Mahar Officers', *Economic and Political Weekly*, Vol. 44 (31), pp. 29-33.

J. Kothari, (2005) 'Criminal Law on Domestic Violence', *Economic and Political Weekly*, Vol. 40(46), pp. 4843-4849.

H. Mander, and A. Joshi, *The Movement for Right to Information in India, People's Power for the Control of Corruption*. Available at <https://www.humanrightsinitiative.org/programs/ai/rti/india/articles/The%20Movement%20for%20RTI%20in%20India.pdf>

P. Mathew, and P. Bakshi, (2005) 'Indian Legal System', New Delhi: Indian Social Institute.

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N. Menon, (2012) 'Sexual Violence', in *Seeing Like a Feminist*, New Delhi: Zubaan and Penguin, pp. 113-146.

M, Mohanty et al. (2011) *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books.

Centre for Good Governance, (2008) *Right to Information Act, 2005: A Citizen's Guide*, Available at <https://www.cgg.gov.in/core/uploads/2017/07/21.A-CITIZENS-GUIDE.pdf>

K. Sankaran, and U. Singh, (eds.) (2008) *Towards Legal Literacy*. New Delhi: Oxford University Press.

A. Pandey, (2004) *Rights of the Consumer*. New Delhi: Indian Social Institute.

Teaching Learning Process

Students will receive interactive lectures on conception of rule of law. Students will engage in discussions on law as a source of rights, as a progressively widening sphere of substantive justice, welfare, and dignity. The relationship between laws and rights will be studied through specific values which have come to be seen as integral for a democratic society viz., equality and non-discrimination, empowerment, redistribution and recognition of traditional rights etc.

Suggested exercises for students

1. Discuss the debates around any recent Ordinance, Bill or Act in Parliament.
2. How to file an FIR? In case there has been a theft in the neighbourhood how would you file the first Hand Information Report?

3. Under what circumstances can detention and arrest become illegal?
4. Discuss any contemporary practice or event that violates the equality and protection against discrimination laws.
5. Read Ordinance XV -D of University of Delhi and make a list of the kinds of conduct that would qualify as sexual harassment.
6. Your friend has shared with you an incident of unwelcome verbal remarks on her by a person of higher authority in your college, what would you do?
7. Visit any nearby construction site and talk to the workers about their daily wage. Find out the minimum wage in Delhi for such construction work. Make an assessment of the awareness among the workers about their minimum wages and the law related to it.
8. You have seen a lady in your neighbourhood being beaten up by her husband. Identify the concerned Protection Officer in case you want to provide information about this incident.
9. Read the Vishakha Guidelines as laid down by the Supreme Court and the Act against sexual harassment at the workplace. Discuss what constitutes sexual harassment and the mechanisms available for its redressal in your institution.
10. What is the procedure to file an RTI?
11. You bought a product from a nearby shop which was expired, the shop keeper refused to return it. Use your knowledge of Consumer Protection Act to decide what you do next?
12. Do you think the provisions of Forest Rights Act (FRA) address the question of gender equality?
13. What must you keep in mind as a consumer while making a purchase that may later help you make use of Consumer Protection Act? (Hint- Should you ask for a Bill?)
14. In your surroundings have you witnessed any incident that would be considered offensive under the SC and ST Act? Make a class room presentation on it.
15. After reading the Disabilities Act, discuss in your classroom, whether the differently abled people in your college are able to exercise the rights and facilities guaranteed under the law.
16. Discuss the procedure for issuing a job card under MNREGA.
17. You have read the rural job guarantee scheme under MNREGA. Do you think that there is a need for similar guarantee scheme in urban areas? Discuss with your classmates

Assessment Methods

Students will be assessed on continuous basis followed by end term examination. Internal assessment will be conducted at the end of each unit which may include viva- voce and participation in class discussions. Students will be assessed on the basis of their ability to think critically and creatively to solve the problems and application of conceptual understanding to field based variables. . Students will be required to submit a critical review of any book or a film that relates to any one unit of the syllabus before end term examination.

Keywords

Democracy, Dignity, Equality, Empowerment, Justice, Recognition, Redistribution, Rule of Law

YOGA IN PRACTICE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Yoga in Practice	2	0	0	2	Class XII Pass	NIL

Total Credits: 02

Learning Objectives:

Students will be able to discern real significance of yogic operations from original sources and will be prone to practicing in their day to day life.

Learning Outcomes:

- (i) Student will form an understanding of the concept of yoga.
- (ii) Students will learn various aspects of the science of yoga.
- (iii) Theoretical and practical knowledge of Aasanas and pranayams to lead a balanced life.

SYLLABUS OF YOGA IN PRACTICE

Practical

Unit: I

30 hours

- (i) Definition and types of yoga:

Karma yoga, Gyana yoga, Bhakti yoga, Laya yoga, Raja yoga, Hatha yoga, Mantra yoga,

Kundalini yoga. (योग एवं 4^०tv – अ०ाय -१)

- (ii) Ashtanga Yoga:

Yam- Ahinsa, Satya, Asteya, Brahmacharya, Aparigraha.

Niyam- Saucha, Santosha, Tapa, Swadhyaya, Ishwarpranidhana

Asana, Pranayama- (the types of Pranayama: Puraka, rechak & Kumbhaka), Pratyahara, Dharana, Dhyana & Samadhi etc.

- (iii) Shat Chakra,s:

Mooladhara, Swadhishtana, Manipura, Anahata, Vishudha, Aagya, Sahasrara

(Sahasradhara chakra). (योग एवं 4^०tv - अ०ाय – २-३)

Unit: II

30 hours

Asana,s and their advantages:-

(i) Asana in standing position:

Surya Namaskara, Tadasana, Padahasthasana, Garudasana, Natarajasana, Cakrasana.

(ii) Asana in sitting position:

Padmasana, Vajrasana, Siddhasana, Bhadrasana, Gomukhasana, Shashankasana, Mandukasana, Kukkutasana.

(iii) Asana in stomach side position:

Dhanurasana, Bhujangasana, Mayurasana, Marjarasana, Makarasana.

(iv) Asana in backbone side position:

Uttanapadasana, Naukasana, Sarvangasana, Sheershasana, Savasana etc.

(v) Practice of pranayama- Purak, Rechak and Kumbhaka. (योग एवं 4०iv - अ०ाय – ३ -४,६)

Essential Readings:

1. योग दर्शन – महर्षि पतंजलि, टीकाकार-हर्षकृष्णदास गोयंका, गीता प्रेस, गोरखपुर, उ०प्र० प्रदेश,

४० वां पुनर्मुद्रण ।

2. योग एवं 4०iv – डॉ० विजय कुमार, चौखटा वि० भारती, वाराणसी, उ०प्र० प्रदेश, प्र० संस्करण – २०२१ ।

3. प्राणायाम रहस्य – (वैय्याकिनक तर्कों के साथ) – 4०मी रामदेव, वि० प्रकाशन, वि० योग महर्षि पतंजलि योगपीठ ,

कनखल, हरद्वार ।

4. योग साधना एवं योग चिकित्सा रहस्य – 4०मी रामदेव, वि० प्रकाशन, वि० योग महर्षि पतंजलि योगपीठ ,

कनखल, हरद्वार ।

5. शतयुव पुष्प – 4०मी रामदेव द्वारा रचनी, आ० प्रकाशन, कुं डेवाली, वि०-सं० २०६२ । (द्विदिक पुष्पकालय, मु०ई)

Suggestive Readings:

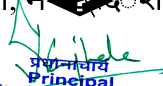
1. योग चिन्ता – 4०मी अ० तानु सराती, गु०कुल वृत्तान्त वातक शोध सं०, आसफ अली रोड, नई वि०-२००६ ।

2. प्राणायाम का महत्त्व – 4०मी ओमान सराती, हरयाणा साहित्य सं०, गु०कुल झर, हरयाणा - २००६ ।

3. आयुर्वेदीय पञ्चक चिकित्सा- आचार्य वि० धर शु०, भारतीय के०पीय चिकित्सा पत्रिका, नई वि० 1

4. रोग और योग- 4०मी कमल सराती, योग प्रकाशन, मुंगेर, बिहार, संस्करण- २०१३ ।

5. संपूर्ण योग वि० - राजीव जैन त्रिलोक, मंजुल पत्रिका शिंग हाउस, भोपाल, म० प्रदेश, संस्करण - २००५ ।


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Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

VAC 1: AYURVEDA AND NUTRITION

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ayurveda and Nutrition	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of the course are:

- To introduce the basic principles of nutrition in Ayurveda
- To link the Ayurvedic nutrition with modern dietary practices for health
- To analyse basic tenets of traditional diets and health recipes
- To understand the contemporary food habits in everyday life

Learning outcomes

The Learning outcomes of the Course are:

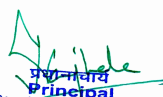
- Awareness of traditional food cultures of India
- Evaluate changing food patterns and lifestyle over the years
- Understand Indian Knowledge Systems (IKS) and key Vedic principles with respect to Food and Nutrition
- Apply basic tenets of traditional diets for health and disease
- Prepare selected healthy recipes based on Ayurvedic principles

SYLLABUS OF AYURVEDA AND NUTRITION

UNIT – I Introduction to Ayurvedic Nutrition

(4 Weeks)

- Ayurveda and Indian food cultures
- Nutrition and lifestyle transition over the years
- Regional Food Traditions of India


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UNIT – II Basic principles of Food and Nutrition and Ayurveda (6 Weeks)

- Understanding rich sources of nutrients
- Concept of Doshas & assessment
- Ayurvedic Principles of food habits and factors determining quality of food (Ahara vidhi visheshaayatana)
- FSSAI regulations on Ayurvedic Aahar

UNIT – III Ayurvedic Diets (5 Weeks)

- Principles of Diet: Aharavidhi vidhan, Sattvic, Rajasi, Tamasic foods
- Incompatible food (Viruddha Ahara), Pathya; Apathya; Viprita Ahaar
- Lifestyle Management with Dincharya and Ritucharya
- Application of Ayurvedic diets to stress linked food behaviour

Practical component (if any) – (15 Weeks)

- Visit your local market and classify the available food items according to Sattvic, Rajasi, Tamasic foods
- Conduct a survey of 10-15 households in your locality:
 - i. to study food behaviour and analyse them in light of Ayurvedic dietary principles of Sattvic, Rajasi, Tamasic
 - ii. to study the food consumption patterns and intake of incompatible food: Viruddha Ahara, Pathya; Apathya; Viprita Ahaar
 - iii To know about their adopted lifestyle Dincharya and Ritucharya
- Students are required to visit available e-resources of University of Delhi, Ministry of Ayush with regard to Ayurveda and Nutrition.
- If required, students can share their experiences in the form of a Project Report.
- The students may share their experiences in the form of audio-visual presentations of 15-30 minutes.
- Any other Practical/Practice as decided from time to time

Essential Readings

- Rastogi S (2014) Ayurvedic Science of Food and Nutrition. ASIN: BOOHWMV094, Springer: ISBN-13:978-1461496274
- Rastogi S (2010) Building bridges between Ayurveda and modern science. Int J Ayurveda Res. 1(1):41-46.
- FSSAI regulations on Ayurveda Aahar Regulations 2022. Gazette of India CG-DL-E-07052022-235642. New Delhi, Friday, May 6, 2022/ Vaisakha 16, 1944.
- Frawley D (2012) Ayurvedic healing: A comprehensive guide. Lotus Press, India.
- <https://iksindia.org/>: Indian Knowledge Systems

Suggested Readings

- Charaka Samhita, Charaka (1998) In: Tripathi BN (ed) Sutra Stahan Maharashitiya Adhyay. Chaukhamba Orientelia, Varanasi.
- Kapoor Kapil & Singh AK Indian Knowledge Systems Volume – 1. Indian Institute of Advanced Study Shimla. Published by DK Printworld (P) Ltd, N.Delhi.
<https://www.lkouniv.ac.in>.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time



VAC 1: ETHICS AND CULTURE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethics and Culture	02	1	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To help students explore ethical and cultural dimensions of their lives.
- To provides a forum for students to pause, revisit their assumptions and beliefs, and become mindful of their thoughts, emotions and actions.
- To give the students an opportunity to express themselves and inquire into their decision making processes.
- To cultivate ethical values and participate in the creation of a society based on acceptance, compassion, and justice.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explore perspectives on ethics in thoughts, words and actions
- Evolve ethical decision making practises
- Understand the need for an ethical society and culture
- Introspect, become conscious of and assess one's stance in life
- Cultivate empathy, tolerance and compassion
- Apply the values learnt in the course to everyday life

SYLLABUS OF ETHICS AND CULTURE

UNIT – I Introduction - The Basis of Ethics

(3 Weeks)

- Getting to Know Each Other
- What to Expect from the Course?
- Recognition of Our Common Humanity
- Empathy, Compassion and Justice

UNIT – II The Role of Intelligence, Reason and Emotions

(4 Weeks)

- Discernment: What Is The Right Thing To Do?
- The Art of Conflict Resolution
- Destructive and Constructive Emotions
- The Need for Emotional Balance

UNIT – III Cultivating Inner Values- Ethics in the World of Work and Play

(4 Weeks)

- Training the Mind: Mindfulness and Kindness
- Meditation
- Discovering your Vocation and Interests
- Self-discipline, Integrity, Commitment, Creativity
- Work-Life Balance

UNIT – IV Striving for a Better World | Outreach Activities

(4 Weeks)

- Means and Ends
- Debate and Dialogue
- Culture as Shared Values
- Creating and Sustaining Ethical Cultures: The Role of Philosophy, Religion, Literature, Theatre, Cinema, Music, Media
- Outreach Activities

Practical component (if any) –

(15 Weeks)

Unit 1

1. The teacher may ask students to introduce themselves, sharing their regional and cultural roots. They may be asked to reflect on those aspects of their identities that reflect their cultural roots.
2. After a round of initial introduction, the teacher may ask students to list down a set of values that they think they have developed through their parents and grandparents. Are these values unique to their families, regional and/or ethnic backgrounds? Of these, which are the values they would like to sustain and which are the ones they would wish to modify?
3. The teacher may draw upon the values discussed by students in the previous lesson. Using these as the base, the teacher may ask students to think of ethical values that form the basis of their decisions.

4. The teacher may ask students to think of people who they think have lived an 'ethical life'. These may be people who they know from their personal lives or people known for upholding ethical values in the face of adversity.
5. Students are encouraged to identify what common human values are necessary are Realise shared common humanity– the feeling of interconnectedness/interdependence.
6. Class to be divided in small groups to discuss how each would make an effort to cultivate new morals/ethical values for betterment of their local environment.
7. Celebrating 'Sharing and Caring' based on regional diversity can be encouraged.
8. Engage students to do activities of 'being in the shoes of others' (peers, parents, siblings, house help/support or in any local community grappling with problems) to understand the problems empathetically.
9. The students can be asked to make bookmarks/cards to remind them about virtues pertaining to empathy versus sympathy, need versus greed, just versus unjust or compassion versus insensitivity.
10. Compassion is about cultivation of it as a daily value so students can in small groups undertake compassion based activities of looking after animals, birds, needy, elderly, differently abled, non-privileged etc. and share their thoughts in the class.

Unit 2

1. Make the student think of a hard decision they have made. What made it hard? How did you make the decision? How do you assess it retrospectively?
2. Encourage students to think of judgements and decisions based on the dilemmas and challenges they faced? How do they go about making these decisions?
3. The teacher may introduce any well known story and ask the students to discuss the story from the point of view of the different characters.
4. Ask students how willing they are to deal with a conflict when it occurs. What strategies do they adopt to resolve the conflict?
5. The teacher may ask students to prepare posters with captions like "avoidance", "competition", "cooperation" and "adaptation" and then may ask students to identify with one of these styles which according to them best represents their style of dealing with conflict.
6. The students may be asked to discuss different such similar situations that they may have encountered and a discussion may be initiated on how they resolve those conflicts.
7. The students can be asked to write down certain destructive emotions that they are experiencing presently. How would they work to make them constructive? A classroom discussion could follow around this.

8. Ask the students to note down a list of constructive emotions experienced by them recently. Were the constructive emotions less powerful as compared to the destructive ones experienced by them? Discussion in class can follow.
9. How do you (i) express, (ii) handle anger/ disgust/ distress/ fear (any destructive emotion can be taken up). A healthy discussion in the class can take place around this.
10. Students may be asked to practice a simple breathing exercise. They can sit straight with eyes opened or closed in a comfortable position to just observe their breathing. They can repeat this exercise six to eight times and share (if they like) their experience of silence.
11. To identify your interests and develop a meaningful hobby.
12. Have an open conversation in the class about happiness.

Unit 3

1. The students could observe various emotions that bottle-up in their minds and be asked to watch the flow of emotions non-judgmentally.
2. Students may be asked to recall their journey to the college that morning. Do they remember road signs, faces of people they crossed, the roads that they took, the people they interacted with, the sights and smells around them, or anything else?
3. Students could be asked to cultivate the habit of simple greeting as practice of gratitude and celebrate a day of joyful giving.
4. The students can close their eyes for 2-3 minutes and be asked to observe their thoughts, list them and categorise them into 'to be kept' or 'to let go'.
5. The teacher may ask students to close their eyes and imagine a situation in which they are truly happy. Students could wish for the well-being of two students in the same classroom in their meditative state.
6. Students could meditate on who has been their inspiration and the qualities of the person who has inspired them and then express gratitude to the person concerned.
7. The teacher may ask the students to think retrospectively about what they thought they would take up as a vocation when they were younger. How and why their choices were influenced and changed, if at all.
8. The teacher may ask the students to imagine and chart a journey and destination for themselves. They may also talk about the challenges they foresee.
9. The teacher may encourage the students to maintain a daily diary of their scheduling of time or a worklog and see how much time they effectively give to their work. The teacher may help the students identify the distractors and where one may be 'wasting' time and energy. The activity is designed to help students understand the value of effective time utilisation.

10. In this lesson, the teacher may ask the students to draw up a list of team ethics. They may build this based on their experiences of working with each other in groups.
11. The teacher may ask the students to share an incident each where they felt pressurised/ bored to complete some work. How did they deal with their stress and monotony of work?

Unit 4

1. Students will be asked to work in pairs and develop situations that pose ethical dilemmas and how to resolve them.
2. Students may be asked to look at a film or at an advertisement and discuss what they think about the question/s posed in them. The teacher may ask them if they can think of an alternative ethical approach to the problem posed.
3. Students will be asked to think of situations in which they lost their temper. Have they ever felt that in a fit of emotion they said something that they regretted later? If they had paused to listen and then respond, what would the other person have said? How would the outcome of the situation have been different?
4. A debate on any relevant topic may be conducted in the class. After the first round the students may be asked to adopt and argue their opponents point of view. At the end of this exercise the students can have an open discussion on which position finally appealed to them.
5. The teacher may give a short story to the students and ask them to change the ending. They may be asked to observe how characters and their views may have undergone change in the process.
6. There can be a discussion around a topic such as, the idea of corporal punishment, euthanasia etc. Students can be given a sheet of paper and can be asked to write for or against the theme. The idea is to enable them to understand that the positions they have taken vis-a-vis the theme are a result of different value orientations.
7. Popular foods from many parts of India can be discussed. Their origins can be traced to chart a kind of food history.
8. The teacher on the basis of discussions with students can draw from Philosophy, Religion, Literature, Theatre, Cinema, and Media to highlight that the choices people/characters make are grounded in their culture.
9. The students can discuss classical/folk dances that are performed in their respective groups. Details can be drawn based on the number of dancers, music (live or recorded) and costumes. 3. The role of oral traditions and literature in indicating the importance of ethics in our everyday lives can be discussed.

Suggested Activities for Outreach: Social/ Community Engagement and Service

In the weeks that follow, students will be expected to engage in outreach activities that shall enable them to put into practice some of the ethical considerations deliberated upon and imbibed in the previous modules. A list of suggested outreach activities is as follows:

- Adopt a village with the aim of cultural and ethical learning
- Discussing health and hygiene issues in a community
- Tutoring students
- Gender sensitisation
- Working on environmental issues
- Working with Child Care Centres such as Anganwadis and Balwadis
- Working with differently abled students
- Preserving cultural and heritage sites
- Spending time with senior citizens including in a Senior Citizens Home
- Extending care to animals in animal welfare shelters
- Addressing issues relating to Reproductive Health
- Spreading awareness about adolescent health
- Addressing issues relating to mental health
- Health and nutrition awareness
- Swacchata Abhiyaan
- Sensitisation towards disease awareness
- Vriksharopan
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Suggested Readings:

- Aristotle. Nichomachean Ethics. London: Penguin Classics, 2004
- Swami Vivekananda. The Complete Works of Swami Vivekananda. Advaita Ashrama, 2016.
---https://www.ramakrishnavivekananda.info/vivekananda/complete_works.html
- Panch Parmeshwar in English translation as The Holy Panchayat by Munshi Premchand
- The Silas Marner by George Eliot
- We are Seven by Wordsworth
- The Chimney Sweeper by William Blake

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

BA (H) Sociology

Discipline Specific Elective 07

Visual Culture

Course Objectives

1. The objective of this paper is to introduce the students to various perspectives that enable a contextualisation of everyday visual culture within the larger debates around power, politics, identity and resistance.
2. It brings together debates from the field of Art History, Social Sciences and Visual Art Practices to enable the students to understand the processes through which different visual environments can be sociologically analyzed. One of the central arguments of this paper is to understand how the very process of ‘seeing’ can be problematized.

Course Learning Outcomes

1. Developing the techniques to understand and appreciate visuals; working with visuals as potential representations of matters of sociological interest.
2. Understanding ‘visuality’/‘visualization’ as a technique of asserting power and dominance in society; simultaneously locating the subversive potential of alternative or ‘counter-visualities’.
3. Discovering the strength of ‘visuals’ in an age dominated by techniques of mass production and dissemination of images.

Course Content:

Unit 1 Introduction

1.1 Introducing Visual Cultures and the Process of ‘Seeing’

1.2 The Spectacles of Modernity

Unit 2 Visual Environments and Representations

2.1 Power, Knowledge and gaze of the State

2.2 Visual Contestations

2.3 Visual Practices and Identity formation

2.4 Visual Cultures of Everyday Life

*

Unit 1. Introduction (Weeks 1-4)

1.1 Introducing Visual Culture and the process of 'seeing' (Weeks 1-2)

Mitchell, W.J.T. 'Showing Seeing: A Critique of Visual Culture' In *Journal of Visual Culture*, August 2002 vol. 1 no. 2 165-180

Berger, John. *Ways of Seeing*. London: British Broadcasting, 1972. (p. 7- 33)

1.2 The Spectacles of Modernity (Weeks 3-4)

Debord, Guy. *Society of the Spectacle*. Detroit: Black & Red, 1983. (p. 7- 17)

Shohat, Ella & Robert Stam 'Narrativizing Visual Culture', In Nicholas Mirzoeff (ed) *The Visual Culture Reader*. 2nd ed. London: Routledge, 2002. (p. 37-41)

Fenske, Gail & Deryck Holdsworth, 'Corporate Identity and the New York Office Building: 1895-1915' In David Ward and Olivier Zunz (ed) *The Landscape of Modernity: New York City, 1900-1940*. Baltimore: Johns Hopkins UP, 1997.

Roma Chatterji 'Global Events and Local Narratives: 9/11 and the Chitrakaars' In *Speaking with Pictures: Folk Art and Narrative Tradition in India* (p 62-103)

Unit 2. Visual Environments and Representations (Weeks 5-14)

2.1 Power, Knowledge and gaze of the State (Weeks 5-7)

Foucault, Michel. 'Panopticism' In *Discipline and Punish: The Birth of the Prison*. New York: Pantheon, 1977. (p. 195-203)

Mirzoeff, Nicholas. 'The Right to Look, or, How to Think With and Against Visuality' In *The Right to Look: A Counterhistory of Visuality*. Durham, NC: Duke UP, 2011.

Cohn, Bernard, 1987 (1983), "Representing Authority in Colonial India", in *An Anthropologist Among the Historians and Other Essays*, Delhi: OUP, pp. 632-650

Tagg, John. 'Evidence, Truth and Order: Photographic Records and the Growth of the State' In *Essays on Photographies and Histories*. Amherst: University of Massachusetts, 1988

2.2 Visual Contestations (Weeks 8-10)

Eco, Umberto. *On Ugliness*. New York: Rizzoli, 2007. Print. pp. 8-20.

Bakhtin, Mikhail. 'The Grotesque Image of the Body and Its Sources' In Mariam Fraser & Monica Greco (ed) *The Body: A Reader*. London: Routledge, 2005.

Ranciere, Jacques. 'Problems and Transformations of Critical Art' In *Aesthetics and Its Discontents*. Cambridge, UK: Polity, 2009.

Mally, Lynn. *Revolutionary Acts: Amateur Theater and the Soviet State, 1917-1938*. Ithaca: Cornell UP, 2000. p. 147-169

2.3 Visual Practices and Identity Formation (Weeks 11-12)

Srivastava, Sanjay. 'Urban spaces, Disney-Divinity and Moral Middle classes in Delhi' In *Economic and Political Weekly* Vol. XLIV, Nos. 26 & 27 (June 27, 2009), pp. 338-345

MacDougall, David. 'Photo Hierarchicus: Signs and Mirrors in Indian Photography' in *Visual Anthropology*, 1992, 5 (2): 103-29.

2.4 Visual Culture of the everyday life (Weeks 13-14)

Certeau, Michel De. *The Practice of Everyday Life*. (Trans) Steven Rendall, Berkeley: University of California, 1984 (p. xi-xxiv)

Pinney, Christopher. 'What do Pictures Want Now: Rural Consumers of Images, 1980-2000' In *Photos of the Gods: The Printed Image and Political Struggle in India*. London: Reaktion, 2004. Pp. 181-200

Thomas de la Peña, Carolyn. 'Ready-to-Wear Globalism: Mediating Materials and Prada's GPS' In *Winterthur Portfolio*. Vol. 38, No. 2/3 (Summer/Autumn 2003), pp. 109-129

References:

Compulsory Readings:

Bakhtin, Mikhail. 'The Grotesque Image of the Body and Its Sources' In Mariam Fraser & Monica Greco (ed) *The Body: A Reader*. London: Routledge, 2005.

Berger, John. *Ways of Seeing*. London: British Broadcasting, 1972. (p. 7- 33)

Certeau, Michel De. *The Practice of Everyday Life*. (Trans) Steven Rendall, Berkeley: University of California, 1984 (p. xi-xxiv)

Cohn, Bernard, 1987 (1983), "Representing Authority in Colonial India", in *An Anthropologist Among the Historians and Other Essays*, Delhi: OUP, pp. 632-650

- Debord, Guy. *Society of the Spectacle*. Detroit: Black & Red, 1983. (p. 7- 17)
- Eco, Umberto. *On Ugliness*. New York: Rizzoli, 2007. Print. pp. 8-20.
- Fenske, Gail & Deryck Holdsworth, 'Corporate Identity and the New York Office Building: 1895-1915' In David Ward and Olivier Zunz (ed) *The Landscape of Modernity: New York City, 1900-1940*. Baltimore: Johns Hopkins UP, 1997.
- Foucault, Michel. 'Panopticism' In *Discipline and Punish: The Birth of the Prison*. New York: Pantheon, 1977. (p. 195-203)
- MacDougall, David. 'Photo Hierarchicus: Signs and Mirrors in Indian Photography' in *Visual Anthropology*, 1992, 5 (2): 103-29.
- Mally, Lynn. *Revolutionary Acts: Amateur Theater and the Soviet State, 1917-1938*. Ithaca: Cornell UP, 2000. p. 147-169
- Mirzoeff, Nicholas. 'The Right to Look, or, How to Think With and Against Visuality' In *The Right to Look: A Counterhistory of Visuality*. Durham, NC: Duke UP, 2011.
- Mitchell, W.J.T. 'Showing Seeing: A Critique of Visual Culture' In *Journal of Visual Culture*, August 2002 vol. 1 no. 2 165-180
- Pinney, Christopher. 'What do Pictures Want Now: Rural Consumers of Images, 1980-2000' In *Photos of the Gods: The Printed Image and Political Struggle in India*. London: Reaktion, 2004. Pp. 181-200
- Ranciere, Jacques. 'Problems and Transformations of Critical Art' In *Aesthetics and Its Discontents*. Cambridge, UK: Polity, 2009.
- Roma Chatterji 'Global Events and Local Narratives: 9/11 and the Chitrakaars' In *Speaking with Pictures: Folk Art and Narrative Tradition in India* (p 62-103)
- Shohat, Ella & Robert Stam 'Narrativizing Visual Culture', In Nicholas Mirzoeff (ed) *The Visual Culture Reader*. 2nd ed. London: Routledge, 2002. (p. 37-41)
- Srivastava, Sanjay. 'Urban spaces, Disney-Divinity and Moral Middle classes in Delhi' In *Economic and Political Weekly* Vol. XLIV, Nos. 26 & 27 (June 27, 2009), pp. 338-345
- Tagg, John. 'Evidence, Truth and Order: Photographic Records and the Growth of the State' In *Essays on Photographies and Histories*. Amherst: University of Massachusetts, 1988
- Thomas de la Peña, Carolyn. 'Ready-to-Wear Globalism: Mediating Materials and Prada's GPS' In *Winterthur Portfolio*. Vol. 38, No. 2/3 (Summer/Autumn 2003), pp. 109-129.

Additional Resources:

Books & Articles:

Appadurai, Arjun, and Carol A. Breckenridge. 'Museums are Good to Think: Heritage on View in India.' *Representing the Nation: A Reader: Histories, Heritage, and Museums*. (Eds.) David Boswell and Jessica Evans .New York: Routledge, 1999.

Babb, Lawrence A., and Susan Snow Wadley. *Media and the Transformation of Religion in South Asia*. Philadelphia: University of Pennsylvania, 1995.

Mazumdar, Ranjani. *Bombay Cinema: An Archive of the City*. Minneapolis: University of Minnesota, 2007

Pinney, Christopher. *Camera Indica: The Social Life of Indian Photographs*. Chicago: University of Chicago, 1997.

Rappoport, Erika D. 'A New Era of Shopping: The Promotion of Women's Pleasure', Leo Charney and Vanessa R. Schwartz (ed) *Cinema and the Invention of Modern Life*. Berkeley & Los Angeles: University of California Press, 1995

Sciorra, Joseph. 'Religious Processions as Ethnic and Territorial Markers in a Multi-ethnic Brooklyn Neighborhood' In Robert A. Orsi (ed) *Gods of the City*. Indiana University Press: 1999

Weinbaum, Alys Eve. *The Modern Girl around the World: Consumption, Modernity, and Globalization*. Durham: Duke UP, 2008. Print.

Teaching-Learning Process

- a. The teaching-learning process for this course is centered on idea that students develop the capacity to connect concepts and debates from different visual art and social science fields, thereby understanding the interdisciplinary premise of this paper.
- b. The role of the teacher is demanding here since this interdisciplinary aspect requires the students to be continually engaging with past and present artistic approaches, architectural developments, and advances in film, photographic and other visual practices.
- c. This is not a course that can be transacted purely within the limits of a classroom. Accordingly, the pedagogic approach for this paper encourages visits to museums and art exhibitions along with regular conversations with artists and producers of various visual materials. It is expected that this course be transacted keeping in mind the constant encounter that the students have with the visual, thus enabling them to receive this data not as passive observers but with keen and analytical minds.

Assessment:

Given the interdisciplinary nature of the course and its requirement to move beyond the classroom and text books, assessment methods would involve tutorial and seminar presentations, guided term papers, group discussions and periodic class tests (closed or open book depending on the topic addressed).

Keywords:

Visual, Visuality, Seeing, Folk Art, Panopticon, Authority, Modernity, Countervisuality, Grotesque, Amateur Art, Camera, Photographic Representation, Photography, Critical Art, Identity, Representation, Everyday Life.

B.A. (H) Sociology
Discipline Specific Core (DSC) 11
Economic Sociology

Discipline Specific Core Course -11 (DSC-11) : Economic Sociology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
DSC 11 Economic Sociology	4	3	1	0	12th Class Pass	BA (H) DSC 01: Introduction to Sociology or equivalent course

Learning Objectives:

1. To familiarise students with the key concepts and theoretical perspectives in Economic Sociology.
2. To provide an understanding of the social and cultural bases of various dimensions of the economy such as production, distribution, exchange, consumption and markets.
3. To enable students to comprehend economic processes at all levels as embedded and interconnected.

Learning outcomes:

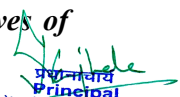
Students will be able to:

1. *Understand* the key concepts and theories of economic sociology as a specialised branch of knowledge.
2. *Identify* the diverse ways in which the economy is embedded in other aspects of society and culture.
3. *Use* sociological concepts and theories to understand and analyse the transformations of the economy and its key processes and institutions from a comparative perspective.
4. *Generate* research questions and arguments about the intersections of economy and society.

SYLLABUS OF DSC-11: Economic Sociology

Unit I: Introduction to Economic Sociology (15 hours)

This unit provides an understanding of the key concepts and theoretical perspectives of Economic Sociology as a specialised branch of knowledge.


 श्री वेंकटेश्वर महाविद्यालय
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- a. What is Economic Sociology?
- b. Perspectives in Economic Sociology

Unit II: Economic Action and its Locations (24 hours)

This unit provides an understanding of the various dimensions of economy such as production, distribution and consumption while highlighting their sociocultural bases.

- a. Production and its Logics
- b. Distribution and its Reach

Unit III: Contemporary Directions in Economic Sociology (6 hours)

This unit provides an understanding of the changing economic processes and institutions in contemporary times.

- a. Informal Economy
- b. Platform Society

Practical Component: NIL

Essential/Recommended Readings:

Unit I. Introduction to Economic Sociology (15 hours)

a. What is Economic Sociology

Martinelli, Alberto. 2023. 'The conception and definition of economic sociology' in *The Routledge International Handbook of Economic Sociology*. New York: Taylor & Francis, 2023. Pp. 57-74.

Portes, Alejandro. 2010. 'The Assumptions That Ground the Field' in *Economic Sociology: A Systematic Inquiry*. New Jersey: Princeton University Press. Chapter 2. Pp. 10-26.

b. Perspectives in Economic Sociology

Polanyi, Karl. 1992. 'Economy as an Instituted Process' in M. Granovetter and R. Swedberg (eds.) *The Sociology of Economic Life*. Colorado: West View Press. Pp. 27-50.

Granovetter, Mark. 1985. 'Economic Action and Social Structure: The Problem of Embeddedness'. *American Journal of Sociology*. 91(3). Pp. 481- 507.

Unit II: Economic Action and its Locations (24 hours)

a. Production and its Logics

Sahlins, Marshall. 2017. 'The Original Affluent Society' in *Stone Age Economics*. New York: Routledge. Chapter 1. Pp. 1-37.

Scott, James C. 1976. 'The Economics and Sociology of Subsistence Ethics' in *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia*. Chapter 1. New Haven, Yale University press. Pp. 13-34.

Wallerstein, Immanuel. 1983. 'The Commodification of Everything: Production of Capital' in *Historical Capitalism*. London: Verso. Chapter 1. Pp. 13-46.

b. Distribution and its Reach

Mauss, Marcel. 1966. 'The Gifts and Obligation of Return Gift' and 'Distribution of the System: Generosity, Honour and Money' in *The Gift: Forms and Functions of Exchange in Archaic Societies*. (tr. Ian Cunnison). London: Cohen and West. Chapters. 1, 2. Pp. 1-46.

Patterson, Thomas C. 2005. 'Distribution and Redistribution' in James G. Carrier (ed.) *A Handbook of Economic Anthropology*. Cheltenham: Edward Elgar. Pp. 194-209.

Weiss, Brad. 1996. 'Coffee Breaks and Coffee Connections: The Lived Experience of a Commodity in Tanzanian and European Worlds' in David Howes (ed.) *Cross-Cultural Consumption: Global Market, Local Realities*. London and New York: Routledge. Pp. 93-105.

Unit III: Contemporary Directions in Economic Sociology (6 hours)

a. Informal Economy

Light, Donald W. 2004. 'From Migrant Enclaves to Mainstream: Reconceptualizing Informal Economic Behaviour' in *Theory and Society*. 33(6). Pp. 705-737.

b. Platform Society

Dijk, Jose Van. et al. 2018. 'The Platform Society as a Contested Concept' in *The Platform Society: Public Values in a Connected World*. New York: Oxford University Press. Chapter 1, Pp. 1-30.

Suggested Readings:

Appadurai, A. 1986. *The Social Life of Things: Commodities in Cultural Perspective*. Cambridge: Cambridge University Press.

Carrier, James G. 1995. *Gifts and Commodities*. London: Routledge.

DiMaggio, Paul. 2019. 'Cultural Aspects of Economic Action and Organization' in R. Friedland and A. F. Robertson (eds.) *Beyond the Market Place: Rethinking Economy and Society*. New York: Routledge. Pp. 113-136.

Graeber, David. 2001. *Toward an Anthropological Theory of Value: The False Coin of Our Own Dreams*. New York: Palgrave.

Hann, Chris and Keith Hart. 2011. *Economic Anthropology*. Cambridge: Polity Press.

Hirst, Paul and G Thompson 1999. *Globalization in Question*. 2nd Edition. Cambridge, Oxford: Polity Press.

Sahlins, Marshal. 1974. *Stone Age Economics*. London: Tavistock.

Smelser, Neil. J. and Richard Swedberg. 2005. *The Handbook of Economic Sociology*. New York: Russel Sage Foundation.

Tonkiss, Fran. 2006. *Contemporary Economic Sociology*. London: Routledge.

Verdery, Katherine. 1996. *What Was Socialism, And What Comes Next?* New Jersey: Princeton University Press.

Zelizer, Viviana A. 1989. 'The Social Meaning of Money: Special Monies'. *American Journal of Sociology*, Vol. 95 (Sept.). Pp. 342-377.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ZH DSE Course-I: Animal Behaviour and Chronobiology

Course Learning Objective:

Animal Behaviour is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment in which they live in. One important aspect pertaining to the studies on Animal Behaviour is that it can be conducted anywhere and at any time, depending on the interest of the researcher. Moreover, it is not confined to the four walls of the classroom or the laboratory. The behavioural biology has high applied value and currently linked to conservation biology, molecular biology, behavioural ecology and integrated pest management. The chronobiology addresses some periodic and cyclic nature of various life phenomena occurring in living beings in nature. They often correlate with the external environmental factors. Chronopharmacology, chronomedicine and chronotherapy are some of the direct applications of chronobiology in human health. This course aims to provide an overview of animal behaviour and chronobiology starting from historical prospective to types of behaviours and their evolutionary significance. The course also highlights types, mechanisms and importance of the biological rhythms and biological clocks operating in the living organisms. This course will help the learners to understand and appreciate different types of animal behaviours, their adaptive, evolutionary and practical significance.

Course Learning Outcome:

Upon completion of the course, students should be able to:

- Understand types of animal behaviour and their importance to the organisms.
- Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.
- Relate animal behaviour with other subjects such as Animal biodiversity, Evolutionary biology, Ecology, Conservation biology and Genetic basis of the behaviour.
- Understand various process of chronobiology in their daily life such as jet lag.
- Learn about the biological rhythm and their application in pharmacology and modern medicine.
- Realize, appreciate and develop passion to biodiversity; and will respect the nature and environment.

Course Content:

Theory [Credits: 4]

60 hrs

Unit 1: Introduction to Animal Behaviour

8 hrs

Origin and history of Ethology; Pioneers of Modern Ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behaviour; tools, techniques and methods used in studying animal behaviour
(Chapter 1, 2: Alcock; Section 2.3, 3.1, 3.2: McFarland)

Unit 2: Patterns of Behaviour

10 hrs

Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct *versus* Learned behaviour; Associative learning, Classical and Operant conditioning, Habituation, Imprinting
(Part 2 & 3: McFarland; Chapter 2, 5: Manning)

Unit 3: Social and Sexual Behaviour

15 hrs

Social Behaviour: Concept of Society, Communication and the senses (Chemical, Tactile, Auditory, Visual); Altruism, Inclusive fitness, Hamilton's rule; Insects' society (Example: Honey bee); Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Courtship behaviour; Parental care, sexual conflict in parental care.

(Chapter 2, 3, 4, 7 and 9: Alcock)

Unit 4: Introduction to Chronobiology

6 hrs

Historical developments in chronobiology, Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

(Chapter 2: Vinod Kumar; Chapter 1, 2: Dunlap et al; Chapter 1: Saunders)

Unit 5: Biological Rhythm

13 hrs

Characteristics of biological rhythms; Short-and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

(Chapter 2, 3, 4: Dunlap et al; Chapter 16, 17, 20: Vinod Kumar; Chapter 9: Saunders)

Unit 6: Biological Clocks

8 hrs

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy

(Chapter 2, 3 and 4: Dunlap et al; Chapter 16, 17, 20: Vinod Kumar; Chapter 9: Saunders)

Practical [Credits: 2]

1. To study nests and nesting behaviour of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae.
4. Study of courtship behaviour in birds and insects from short videos/films.
5. Visit to Forest/Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. To study circadian functions in humans (daily eating, sleep and temperature patterns).

Teaching and Learning Process:

Teaching learning methods for the Animal behaviour and chronobiology paper should include conventional black board teaching coupled with power point presentations and smart board. The animal behaviour in wild life can be shown to the student with the help of videos and short films. The classroom teaching should be inclusive and have opportunities for the students to participate in the class discussion. The students should be encouraged to observe various live animal behaviours in their immediate surrounding environment and interpret them. There should be ample scope for field visits and visit to the research laboratories. Seminar should be arranged at the departmental level for the student, where student can have paper presentation on various themes of animal behaviour and chronobiology. Quizzes and debates can be arranged to make the teaching learning more innovative. Students should be advised to use e resources along with standard text books and reference books. They should take short project work and case study on the animal behaviour. They should relate various concepts in chronobiology taught in the classroom with their daily life. The students should be regularly assessed.

Assessment Methods:

- Scheme for the assessment of students would have two components.
- The first component will include continuous evaluation of the student throughout the course work by assessing assignments, project works, presentations, quiz, class tests and regularity in attending the classes.
- The second component will carry examination carried by the University at the end of semester.

Keywords:

Animal behaviour, Types of behaviour, Social behaviour, Reproductive behaviour, Altruism, Courtship behaviour, Communication, Chronobiology, Biological rhythm, Biology Clocks

Recommended Books:

- Alcock J. (2013). Animal Behaviour. Sinauer Associate Inc., USA.
- McFarland D. Animal Behaviour. (1982). Pitman Publishing Limited, London, UK.
- Vinod Kumar (2002) Biological Rhythms. Narosa Publishing House, Delhi/ Springer-Verlag, Germany
- Dunlap J. C, Loros J. J, DeCoursey P. J. (2004) Chronobiology Biological Timekeeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

Suggested Readings:

- Manning, A. and Dawkins, M. S. (2012). An Introduction to Animal Behaviour. Cambridge, University Press, UK.
- Paul W. Sherman and Alcock J. (2013). Exploring Animal Behaviour. Sinauer Associate Inc., Massachusetts, USA.
- Saunders D. S. (2002). Insect Clocks. III Edition, Barends and Noble Inc. New York, USA

ZH DSE Course-XI: Wildlife Conservation and Management

Course Learning Objective:

The Discipline Specific Paper on Wildlife Conservation and Management is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, management of their habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. This course will motivate students to pursue career in the field of wildlife conservation and management.

Course Learning Outcome:

Upon completion of the course, students will be able to:

- Become aware about the importance of wildlife in general, and its conservation and management in particular.
- Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- Know the key factors for loss of wildlife and important strategies for their *in situ* and *ex situ* conservation.
- Recognize the techniques for estimation, remote sensing and Global Position Tracking for wildlife.
- Gain knowledge about the wildlife diseases and the quarantine policies.
- Know about the Protected Area Networks in India, Ecotourism, Ecology of perturbation and Climax persistence.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.

Course Content:

Theory [Credits: 4]

60hrs

Unit 1: Introduction to Wildlife

6hrs

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21
(Chapter 1, 2, 3 and 10: Singh; Chapter 1 and 3: Saha and Mazumdar)

Unit 2: Evaluation and Management of Wildlife

10hrs

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.
(Chapter 2, 11 & 12: Sutherland; Chapter 6: Singh; Chapter 6: Saha and Mazumdar)

Unit 3: Management of Habitats

10hrs

Setting back succession: Grazing logging; Mechanical treatment; Advancing the successional process: Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats.
(Chapter 11 & 12: Sutherland; Chapter 6: Singh)

Unit4: Population Estimation

12 hrs

Population density, Natalty, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods
(Chapter 2 & 4: Sutherland; Chapter 8 and 9: Singh; Chapter 6: Saha and Mazumdar)

Unit5: Management Planning of Wildlife in Protected Areas

8hrs

Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories; Ecology of perturbation.
(Chapter 9: Sutherland; Chapter 1: Woodroff; Chapters 8 and 11: Singh; Chapter 9: Saha and Mazumdar)

Unit6: Management of Excess Population

6hrs

Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (Ebola and Salmonellosis), Rabies, Foot and Mouth Disease, Mycobacterium TB, Bovine and Avian Flu
(Chapters 6, 7 and 11: Saha and Mazumdar)

Unit:7 Protected Areas

8hrs

National parks and sanctuaries; Biosphere reserves; Conservation and Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India and Management challenges in Tiger reserve
(Chapters 11 and 12: Singh; Chapters 3 and 9: Saha and Mazumdar)

Practical [Credits: 2]

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats, nests and antlers.
4. Demonstration of different field techniques for flora and fauna: PCQM.
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
6. Identification of big cats: Lion, tiger, panther, cheetah, leopard and jaguar.
7. A report based on a visit to National Park/Wildlife Sanctuary/Biodiversity Park or any other wildlife conservation site.

Teaching and Learning Process:

The case study approach with real-life examples from the field will give a better understanding of the subject and its applications. The traditional chalk and talk method will be supplemented with LCD projection system and use of visualizer for theory classes. Projection of videos or short movies available on the subject will enhance the understanding of the subject. Digital collection of pictures of pugmarks, hoof marks, bird's nests, wild fauna and flora will facilitate observation of their characteristic features with ease. Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching. Project based reports, assignments and E-posters can also form an important part of learning regime. Field-based research projects will develop interest in the subject and motivate students to peruse research as a

future. Laboratory visits to renowned institutions like WII, Dehradun and Field visits to various conservation sites like Jim Corbett National Park, Aravali Biodiversity Park and National Zoological Park will provide students a practical or hands on knowledge of the subject. Students should participate in citizen science initiatives related to wildlife such as bird counts and uploading of the data on E-bird.org.

Assessment Methods:

Students will be assessed using the following methods:

- Formative/ Continuous assessment: This will be done through problem solving exercises, oral and written examinations, closed-book and open book tests, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation, viva voce interviews, computerized adaptive testing, literature surveys and evaluations, outputs from collaborative work etc. to assess the retention abilities of students.
- Summative assessment: Semester-end written and practical examinations will be an indicator of student's learning throughout the semester and analyses comprehensive knowledge gained by the students.

Keywords:

Wildlife, Conservation, Management, Population, Habitat, Succession, Climax, Quarantine, Tiger Project, National Park, Wildlife Sanctuaries, Biodiversity Reserves, Wildlife Diseases, Protected Areas

Recommended Books:

- Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
- Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
- Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow.

Suggested Readings:

- Hudson, P.J., Rizzoli, A., Grenfell, B.T. Heesterbeek, H. and Dobson, A.P. (2002). The Ecology of Wildlife Diseases. Oxford University Press, Oxford.
- Banerjee, K. (2002). Biodiversity Conservation in Managed and Protected Areas. Agrobios, India.
- Sharma, B.D. (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.
- Primack, R.B. (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
- Hossetti, B. B. (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

Online Tools and Web Resources:

- <https://swayam.gov.in/courses/4687-july-2018-wildlife-conservation>
- <https://swayam.gov.in/courses/5364-jan-2019-wild-life-ecology>
- <https://papaco.org/mooc-on-species-conservation/>
- <https://www.iucn.org/theme/protected-areas/our-work/capacity-development/moocs>
- <https://www.zsl.org/united-for-wildlife-free-conservation-courses>
- <https://wildlife.org/next-generation/career-development/online-courses/>
- <https://www.openlearning.com/umtmooc/courses/wildlife-management>

VAC 1: FIT INDIA

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fit India	02	0	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Encourage physical activity through engaging the students in sports and yoga.
- Understand the importance of a balanced diet .
- Build skills for self-discipline, self-confidence, cooperation and teamwork.
- Promote fitness as a joyful activity

Learning outcomes

The Learning Outcomes of this course are as follows:

- Adopting a healthy lifestyle.
- Knowledge of nutrition, diet and psycho-physiological aspects of fitness.
- Develop Self-esteem, Self-confidence, Self-discipline and team spirit as indicators of fitness.

SYLLABUS OF FIT INDIA

ONLY PRACTICAL

Note: Concepts are to be taken up during the practical/practice hours.

Practical component (if any) –

(15 Weeks)

UNIT – I Participation in Physical Activity

(4 Weeks)

- Fit India Protocol

- Physical Activity, Health and Fitness
- Indicators of Fitness

Practical/Practice

- Aerobic Work Out / Physical Activity (Walking)
- Yoga – Asanas (Lying, Sitting and Standing positions) and Pranayama
- Cardiovascular Testing by 12min/9 min Cooper Run/Walk test

UNIT – II Health Related Fitness and their Components

(4 Weeks)

- Muscular Strength and Endurance
- Body Composition and Flexibility

Practical/Practice

- Flexibility Training: Back Saver Sit and Reach test
- Muscular Strength Training: Curl Ups / Standing Broad Jump/ Vertical Jump/ Plyometric
- Endurance Training: 1 Mile RockPort Test or 12 /9 minute Cooper run/walk test.
- Ideal Body Weight, Body Mass Index (BMI), Waist-Hip Ratio, Waist-Height Ratio (Data of at least 10 persons to be collected)

UNIT – III Nutrition and Fitness

(4 Weeks)

- Healthy Eating Plate
- Balanced Diet
- Caloric Content of Food

Practical/Practice

- Preparing Daily Diet and Calorie Chart
- Aerobic Work Out / Physical Activity (Walking)
- Assessment of Physical Activity with the Calorie intake.
- Asanas for digestive system excretory system

UNIT – IV Sports Physiology and Psychology

(3 Weeks)

- Depression, Anxiety and Stress Scale (DASS)
- Rosenberg Self Esteem Scale

Practical/Practice

- Skills learning and Participation in sports
- Group Games / Relays/ Minor Games
- Meditative Asanas and Pranayama
- Fitness component testing (as per Fit India Protocol and Norms) and Analysis of Results
- Data of at least 10 persons to be collected on DASS and self-esteem scale

Essential/recommended readings

- Fit India Website: <https://fitindia.gov.in>
- Wener W.K. Hoeger, Sharon
- A. Hoeger - Fitness and Wellness-Cengage Learning (2014).

Suggested readings

- Charles B. Corbin, Gregory J Welk, William R Corbin, Karen A Welk - Concepts of Fitness And Wellness_ A Comprehensive Lifestyle Approach-McGraw-Hill (2015)
- W.Larry Kenney, Jack H. Wilmore, Devid L.Costil(2015). Physiology of Sports and Exercise, Second Edition. USA. Human Kinetics.
- Websites of International Sports Federations
- Website of Ministry of Youth Affairs and Sports

 **Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time**

ZH DSE Course-I: Animal Behaviour and Chronobiology

Course Learning Objective:

Animal Behaviour is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment in which they live in. One important aspect pertaining to the studies on Animal Behaviour is that it can be conducted anywhere and at any time, depending on the interest of the researcher. Moreover, it is not confined to the four walls of the classroom or the laboratory. The behavioural biology has high applied value and currently linked to conservation biology, molecular biology, behavioural ecology and integrated pest management. The chronobiology addresses some periodic and cyclic nature of various life phenomena occurring in living beings in nature. They often correlate with the external environmental factors. Chronopharmacology, chronomedicine and chronotherapy are some of the direct applications of chronobiology in human health. This course aims to provide an overview of animal behaviour and chronobiology starting from historical prospective to types of behaviours and their evolutionary significance. The course also highlights types, mechanisms and importance of the biological rhythms and biological clocks operating in the living organisms. This course will help the learners to understand and appreciate different types of animal behaviours, their adaptive, evolutionary and practical significance.

Course Learning Outcome:

Upon completion of the course, students should be able to:

- Understand types of animal behaviour and their importance to the organisms.
- Enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.
- Relate animal behaviour with other subjects such as Animal biodiversity, Evolutionary biology, Ecology, Conservation biology and Genetic basis of the behaviour.
- Understand various process of chronobiology in their daily life such as jet lag.
- Learn about the biological rhythm and their application in pharmacology and modern medicine.
- Realize, appreciate and develop passion to biodiversity; and will respect the nature and environment.

Course Content:

Theory [Credits: 4]

60 hrs

Unit 1: Introduction to Animal Behaviour

8 hrs

Origin and history of Ethology; Pioneers of Modern Ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behaviour; tools, techniques and methods used in studying animal behaviour
(Chapter 1, 2: Alcock; Section 2.3, 3.1, 3.2: McFarland)

Unit 2: Patterns of Behaviour

10 hrs

Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct *versus* Learned behaviour; Associative learning, Classical and Operant conditioning, Habituation, Imprinting
(Part 2 & 3: McFarland; Chapter 2, 5: Manning)

Unit 3: Social and Sexual Behaviour

15 hrs

Social Behaviour: Concept of Society, Communication and the senses (Chemical, Tactile, Auditory, Visual); Altruism, Inclusive fitness, Hamilton's rule; Insects' society (Example: Honey bee); Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Courtship behaviour; Parental care, sexual conflict in parental care.

(Chapter 2, 3, 4, 7 and 9: Alcock)

Unit 4: Introduction to Chronobiology

6 hrs

Historical developments in chronobiology, Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

(Chapter 2: Vinod Kumar; Chapter 1, 2: Dunlap et al; Chapter 1: Saunders)

Unit 5: Biological Rhythm

13 hrs

Characteristics of biological rhythms; Short-and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

(Chapter 2, 3, 4: Dunlap et al; Chapter 16, 17, 20: Vinod Kumar; Chapter 9: Saunders)

Unit 6: Biological Clocks

8 hrs

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy

(Chapter 2, 3 and 4: Dunlap et al; Chapter 16, 17, 20: Vinod Kumar; Chapter 9: Saunders)

Practical [Credits: 2]

1. To study nests and nesting behaviour of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae.
4. Study of courtship behaviour in birds and insects from short videos/films.
5. Visit to Forest/Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. To study circadian functions in humans (daily eating, sleep and temperature patterns).

Teaching and Learning Process:

Teaching learning methods for the Animal behaviour and chronobiology paper should include conventional black board teaching coupled with power point presentations and smart board. The animal behaviour in wild life can be shown to the student with the help of videos and short films. The classroom teaching should be inclusive and have opportunities for the students to participate in the class discussion. The students should be encouraged to observe various live animal behaviours in their immediate surrounding environment and interpret them. There should be ample scope for field visits and visit to the research laboratories. Seminar should be arranged at the departmental level for the student, where student can have paper presentation on various themes of animal behaviour and chronobiology. Quizzes and debates can be arranged to make the teaching learning more innovative. Students should be advised to use e resources along with standard text books and reference books. They should take short project work and case study on the animal behaviour. They should relate various concepts in chronobiology taught in the classroom with their daily life. The students should be regularly assessed.

Assessment Methods:

- Scheme for the assessment of students would have two components.
- The first component will include continuous evaluation of the student throughout the course work by assessing assignments, project works, presentations, quiz, class tests and regularity in attending the classes.
- The second component will carry examination carried by the University at the end of semester.

Keywords:

Animal behaviour, Types of behaviour, Social behaviour, Reproductive behaviour, Altruism, Courtship behaviour, Communication, Chronobiology, Biological rhythm, Biology Clocks

Recommended Books:

- Alcock J. (2013). Animal Behaviour. Sinauer Associate Inc., USA.
- McFarland D. Animal Behaviour. (1982). Pitman Publishing Limited, London, UK.
- Vinod Kumar (2002) Biological Rhythms. Narosa Publishing House, Delhi/ Springer-Verlag, Germany
- Dunlap J. C, Loros J. J, DeCoursey P. J. (2004) Chronobiology Biological Timekeeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

Suggested Readings:

- Manning, A. and Dawkins, M. S. (2012). An Introduction to Animal Behaviour. Cambridge, University Press, UK.
- Paul W. Sherman and Alcock J. (2013). Exploring Animal Behaviour. Sinauer Associate Inc., Massachusetts, USA.
- Saunders D. S. (2002). Insect Clocks. III Edition, Barends and Noble Inc. New York, USA

ZH DSE Course-XI: Wildlife Conservation and Management

Course Learning Objective:

The Discipline Specific Paper on Wildlife Conservation and Management is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, management of their habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. This course will motivate students to pursue career in the field of wildlife conservation and management.

Course Learning Outcome:

Upon completion of the course, students will be able to:

- Become aware about the importance of wildlife in general, and its conservation and management in particular.
- Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- Know the key factors for loss of wildlife and important strategies for their *in situ* and *ex situ* conservation.
- Recognize the techniques for estimation, remote sensing and Global Position Tracking for wildlife.
- Gain knowledge about the wildlife diseases and the quarantine policies.
- Know about the Protected Area Networks in India, Ecotourism, Ecology of perturbation and Climax persistence.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.

Course Content:

Theory [Credits: 4]

60hrs

Unit 1: Introduction to Wildlife

6hrs

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21
(Chapter 1, 2, 3 and 10: Singh; Chapter 1 and 3: Saha and Mazumdar)

Unit 2: Evaluation and Management of Wildlife

10hrs

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.
(Chapter 2, 11 & 12: Sutherland; Chapter 6: Singh; Chapter 6: Saha and Mazumdar)

Unit 3: Management of Habitats

10hrs

Setting back succession: Grazing logging; Mechanical treatment; Advancing the successional process: Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats.
(Chapter 11 & 12: Sutherland; Chapter 6: Singh)

Unit4: Population Estimation

12 hrs

Population density, Natalty, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods
(Chapter 2 & 4: Sutherland; Chapter 8 and 9: Singh; Chapter 6: Saha and Mazumdar)

Unit5: Management Planning of Wildlife in Protected Areas

8hrs

Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories; Ecology of perturbation.
(Chapter 9: Sutherland; Chapter 1: Woodroff; Chapters 8 and 11: Singh; Chapter 9: Saha and Mazumdar)

Unit6: Management of Excess Population

6hrs

Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (Ebola and Salmonellosis), Rabies, Foot and Mouth Disease, Mycobacterium TB, Bovine and Avian Flu
(Chapters 6, 7 and 11: Saha and Mazumdar)

Unit:7 Protected Areas

8hrs

National parks and sanctuaries; Biosphere reserves; Conservation and Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India and Management challenges in Tiger reserve
(Chapters 11 and 12: Singh; Chapters 3 and 9: Saha and Mazumdar)

Practical [Credits: 2]

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats, nests and antlers.
4. Demonstration of different field techniques for flora and fauna: PCQM.
5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
6. Identification of big cats: Lion, tiger, panther, cheetah, leopard and jaguar.
7. A report based on a visit to National Park/Wildlife Sanctuary/Biodiversity Park or any other wildlife conservation site.

Teaching and Learning Process:

The case study approach with real-life examples from the field will give a better understanding of the subject and its applications. The traditional chalk and talk method will be supplemented with LCD projection system and use of visualizer for theory classes. Projection of videos or short movies available on the subject will enhance the understanding of the subject. Digital collection of pictures of pugmarks, hoof marks, bird's nests, wild fauna and flora will facilitate observation of their characteristic features with ease. Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching. Project based reports, assignments and E-posters can also form an important part of learning regime. Field-based research projects will develop interest in the subject and motivate students to peruse research as a

future. Laboratory visits to renowned institutions like WII, Dehradun and Field visits to various conservation sites like Jim Corbett National Park, Aravali Biodiversity Park and National Zoological Park will provide students a practical or hands on knowledge of the subject. Students should participate in citizen science initiatives related to wildlife such as bird counts and uploading of the data on E-bird.org.

Assessment Methods:

Students will be assessed using the following methods:

- Formative/ Continuous assessment: This will be done through problem solving exercises, oral and written examinations, closed-book and open book tests, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation, viva voce interviews, computerized adaptive testing, literature surveys and evaluations, outputs from collaborative work etc. to assess the retention abilities of students.
- Summative assessment: Semester-end written and practical examinations will be an indicator of student's learning throughout the semester and analyses comprehensive knowledge gained by the students.

Keywords:

Wildlife, Conservation, Management, Population, Habitat, Succession, Climax, Quarantine, Tiger Project, National Park, Wildlife Sanctuaries, Biodiversity Reserves, Wildlife Diseases, Protected Areas

Recommended Books:

- Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
- Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
- Singh, S.K. (2005). Text Book of Wildlife Management. IBDC, Lucknow.

Suggested Readings:

- Hudson, P.J., Rizzoli, A., Grenfell, B.T. Heesterbeek, H. and Dobson, A.P. (2002). The Ecology of Wildlife Diseases. Oxford University Press, Oxford.
- Banerjee, K. (2002). Biodiversity Conservation in Managed and Protected Areas. Agrobios, India.
- Sharma, B.D. (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.
- Primack, R.B. (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
- Hossetti, B. B. (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

Online Tools and Web Resources:

- <https://swayam.gov.in/courses/4687-july-2018-wildlife-conservation>
- <https://swayam.gov.in/courses/5364-jan-2019-wild-life-ecology>
- <https://papaco.org/mooc-on-species-conservation/>
- <https://www.iucn.org/theme/protected-areas/our-work/capacity-development/moocs>
- <https://www.zsl.org/united-for-wildlife-free-conservation-courses>
- <https://wildlife.org/next-generation/career-development/online-courses/>
- <https://www.openlearning.com/umtmooc/courses/wildlife-management>

DISCIPLINE SPECIFIC ELECTIVES (DSE-4): Wildlife Conservation & Management Zoo-DSE-4

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Wildlife Conservation & Management Zoo-DSE-4	04	03	00	01	Passed Class 12 th	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To acquaint the students with varied aspects of wildlife conservation, including its importance, major threats, and management of their habitats and populations.
- The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation.
- The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals.
- To motivate students to pursue a career in the field of wildlife conservation and management.

Learning Outcomes

By studying this course, students will be able to:

- Appreciate wildlife in general and realize its conservation and management in particular.
- Better understand the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- comprehend the key factors for loss of wildlife and important strategies for their in situ and ex situ conservation.
- recognize the techniques for estimation, remote sensing and Global Position Tracking for wildlife.
- gain knowledge about the wildlife diseases and the quarantine policies.
- know about the Protected Area Networks and Ecotourism in India.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.

SYLLABUS OF DSE-4

UNIT-1: Introduction to Wildlife

3 hrs

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion.

UNIT-2: Evaluation and Management of Wildlife

9 hrs

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage; Standard evaluation procedures: Bio-telemetry, Remotesensing and GIS.

UNIT- 3: Management of Habitats

9 hrs

Setting back succession: Grazing, prescribed fire, mechanical treatment and selective herbicide application; Advancing the successional process and cover construction; Preservation of genetic diversity; Restoration of degraded habitats.

UNIT- 4: Population Estimation

6 hrs

Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation and hair identification; Pug marks and census methods.

UNIT- 5: Wildlife Health and Rehabilitation

9 hrs

Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (*Ebola* and *Salmonella*), Rabies, Foot and Mouth Disease, *Mycobacterium* TB, Bovine and Avian Flu (Any 3 in detail).

UNIT- 6: Protected Areas and their management

9 hrs

National parks and Sanctuaries; Biosphere reserves; Conservation and Community reserve; Important features of Protected Areas in India; Project Tiger- conservation and management challenges in Tiger reserves; Human-wildlife conflict; Eco-tourism.

Practical

30 hrs

(Laboratory periods: 15 classes of 2 hours each)

1. Demonstration of basic equipment needed in wildlife studies- use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
2. Familiarization and study of animal evidences in the field: Identification of animals through pugmarks, hoof marks and scats.
3. Trail/ transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
4. Identification of Big cats: Lion, Tiger, Cheetah, Leopard and Jaguar.
5. Project Report: Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a National Park/Wildlife

Sanctuary/Biodiversity Park or any other wildlife conservation site.

Essential/recommended readings:

1. Hudson, P.J., Rizzoli, A., Grenfell, B.T. Heestrbeek, H. and Dobson, A.P. (2002) The Ecology of Wildlife Diseases. Oxford University Press, Oxford.
2. Banerjee, K. (2002) Biodiversity Conservation in Managed and Protected Areas. Agrobios, India.
3. Kenneth Anderson (2000) The Kenneth Anderson Omnibus Vol I. Rupa Publications.
4. Jim Corbett. (2017) Man Eaters of Kumaon. Om Books International.
5. Saha, G.K. and Mazumdar, S. (2017) Wildlife Biology: An Indian Perspective. PH Learning Pvt. Ltd. ISBN: 8120353137, 978-812035313.
6. Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006) Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
7. Singh, S.K. (2005) Text Book of Wildlife Management. IBDC, Lucknow.

Suggested readings:

1. Primack, R.B. (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
2. Hossetti, B.B. (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.
3. Sharma, B.D. (1999) Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.

DISCIPLINE SPECIFIC CORE COURSE– 12:**Animal Behaviour Zoo-DSC-12****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Animal Behaviour Zoo-DSC- 12	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To provide an overview of animal behaviour in a scientific study of the wild and the wonderful ways in which animals interact with each other, with other living beings, and with the environment.
- to understand and appreciate different types of animal behaviour, their adaptive and evolutionary significance.
- to equip the students with an ability to pursue career in behavioural ecology other related areas.
- to apprise the students of the versatility of Animal behaviour and its crosstalk among conservation biology, molecular biology, behavioural ecology and integrated pest management.

Learning Outcomes

By studying this course, students will be able to:

- comprehend various types of animal behaviour and their importance.
- observe, analyse, interpret and document the different types of behaviour.
- enhance their skills by taking short projects pertaining to Animal behaviour.
- appreciate and develop passion to biodiversity; and respect the nature and environment.
- better understand and relate the fundamentals and advanced concepts so as to develop a strong foundation that will enable them to acquire skills and knowledge.

SYLLABUS OF DSC-12**UNIT- I Introduction to Animal Behaviour****4 hrs**

Origin and history of ethology; Pioneers of modern ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behavior.

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घौला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

UNIT- 2 Mechanisms of Behaviour**5 hrs**

Innate behaviour, Instinct, Stimulus filtering, Sign stimuli, Code breakers.

UNIT- 3: Patterns of Behaviour**5 hrs**

Orientation: Primary and secondary orientation; Kinesis - orthokinesis, klinokinesis;

Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation).

Learning: Associative learning, Classical and operant conditioning, Habituation, Imprinting;

Reasoning: Intelligence and artificial intelligence.

UNIT- 4: Communication**3 hrs**

Importance of communication; Role of Tactile, Chemical, Auditory, Visual stimuli in communication.

UNIT- 5: Social Behaviour**4 hrs**

Concept of Society; Insects' society; Honey bee: Society organization, polyphenism and polyethism; Foraging in honey bee, round dance, waggle dance; Experiments to prove distance and direction component of dance; Formation of new hive/queen.

UNIT- 6: Altruism**3 hrs**

Altruism, Inclusive fitness, Hamilton's rule

UNIT 7: Sexual Behaviour**6 hrs**

Asymmetry of sex; Sexual dimorphism, mate choice; Intra-sexual selection (male rivalry); Inter- sexual selection (female choice); Courtship behaviour, Courtship behavior in 3-spine stickleback; Infanticide; Parental care, sexual conflict in parental care.

Practical**(60 hrs)****(Laboratory periods: 15 classes of 4 hours each)**

1. Tools, techniques and methods used in studying animal behavior.
2. To study nests and nesting behaviour of the birds and social insects.
3. To study the behavioural responses of wood lice to dry and humid conditions.
4. To study geotaxis behaviour in earthworm.
5. To study the phototaxis behaviour in insect larvae.
6. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects and birds, and parental care from short videos/movies. At least two videos for each behaviour.
7. Construction of ethogram using suitable data to study animal behaviour.
8. Visit to Forest/Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.

Essential/recommended readings

1. John Alcock, (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
2. Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, VI th Edition, Cambridge University Press, UK.
3. McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK.

Suggestive readings

1. Rubenstein, D. (2022) Animal Behavior, XIIth Edition, Sinauer Associates, Oxford University Press, UK.
2. Gadagkar, R. (2021) Experiments in Animal Behaviour: Cutting-Edge Research at Trifling Cost, Indian Academy of Sciences. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**Intellectual Property Right
(LSSE6)
Skill-Enhancement Elective Course - (SEC) Credit:4**

Course Objective (2-3)

To have knowledge of roles regulations, laws and processes of patents, copyright trademarks and concepts of traditional knowledge and protection of plant varieties.

Course Learning Outcomes

Students would have deep understanding of patents copyrights, their importance. They can think about the importance of traditional knowledge, bio-prospecting, biopiracy. They would gain the knowledge of farmers rights and the importance on indigenous plant varieties, concept of novelty and biotechnological inventions

Unit 1

Introduction to intellectual property right (IPR) (2 lectures)

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2

Patents (3 Lectures)

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3

Copyrights (3 Lectures)

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement

Unit 4

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Trademarks (3 Lectures)

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name

Unit 5

Geographical Indications (3 Lectures)

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position

Unit 6

Protection of Traditional Knowledge (4 Lectures)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio- Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7

Industrial Designs (2 Lectures) Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8

Protection of Plant Varieties (2 Lectures)

Plant Varieties Protection- Objectives, Justification, International Position, Plant varieties protection in India. Rights of Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9

Information Technology Related Intellectual Property Rights (4 Lectures)

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10

Biotechnology and Intellectual Property Rights (4 Lectures): Patenting Biotech Inventions

Practical

1. Patent search
2. Trademark search
3. copyright infringement (Plagiarism checkby Urkundand other available software,
4. Geographical Indicators
5. food- Malabar pepper, Basmati rice, Darjeeling Tea, and Requefort cheese,
6. handlooms (Kota Doria, Banarasi Sari, Muga Silk, Kanchipuram),
7. Industry (Mysore agarbatti, Feni Goa, ChampagneFrance).
8. Natural resources- Makrana marbles Two example of each category Biopiracy- neem, turmeric
9. Industrial designs- Jewelry design, chair design, car design, Bottle design, Aircraft design,
10. IPR e diary

UNIVERSITY OF DELHI

CNC-II/093/1(22)/2022-23/ 197

Dated: 14.09.2022

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1-20 dated 18.08.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

**VALUE ADDITION COURSES (VACs)
UNDER
UGCF-2022
LISTED UNDER APPENDIX-II-A TO THE ORDINANCE V (2-A) OF THE
ORDINANCES OF THE UNIVERSITY
(With effect from Academic Year 2022-23)**

In pursuance of the objectives outlined in the National Education Policy 2020, the Value Addition Courses (VACs) seek to fulfil the mandate of providing holistic education to the students. As the NEP elucidates, "the purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values." The Value Addition Courses will introduce students to the rich heritage of the nation as well as to important social concerns of the current times, helping them to make connections between what they learn and how they live.

The courses have a sound theoretical base as well as appropriate hands-on components. At the same time, they clearly set out measurable and attainable Learning Outcomes. Knowledge, in essence, being integrated, these courses are essentially multidisciplinary in nature.

Designed to ignite the intellectual curiosity of the learners, the Value Addition courses will inspire and guide them in their journey of personal and professional development making them thoughtful, well-rounded, and creative individuals, with a sense of service and responsibility towards the Nation.

A student who pursues any undergraduate programme in the University and its Colleges is offered a pool of Value Addition Courses, from which he has to choose one to study in the first Semester. A list of such courses as passed by the Executive Council in its meeting dated 18.08.2022 is as below:

SL.NO.	COURSE TITLE	TOTAL CREDITS: 2
1	Ayurveda and Nutrition	
2	Constitutional Values and Fundamental Duties	
3	Culture and Communication	
4	Digital Empowerment	
5	Emotional Intelligence	
6	Ethics and Culture	
7	Ethics and Values in Ancient Indian Traditions	
8	Financial Literacy	
9	Fit India	
10	Gandhi and Education	
11	Ecology and Literature	
12	National Cadet Corps-I	
13	Panchkosha: Holistic Development of Personality	
14	Reading Indian Fiction in English	
15	Science and Society	
16	Social and Emotional Learning	
17	Sports for Life-I	
18	Swachh Bharat	
19	The Art of Being Happy	
20	Vedic Mathematics-I	
21	Yoga: Philosophy and Practice	
22	भारतीय भक्ति : परम्परा और मानव मूल्य	
23	साहित्य संस्कृति और सिनेमा	
24	सृजनात्मक लेख के आयाम	



VAC 1: AYURVEDA AND NUTRITION

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ayurveda and Nutrition	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of the course are:

- To introduce the basic principles of nutrition in Ayurveda
- To link the Ayurvedic nutrition with modern dietary practices for health
- To analyse basic tenets of traditional diets and health recipes
- To understand the contemporary food habits in everyday life

Learning outcomes

The Learning outcomes of the Course are:

- Awareness of traditional food cultures of India
- Evaluate changing food patterns and lifestyle over the years
- Understand Indian Knowledge Systems (IKS) and key Vedic principles with respect to Food and Nutrition
- Apply basic tenets of traditional diets for health and disease
- Prepare selected healthy recipes based on Ayurvedic principles

SYLLABUS OF AYURVEDA AND NUTRITION

UNIT – I Introduction to Ayurvedic Nutrition

(4 Weeks)

- Ayurveda and Indian food cultures
- Nutrition and lifestyle transition over the years
- Regional Food Traditions of India

UNIT – II Basic principles of Food and Nutrition and Ayurveda (6 Weeks)

- Understanding rich sources of nutrients
- Concept of Doshas & assessment
- Ayurvedic Principles of food habits and factors determining quality of food (Ahara vidhi visheshaayatana)
- FSSAI regulations on Ayurvedic Aahar

UNIT – III Ayurvedic Diets (5 Weeks)

- Principles of Diet: Aharavidhi vidhan, Sattvic, Rajasi, Tamasic foods
- Incompatible food (Viruddha Ahara), Pathya; Apathya; Viprita Ahaar
- Lifestyle Management with Dincharya and Ritucharya
- Application of Ayurvedic diets to stress linked food behaviour

Practical component (if any) – (15 Weeks)

- Visit your local market and classify the available food items according to Sattvic, Rajasi, Tamasic foods
- Conduct a survey of 10-15 households in your locality:
 - i. to study food behaviour and analyse them in light of Ayurvedic dietary principles of Sattvic, Rajasi, Tamasic
 - ii. to study the food consumption patterns and intake of incompatible food: Viruddha Ahara, Pathya; Apathya; Viprita Ahaar
 - iii To know about their adopted lifestyle Dincharya and Ritucharya
- Students are required to visit available e-resources of University of Delhi, Ministry of Ayush with regard to Ayurveda and Nutrition.
- If required, students can share their experiences in the form of a Project Report.
- The students may share their experiences in the form of audio-visual presentations of 15-30 minutes.
- Any other Practical/Practice as decided from time to time

Essential Readings

- Rastogi S (2014) Ayurvedic Science of Food and Nutrition. ASIN: BOOHWMV094, Springer: ISBN-13:978-1461496274
- Rastogi S (2010) Building bridges between Ayurveda and modern science. Int J Ayurveda Res. 1(1):41-46.
- FSSAI regulations on Ayurveda Aahar Regulations 2022. Gazette of India CG-DL-E-07052022-235642. New Delhi, Friday, May 6, 2022/ Vaisakha 16, 1944.
- Frawley D (2012) Ayurvedic healing: A comprehensive guide. Lotus Press, India.
- <https://iksindia.org/>: Indian Knowledge Systems

Suggested Readings

- Charaka Samhita, Charaka (1998) In: Tripathi BN (ed) Sutra Stahan Maharashitiya Adhyay. Chaukhamba Orientelia, Varanasi.
- Kapoor Kapil & Singh AK Indian Knowledge Systems Volume – 1. Indian Institute of Advanced Study Shimla. Published by DK Printworld (P) Ltd, N.Delhi.
<https://www.lkouniv.ac.in>.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: CONSTITUTIONAL VALUES AND FUNDAMENTAL DUTIES**Credit distribution, Eligibility and Pre-requisites of the Course**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Constitutional Values And Fundamental Duties	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Enrich students with knowledge and relevance of the Constitution.
- Develop awareness about Duties and Values.
- Inculcate a sense of Constitutionalism in thought and action.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the Constitution and its relevance
- Appreciate the values and goals embedded in the Constitution.
- Recognise the importance of Fundamental Duties enshrined in the Constitution.
- Apply the spirit of fundamental values and duties in everyday national life.

SYLLABUS OF CONSTITUTIONAL VALUES AND FUNDAMENTAL DUTIES**UNIT – I The Constitution of India – An Introduction****(5 Weeks)**

- Federal Republic, Rule of Law, Separation of Powers
- Sovereignty, Socialism, Democracy
- Secularism and Sarva Dharma Sama Bhava

UNIT – II Constitutional Values**(5 Weeks)**

- Justice: Social, Political, Economic

- Liberty: Thought, Expression, Belief, Faith, Worship
- Equality: Equality before law & equal application of laws
- Fraternity: Dignity, Unity and Integrity

UNIT – III Fundamental Duties

(5 Weeks)

- Reflecting on the ancient Indian notions of righteousness and duty consciousness
- Fundamental Duties- Article 51A [(a) – (k)]
- Legal status of Fundamental Duties - Judicial approach

Practical component (if any) –

(15 Weeks)

- Reflections on some of the constitutional values/ fundamental duties and its contemporary relevance in day-to-day national life through group discussions and projects.
- Conduct workshops to spread awareness on the Fundamental Duties and Values.
- Students are required to conduct a survey (minimum 25 respondents) on assessing the awareness of the constitutional duties amongst the citizens.
- Students may share their experiences on Fundamental Duties and Values in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Preamble to the Constitution of India, 1950.
- The Constitution of India, Articles - 14, 19, 21.
- The Constitution of India, Fundamental Duties [Ar. 51 A (a) – (k)].

Suggested readings

- Durga Das Basu, et al., Introduction to the Constitution of India (LexisNexis, 26th edn, 2022).
- Leila Seth, We, the Children of India: The Preamble to Our Constitution (New Delhi, Puffin Books, Penguin Books India, 2010).
- Mahendra Pal Singh, V.N. Shukla's Constitution of India, (Eastern Book Company, Lucknow, 13th revised edn. 2017)
- B.R. Ambedkar Selected Speeches, (Prasar Bharati, New Delhi, 2019) available at: https://prasarbharati.gov.in/whatsnew/whatsnew_653363.pdf.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC: Culture and Communication

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the Course
		Lecture	Tutorial	Practical/ Practice		
Culture and Communication	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives:

- To focus on traditional values disseminated from Indian cultural heritage.
- To understand the interconnections between the legacy of our past and needs of our contemporary society.
- To learn to adapt, interact and celebrate our diversity and pluralistic culture.
- To develop communication skills in speaking, listening, reading and writing and apply them in our quotidian life as young citizens of contemporary India.
- To integrate ethical values and life skills.

Course Outcomes

- Students will be able to appreciate the relevance of ancient Indian wisdom and core ethical values in our contemporary life.
- Students will be able to engage in a dialogue between the past and the present and inculcate the best principles towards a meaningful life.
- Students will be encouraged to involve themselves in team work and group activities to address challenges faced in metropolitan cities.
- Students will be able to develop communication skills, that is, analytical reading, empathetic listening, considerate speaking as well as informed writing.

- Extension activities will equip the students, drawn from diverse backgrounds, with life skills and confidence to integrate with a multicultural environment and work towards an inclusive community.
- Students will be encouraged to envisage and work towards an ethically robust society and thereby strengthen the nation.

UNIT - I Ethical Values from Indian Cultural Heritage • <i>Vasudhaiva Kutumbakam</i> • United We Stand, Divided We Fall • <i>Ek Bharat, Shresht Bharat</i>	3 Classes
UNIT - II Developing Life Skills • Empathy • Adaptability • Conserving our natural resources • Sharing knowledge resources	4 Classes
UNIT - III Effective Communication in Everyday Life • Empathetic listening • Considerate speaking • Analytical reading • Informed writing	8 Classes

Practical/ Practice Component

(15 Sessions of 2 hours each= 30 hours)

As hands-on experience is an essential component of the course, this section will focus on the practical aspects to correlate with the fundamental principles and learnings of the theory portion. Students will be encouraged to use the communication tools learnt through Unit 3 and corroborate the continuities of core principles studied in Unit 1 and 2.

- Students will be asked to conduct surveys/interviews in their neighbourhood or commuting routes to assess the nature and quality of negotiating our cultural diversity and pluralist traditions.

- Students would be assigned visits to old-age homes, hospitals, cancer wards, etc. to interact and write about their experiences with old people, caregivers, patients, nursing staff, helpers, etc.
- They will also be assigned visits to historically important places and monuments within the city and also converse with the tourists in order to trace a comprehensive view of the rich cultural history of India. They may create video documentaries, take and record tourists' interviews and/or write a journal entry of the visit using the communication skills learnt.
- Students shall make group presentations or individual reports on the activities undertaken. Discussions with classmates and the teacher shall be undertaken to evolve clarity of vision on the ethical values and effective communication skills learned through this course.
- Any other related activity.

Essential Readings:

- Aurobindo, Sri. *Introduction To The Gita*. Sri Aurobindo Ashram Press, 2017. pp 23-40
- Dhanavel. S.P. *English and Soft Skills*. Orient Black Swan, 2010.
- Haksar, A. N. D. 'Chanakya Niti Shastra', *Chanakya Niti*. India, Penguin Random House India Private Limited, 2020.
- Malik, Keshav. "A Dehumanized Environment". *Culture of Peace: Experience and Experiment*, edited by Baidyanath Saraswati. Indira Gandhi National Centre for the Arts, New Delhi, 1999. pp 77-79
- Murthy, Sudha. 'How to Beat the Boys', *Three Thousand Stitches: Ordinary People, Extraordinary Lives*. Penguin Books, 2017.
- Ramanujan, A.K. 'A Flowering Tree', *Cultural Diversity, Linguistic Plurality & Literary Traditions in India*. Department of English, OUP, 2015. pp 125-138.
- Vande Mataram Song from Chatterji, Bankimchandra. *Anandamath, or The Sacred Brotherhood*. Translated by Julius J. Lipner, Oxford University Press, 2005. pp 297-299.
- Vivekananda, Swami. "Response to the Welcome and Address at the Final Session." *Swami Vivekananda: A Contemporary Reader*, edited by Makarand R. Paranjape, Routledge, New Delhi, 2015, pp. 3–4, 18–19.

VAC 1: DIGITAL EMPOWERMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Digital Empowerment	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand the digital world and need for digital empowerment
- Create awareness about Digital India.
- Explore, communicate and collaborate in cyberspace.
- Building awareness on cyber safety and security.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use ICT and digital services in daily life.
- Develop skills to communicate and collaborate in cyberspace using social platforms, teaching/learning tools.
- Understand the significance of security and privacy in the digital world.
- Evaluate ethical issues in the cyber world

SYLLABUS OF DIGITAL EMPOWERMENT

UNIT – I Digital inclusion and Digital Empowerment

(5 Weeks)

- Needs and challenges
- Vision of Digital India: DigiLocker, E-Hospitals, e-Pathshala, BHIM, e-Kranti (Electronic Delivery of Services), e-Health Campaigns
- Public utility portals of Govt. of India such as RTI, Health, Finance, Income Tax filing, Education

UNIT – II Communication and Collaboration in the Cyberspace

(4 Weeks)

- Electronic Communication: electronic mail, blogs, social media
- Collaborative Digital platforms
- Tools/platforms for online learning
- Collaboration using file sharing, messaging, video conferencing

UNIT – III Towards Safe and Secure Cyberspace

(4 Weeks)

- Online security and privacy
- Threats in the digital world: Data breach and Cyber Attacks
- Blockchain Technology
- Security Initiatives by the Govt of India

UNIT – IV Ethical Issues in Digital World

(2 Weeks)

- Netiquettes
- Ethics in digital communication
- Ethics in Cyberspace

Practical component (if any)

(15 Weeks)

- The course should be conducted in an interactive mode through demonstration, using appropriate tools.
- Conduct workshops on e-services initiated under Digital India.
- Spread digital literacy/awareness amongst the vulnerable groups and marginalised sections of the society like street vendors, domestic help, security guards, senior citizens.
- Students will take up team activities/ projects exploring digital services in the areas such as education, health, planning, farming, security, cyber security, financial inclusion, and justice, e-Kranti.
- Any other Practical/Practice as decided from time to time.

Essential Readings /Online Resources

- Rodney Jones and Christoph Hafner. "Understanding digital literacies: A practical
- Introduction". Routledge Books, 2nd edition, 2021.

- <https://www.digitalindia.gov.in>
- <https://www.digilocker.gov.in>
- <https://www.cybercrime.gov.in>
- <https://www.cybersafeindia.in>
- <https://www.meity.gov.in/cyber-surakshit-bharat-programme>

Suggested Readings

- David Sutton. "Cyber security: A practitioner's guide", BCS Learning & Development Limited, UK, 2017.
- <https://www.mha.gov.in/document/downloads/cyber-safety-handbook>

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: EMOTIONAL INTELLIGENCE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Emotional Intelligence	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of the course are:

- Introduce the concept of emotional intelligence, its models and components.
- Understand the significance of emotional intelligence in self-growth and building effective relationships.
- Identify the measures of emotional intelligence.

Learning outcomes

The Learning Outcomes of the course are

- Self-Awareness, Self-Management, Social Awareness & Relationship Management.
- Discover personal competence and techniques of building emotional intelligence.
- Gain insights into establishing positive relationships.

SYLLABUS OF EMOTIONAL INTELLIGENCE

UNIT – I Fundamentals of Emotional Intelligence

(4 Weeks)

- Nature and Significance
- Models of emotional intelligence: Ability, Trait and Mixed
- Building blocks of emotional intelligence: self-awareness, self-management, social awareness, and relationship management

UNIT – II Personal Competence

(5 Weeks)

- Self Awareness: Observing and recognizing one's own feelings, Knowing one's strengths and areas of development.
- Self Management: Managing emotions, anxiety, fear, and anger.

UNIT – III Social Competence

(3 Weeks)

- Social Awareness: Others' Perspectives, Empathy and Compassion
- Relationship Management: Effective communication, Collaboration, Teamwork, and Conflict management

UNIT – IV Emotional Intelligence: Measurement and Development (3 Weeks)

- Measures of emotional intelligence
- Strategies to develop and enhance emotional intelligence

Practical component (if any)

(15 Weeks)

Students will practice self-management techniques to regulate emotions such as

- Mindfulness
- Conditioned relaxation response
- Boundary setting
- Any other

Students will practice various techniques of relationship management such as engaging with:

- Display of empathy
- Effective communication
- Teamwork
- Conflict resolution
- Any other
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Bar-On, R., & Parker, J.D.A.(Eds.) (2000). The handbook of emotional intelligence. San Francisco, California: Jossey Bros.
- Goleman, D. (2005). Emotional Intelligence. New York: Bantam Book.
- Sternberg, R. J. (Ed.). (2000). Handbook of intelligence. Cambridge University Press.

Suggested Readings

- HBR's 10 Must Reads on Emotional Intelligence (2015)

- HBR's 10 Must Reads on Managing Yourself (2011)
- Self Discipline: Life Management, Kindle Edition, Daniel Johnson.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: ETHICS AND CULTURE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethics and Culture	02	1	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To help students explore ethical and cultural dimensions of their lives.
- To provides a forum for students to pause, revisit their assumptions and beliefs, and become mindful of their thoughts, emotions and actions.
- To give the students an opportunity to express themselves and inquire into their decision making processes.
- To cultivate ethical values and participate in the creation of a society based on acceptance, compassion, and justice.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explore perspectives on ethics in thoughts, words and actions
- Evolve ethical decision making practises
- Understand the need for an ethical society and culture
- Introspect, become conscious of and assess one's stance in life
- Cultivate empathy, tolerance and compassion
- Apply the values learnt in the course to everyday life

SYLLABUS OF ETHICS AND CULTURE

UNIT – I Introduction - The Basis of Ethics

(3 Weeks)

- Getting to Know Each Other
- What to Expect from the Course?
- Recognition of Our Common Humanity
- Empathy, Compassion and Justice

UNIT – II The Role of Intelligence, Reason and Emotions

(4 Weeks)

- Discernment: What Is The Right Thing To Do?
- The Art of Conflict Resolution
- Destructive and Constructive Emotions
- The Need for Emotional Balance

UNIT – III Cultivating Inner Values- Ethics in the World of Work and Play

(4 Weeks)

- Training the Mind: Mindfulness and Kindness
- Meditation
- Discovering your Vocation and Interests
- Self-discipline, Integrity, Commitment, Creativity
- Work-Life Balance

UNIT – IV Striving for a Better World | Outreach Activities

(4 Weeks)

- Means and Ends
- Debate and Dialogue
- Culture as Shared Values
- Creating and Sustaining Ethical Cultures: The Role of Philosophy, Religion, Literature, Theatre, Cinema, Music, Media
- Outreach Activities

Practical component (if any) –

(15 Weeks)

Unit 1

1. The teacher may ask students to introduce themselves, sharing their regional and cultural roots. They may be asked to reflect on those aspects of their identities that reflect their cultural roots.
2. After a round of initial introduction, the teacher may ask students to list down a set of values that they think they have developed through their parents and grandparents. Are these values unique to their families, regional and/or ethnic backgrounds? Of these, which are the values they would like to sustain and which are the ones they would wish to modify?
3. The teacher may draw upon the values discussed by students in the previous lesson. Using these as the base, the teacher may ask students to think of ethical values that form the basis of their decisions.

4. The teacher may ask students to think of people who they think have lived an 'ethical life'. These may be people who they know from their personal lives or people known for upholding ethical values in the face of adversity.
5. Students are encouraged to identify what common human values are necessary are Realise shared common humanity– the feeling of interconnectedness/interdependence.
6. Class to be divided in small groups to discuss how each would make an effort to cultivate new morals/ethical values for betterment of their local environment.
7. Celebrating 'Sharing and Caring' based on regional diversity can be encouraged.
8. Engage students to do activities of 'being in the shoes of others' (peers, parents, siblings, house help/support or in any local community grappling with problems) to understand the problems empathetically.
9. The students can be asked to make bookmarks/cards to remind them about virtues pertaining to empathy versus sympathy, need versus greed, just versus unjust or compassion versus insensitivity.
10. Compassion is about cultivation of it as a daily value so students can in small groups undertake compassion based activities of looking after animals, birds, needy, elderly, differently abled, non-privileged etc. and share their thoughts in the class.

Unit 2

1. Make the student think of a hard decision they have made. What made it hard? How did you make the decision? How do you assess it retrospectively?
2. Encourage students to think of judgements and decisions based on the dilemmas and challenges they faced? How do they go about making these decisions?
3. The teacher may introduce any well known story and ask the students to discuss the story from the point of view of the different characters.
4. Ask students how willing they are to deal with a conflict when it occurs. What strategies do they adopt to resolve the conflict?
5. The teacher may ask students to prepare posters with captions like "avoidance", "competition", "cooperation" and "adaptation" and then may ask students to identify with one of these styles which according to them best represents their style of dealing with conflict.
6. The students may be asked to discuss different such similar situations that they may have encountered and a discussion may be initiated on how they resolve those conflicts.
7. The students can be asked to write down certain destructive emotions that they are experiencing presently. How would they work to make them constructive? A classroom discussion could follow around this.

8. Ask the students to note down a list of constructive emotions experienced by them recently. Were the constructive emotions less powerful as compared to the destructive ones experienced by them? Discussion in class can follow.
9. How do you (i) express, (ii) handle anger/ disgust/ distress/ fear (any destructive emotion can be taken up). A healthy discussion in the class can take place around this.
10. Students may be asked to practice a simple breathing exercise. They can sit straight with eyes opened or closed in a comfortable position to just observe their breathing. They can repeat this exercise six to eight times and share (if they like) their experience of silence.
11. To identify your interests and develop a meaningful hobby.
12. Have an open conversation in the class about happiness.

Unit 3

1. The students could observe various emotions that bottle-up in their minds and be asked to watch the flow of emotions non-judgmentally.
2. Students may be asked to recall their journey to the college that morning. Do they remember road signs, faces of people they crossed, the roads that they took, the people they interacted with, the sights and smells around them, or anything else?
3. Students could be asked to cultivate the habit of simple greeting as practice of gratitude and celebrate a day of joyful giving.
4. The students can close their eyes for 2-3 minutes and be asked to observe their thoughts, list them and categorise them into 'to be kept' or 'to let go'.
5. The teacher may ask students to close their eyes and imagine a situation in which they are truly happy. Students could wish for the well-being of two students in the same classroom in their meditative state.
6. Students could meditate on who has been their inspiration and the qualities of the person who has inspired them and then express gratitude to the person concerned.
7. The teacher may ask the students to think retrospectively about what they thought they would take up as a vocation when they were younger. How and why their choices were influenced and changed, if at all.
8. The teacher may ask the students to imagine and chart a journey and destination for themselves. They may also talk about the challenges they foresee.
9. The teacher may encourage the students to maintain a daily diary of their scheduling of time or a worklog and see how much time they effectively give to their work. The teacher may help the students identify the distractors and where one may be 'wasting' time and energy. The activity is designed to help students understand the value of effective time utilisation.

10. In this lesson, the teacher may ask the students to draw up a list of team ethics. They may build this based on their experiences of working with each other in groups.
11. The teacher may ask the students to share an incident each where they felt pressurised/ bored to complete some work. How did they deal with their stress and monotony of work?

Unit 4

1. Students will be asked to work in pairs and develop situations that pose ethical dilemmas and how to resolve them.
2. Students may be asked to look at a film or at an advertisement and discuss what they think about the question/s posed in them. The teacher may ask them if they can think of an alternative ethical approach to the problem posed.
3. Students will be asked to think of situations in which they lost their temper. Have they ever felt that in a fit of emotion they said something that they regretted later? If they had paused to listen and then respond, what would the other person have said? How would the outcome of the situation have been different?
4. A debate on any relevant topic may be conducted in the class. After the first round the students may be asked to adopt and argue their opponents point of view. At the end of this exercise the students can have an open discussion on which position finally appealed to them.
5. The teacher may give a short story to the students and ask them to change the ending. They may be asked to observe how characters and their views may have undergone change in the process.
6. There can be a discussion around a topic such as, the idea of corporal punishment, euthanasia etc. Students can be given a sheet of paper and can be asked to write for or against the theme. The idea is to enable them to understand that the positions they have taken vis-a-vis the theme are a result of different value orientations.
7. Popular foods from many parts of India can be discussed. Their origins can be traced to chart a kind of food history.
8. The teacher on the basis of discussions with students can draw from Philosophy, Religion, Literature, Theatre, Cinema, and Media to highlight that the choices people/characters make are grounded in their culture.
9. The students can discuss classical/folk dances that are performed in their respective groups. Details can be drawn based on the number of dancers, music (live or recorded) and costumes. 3. The role of oral traditions and literature in indicating the importance of ethics in our everyday lives can be discussed.

Suggested Activities for Outreach: Social/ Community Engagement and Service

In the weeks that follow, students will be expected to engage in outreach activities that shall enable them to put into practice some of the ethical considerations deliberated upon and imbibed in the previous modules. A list of suggested outreach activities is as follows:

- Adopt a village with the aim of cultural and ethical learning
- Discussing health and hygiene issues in a community
- Tutoring students
- Gender sensitisation
- Working on environmental issues
- Working with Child Care Centres such as Anganwadis and Balwadis
- Working with differently abled students
- Preserving cultural and heritage sites
- Spending time with senior citizens including in a Senior Citizens Home
- Extending care to animals in animal welfare shelters
- Addressing issues relating to Reproductive Health
- Spreading awareness about adolescent health
- Addressing issues relating to mental health
- Health and nutrition awareness
- Swacchata Abhiyaan
- Sensitisation towards disease awareness
- Vriksharopan
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Suggested Readings:

- Aristotle. Nichomachean Ethics. London: Penguin Classics, 2004
- Swami Vivekananda. The Complete Works of Swami Vivekananda. Advaita Ashrama, 2016.
---https://www.ramakrishnavivekananda.info/vivekananda/complete_works.html
- Panch Parmeshwar in English translation as The Holy Panchayat by Munshi Premchand
- The Silas Marner by George Eliot
- We are Seven by Wordsworth
- The Chimney Sweeper by William Blake

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: ETHICS AND VALUES IN ANCIENT INDIAN TRADITIONS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethics and Values in Ancient Indian Traditions	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the rich cultural traditions relating to discourses on life and its purpose, instilling of values relating to ethical and moral propriety.
- To make students more engaged with the past traditions of the country.
- To introduce students to early epics: Puranic, Buddhist and other traditions.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will develop an overview of indigenous philosophies.
- Understanding the richness of Indian heritage leading to greater sensitivity.
- Inspiration from history to deal with contemporary issues.
- Appreciate the traditions of diversity, discussions, debates and knowledge transmission.

SYLLABUS OF ETHICS AND VALUES IN ANCIENT INDIAN TRADITIONS

UNIT – I The idea of India and Bharat

(5 Weeks)

- 'Jambudvipa'; 'Aryavrata'; 'Bharat' ; India
- Early discourse on moral order- ṛta in Vedic traditions
- Debates in the Upanishads and the Shramanic traditions

UNIT – II State, Society and Dharma

(5 Weeks)

- Kingship and Society: Dharma, Neeti and Daṇḍa
- Rashtra, Sanskar and making of socio-cultural milieu

UNIT – III The ‘Purpose of Life’ in Texts

(5 Weeks)

- Right Conduct’: Buddhist, Jaina and Shramanic Traditions
- Puruṣārtha Chatushtaya: Dharma, Artha, Kāma and Mokṣa
- Assimilation and Assertion: Ethical issues in Epics and Puranic traditions

Practical component (if any) –

(15 Weeks)

- Discuss in your locality, in 10-15 households with regard to Ethics and Values in Indian traditions:
 - i. Vedic traditions
 - ii. Puruṣārtha Chatushtaya
 - iii. Buddhist, Jaina and Shramanic Traditions
 - iv. Jambudvipa; Aryavrata; Bharat; India
- Students are required to explore e-resources available with University of Delhi and academic institutions.
- Students are required to watch documentaries and films on the subject-related topics.
- If required, students can share their experiences in the form of a Project Report.
- Students may share their experiences in the form of audio-visual presentations of 15-30 minutes.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Buietenen, J.A.B. Van, The Bhagwadgita in the Mahabharata: Text and Translation, Chicago: Chicago University Press, 1981. Bhagwadgita by Geeta Press Gorakhpur.
- Bhasham, A.L, Wonder that was India: A Survey of the Culture of the Indian Subcontinent Before the Coming of the Muslims. London, Sidgwick and Jackson, 1954
- Dasgupta, S. N. History of Indian Philosophy. Cambridge University Press, 1923, Vol. I-II.
- Hildebeital, Alf. Rethinking the Mahabharata: A Reader’s Guide to the Education of the Dharma King. Chicago: Chicago University Press, 2001.
- Kane, P.V. History of Dharmashastra (Ancient and Medieval Religious and Civil Law), vol. II, parts 1-2; vol. III 3rd ed. Pune: Bhandarkar Oriental Research Institute, [1941, 1946].

- Olivelle, Patric. King, Governance, and Law in Ancient India: Kautilya's Arthashastra, Oxford: Oxford University Press, 2013.
- Sharma, Arvind. 'On Hindu, Hindustan, Hinduism and Hindutva'. Numen, 49(1), 2002, p. 1-36.

Suggested readings

- Olivelle, Patric. (text and trans.) *Manu's Code of Law: A Critical Edition and Translation of the Manava-Dharmashastra*. New Delhi: Oxford University Press, 2006.
- Rocher, Ludo. 'The Concept of Boundaries in Classical India', in Peter Gaefkke and David Utz (eds.), *The Countries of South Asia: Boundries, Extensions, and Interrelations*.
- Philadelphia: University of Pennsylvania, Department of South Asia Regional Studies (Proceedings of The South Asia Seminar, III, 1982-1983), 1988, p. 3-10
- Sukthankar, V.S., S.K. Belvalkar, and P.L. Vaidya(ed.). *The Mahabharata*. Poona: Bhandarkar Oriental Research Institute, 1933-66.
- Tripathi, Radhavallabh, ed. *India's Intellectual Traditions: A Revealed Through Sanskrit Sources*. New Delhi: Sahitya Akademi, 2016.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: FINANCIAL LITERACY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Financial Literacy	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Familiarity with different aspects of financial literacy such as savings, investment, taxation, and insurance
- Understand the relevance and process of financial planning
- Promote financial well-being

Learning outcomes

The Learning Outcomes of this course are as follows:

- Develop proficiency for personal and family financial planning
- Apply the concept of investment planning
- Ability to analyse banking and insurance products
- Personal tax planning

SYLLABUS OF FINANCIAL LITERACY

UNIT – I Financial Planning and Financial Products

(3 Weeks)

- Introduction to Saving
- Time value of money
- Management of spending and financial discipline

UNIT – II Banking and Digital Payment

(4 Weeks)

- Banking products and services

- Digitisation of financial transactions: Debit Cards (ATM Cards) and Credit Cards., Net banking and UPI, digital wallets
- Security and precautions against Ponzi schemes and online frauds

UNIT – III Investment Planning and Management (4 Weeks)

- Investment opportunity and financial products
- Insurance Planning: Life and non-life including medical insurance schemes

UNIT – IV Personal Tax (4 Weeks)

- Introduction to basic Tax Structure in India for personal taxation
- Aspects of Personal tax planning
- Exemptions and deductions for individuals
- e-filing

Note: Some of the theoretical concepts would be dealt with during practice hours.

Practical component (if any) – (15 Weeks)

- Regular class activities to enhance students' understanding of topics and the application of concepts. The case study method may be followed as a teaching pedagogy.
- Numerical questions pertaining to each unit wherever applicable should be practiced.
- For the second unit, students may be assigned a project wherein they can log on to the website of various banks and conduct an in-depth analysis and comparison of various financial products offered.
- For Unit III, a Project related to building a dummy portfolio of stocks and tracking their returns may be given.
- An investment budget may be given to the students to select investment options that maximize the return and minimize the tax implications.
- For the last unit, students may also file a dummy IT return to get hands-on experience with e-filing.
- Students may conduct a financial literacy survey among at least 25 respondents to measure the level of financial literacy and share the findings in the awareness in the form of a report.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Introduction to Financial Planning (4th Edition 2017) – Indian Institute of Banking

& Finance.

- Sinha, Madhu. Financial Planning: A Ready Reckoner July 2017, McGraw Hill.

Suggested readings

- Halan, Monika, Lets Talk Money: You've Worked Hard for It, Now Make It Work for You, July 2018 Harper Business.
- Pandit, Amar The Only Financial Planning Book that You Will Ever Need , Network 18 Publications Ltd.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: FIT INDIA

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fit India	02	0	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Encourage physical activity through engaging the students in sports and yoga.
- Understand the importance of a balanced diet .
- Build skills for self-discipline, self-confidence, cooperation and teamwork.
- Promote fitness as a joyful activity

Learning outcomes

The Learning Outcomes of this course are as follows:

- Adopting a healthy lifestyle.
- Knowledge of nutrition, diet and psycho-physiological aspects of fitness.
- Develop Self-esteem, Self-confidence, Self-discipline and team spirit as indicators of fitness.

SYLLABUS OF FIT INDIA

ONLY PRACTICAL

Note: Concepts are to be taken up during the practical/practice hours.

Practical component (if any) –

(15 Weeks)

UNIT – I Participation in Physical Activity

(4 Weeks)

- Fit India Protocol

- Physical Activity, Health and Fitness
- Indicators of Fitness

Practical/Practice

- Aerobic Work Out / Physical Activity (Walking)
- Yoga – Asanas (Lying, Sitting and Standing positions) and Pranayama
- Cardiovascular Testing by 12min/9 min Cooper Run/Walk test

UNIT – II Health Related Fitness and their Components

(4 Weeks)

- Muscular Strength and Endurance
- Body Composition and Flexibility

Practical/Practice

- Flexibility Training: Back Saver Sit and Reach test
- Muscular Strength Training: Curl Ups / Standing Broad Jump/ Vertical Jump/ Plyometric
- Endurance Training: 1 Mile RockPort Test or 12 /9 minute Cooper run/walk test.
- Ideal Body Weight, Body Mass Index (BMI), Waist-Hip Ratio, Waist-Height Ratio (Data of at least 10 persons to be collected)

UNIT – III Nutrition and Fitness

(4 Weeks)

- Healthy Eating Plate
- Balanced Diet
- Caloric Content of Food

Practical/Practice

- Preparing Daily Diet and Calorie Chart
- Aerobic Work Out / Physical Activity (Walking)
- Assessment of Physical Activity with the Calorie intake.
- Asanas for digestive system excretory system

UNIT – IV Sports Physiology and Psychology

(3 Weeks)

- Depression, Anxiety and Stress Scale (DASS)
- Rosenberg Self Esteem Scale

Practical/Practice

- Skills learning and Participation in sports
- Group Games / Relays/ Minor Games
- Meditative Asanas and Pranayama
- Fitness component testing (as per Fit India Protocol and Norms) and Analysis of Results
- Data of at least 10 persons to be collected on DASS and self-esteem scale

Essential/recommended readings

- Fit India Website: <https://fitindia.gov.in>
- Wener W.K. Hoeger, Sharon
- A. Hoeger - Fitness and Wellness-Cengage Learning (2014).

Suggested readings

- Charles B. Corbin, Gregory J Welk, William R Corbin, Karen A Welk - Concepts of Fitness And Wellness_ A Comprehensive Lifestyle Approach-McGraw-Hill (2015)
- W.Larry Kenney, Jack H. Wilmore, Devid L.Costil(2015). Physiology of Sports and Exercise, Second Edition. USA. Human Kinetics.
- Websites of International Sports Federations
- Website of Ministry of Youth Affairs and Sports

 **Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time**

VAC 1: GANDHI AND EDUCATION

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Gandhi and Education	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives:

The Learning Objectives of the course are:

- Seek inspiration from Gandhi's thoughts on education.
- Analyse Gandhian education philosophy for moral and character development.
- Understand Gandhi's Idea on Self-reliant education (Swavalambi Shiksha)
- Relate Gandhi's educational thoughts to NEP 2020

Learning Outcomes

The Learning Outcomes of the course are:

- Value Gandhian perspective on education
- Appreciate the significance of education in Indian languages
- Evaluate the application of Gandhian thoughts in NEP 2020
- Realise the principles of NEP 2020 in vocational and skill oriented education.

SYLLABUS OF GANDHI AND EDUCATION

UNIT – I : Gandhi's Philosophy and education

(Weeks: 5)

- Gandhi's Philosophy on education
- Education for character building and moral development
- Education relating to health, hygiene, heritage, and handicraft

UNIT – II Gandhi's Experiment in Education

(Weeks: 5)

- Gandhi's educational ideas on use of Indian Language as a medium of Instruction, TextBook and Teacher.
- Gandhi's educational thought on Elementary and Adult Education.
- Gandhi's vision on Higher Education

UNIT – III : Gandhi's Educational Thought on Skill and Vocational Education

(Weeks: 5)

- Rural development through Skill and Local Need Based education
- Skill education in NEP 2020 and Gandhi
- Gandhi's Idea on Self-reliance (Swavalambi Shiksha) and its reflection in contemporary educational policy.

Practical component (if any) -

(15 Weeks)

- Regular visits to Gandhi Museum and library to gain insight on Gandhi
- Excursion to Gandhi Ashrams located in different places like Sewagram, Wardha, Sabarmati, Ahmedabad etc.
- Workshops/projects in collaboration with Gandhi Bhawan, Gandhi Smriti and Darshan, Gandhi Peace Center. Ashrams based on innovation in village & cottage industry, Khadi, handicrafts, organic farming etc.
- Adoption of one place for Swachhta Mission or Skill Education
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- महात्मा गांधी. (2014). बुनियादी शिक्षा. वाराणसी : सर्व सेवा संघ प्रकाशन.
- गांधी, मो. क. (2010). मेरे सपनों का भारत. अहमदाबाद : नवजीवन प्रकाशन मंदिर.
- नवजीवन प्रकाशन मंदिर. (1960). शरीर-श्रम. अहमदाबाद: मो. क. गांधी. pp– 196-231
- प्रभु, आर. के. व राव, यू. आर. (1994). महात्मा गांधी के विचार. इंडिया: नेशनल बुक ट्रस्ट.
- Anand T. Hingorani, ed.] Gandhi, M.K. Our Language Problem (Bombay:
- Bharatiya Vidya Bhavan,), pp. 53-55
- TOWARDS NEW EDUCATION written by M. K. Gandhi Edited by Bharatan Kumarappa

Suggestive readings

- गांधी, मो.क. (2012). सत्य के प्रयोग अथवा आत्मकथा (त्रिवेदी, काशीनाथ, अनुवादक)
अहमदाबाद: नवजीवन प्रकाशन मंदिर.
- गांधी, मो.क. (2012). हिंद स्वराज (नणावती, अमृतलाल ठाकोरदास, अनुवादक).
अहमदाबाद: नवजीवन प्रकाशन मंदिर
- Coomaraswamy, Anand K . (1910). Art and Swadeshi . Munshi Ram Manoharalal.
Delhi

Examination scheme and mode: Subject to directions from the Examination
Branch/University of Delhi from time to time

VAC 1: ECOLOGY AND LITERATURE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ecology and Literature	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To raise awareness among students towards the urgent predicament of Environmental and Ecological crisis and the need for reducing our carbon footprint upon fast depleting, ravaged ecological reserves.
- To develop a heightened ecological consciousness among students, leading to more responsible ecological behavior.
- To view environmental concerns as raised through plays, stories and poems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The course will highlight the urgency of environmental crisis, making Students conscious and aware of the role each one of us plays.
- Students will be trained into environmental sensitivity and responsible Ecological behavior.
- Students will be encouraged to respond to incidents of habitat destruction deforestation, etc. and realize the need for our urgent intervention

SYLLABUS OF ECOLOGY AND LITERATURE

UNIT – I Negotiating environmental issues creatively

(5 Weeks)

- William Wordsworth: 'In April beneath the scented thorn'
- Rabindranath Tagore: 'The Waterfall'
- Gieve Patel: 'On Killing a Tree'

UNIT – II Ecocritical literary representations

(5 Weeks)

- Mary Oliver: 'Sleeping in the Forest'
- 2.AK Ramanujan: 'A Flowering Tree'
- 3.Mamang Dai: 'Small Towns and the River'

UNIT – III Empathetic exploration and imaginative re-enactments (5 Weeks)

- Amitav Ghosh's 'Part I: Stories' from The Great Derangement: Climate Change and the Unthinkable.
- Thangjamlbopishak: 'Volcano, You cannot erupt' from Dancing Earth: An Anthology of Poetry from North-East India
- Thangjamlbopishak: 'Dali, Hussain, or Odour of Dream, Colour of Wind' from Dancing Earth: An Anthology of Poetry from North-East India

Practical component (if any) –

(15 Weeks)

- Students would undertake field visits to a school or a slum in the neighborhood or the play area of residential complexes to share, narrate stories, poems and articulate the ideas engaged with in the classroom lectures.
- They shall apply imaginative and creative ways of presenting socially responsible ecological behavior through re-tellings of the texts they have studied in the class.
- Creative re-enactment of key ideas studied by students in the form of a play, to be done individually and/or in a group to create awareness regarding environmental consciousness.
- They can also collectively organize a tree plantation drive in and around the college campus and adopt a sapling each in the college premises and in their neighborhood to take care of.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Akhter, Tawhida, and Ahmad Bhat, Tariq. Literature and Nature. United Kingdom, Cambridge Scholars Publishing, 2022.
- Shiva, Vandana. 'Development, Ecology and Women', Staying Alive: Women Ecology and Development. India: Zed Books, 1988. pp 1-14
- Carl, Safina. Prologue & Chapter 1, Beyond Words: What animals think and feel. Souvenir Press, 2015.
- Garrard, Greg. Ecocriticism. United Kingdom: Taylor & Francis, 2011.
- Wohlleben, Peter. The Hidden Life of Trees: What They Feel, How They Communicate—Discoveries from a Secret World. India: Penguin Books Limited, 2016.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: NATIONAL CADET CORPS- I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
National Cadet Corps -I	02	1	0	1	Pass in Class 12 th	Enrolled as NCC Cadet

Learning Objectives

The Learning Objectives of this course are as follows:

- Provide knowledge about the history of NCC, its organization, and incentives of NCC for their career prospects.
- Inculcate spirit of duty and conduct in NCC cadets.
- Provide understanding about different NCC camps and their conducts.
- Provide understanding about the concept of national integration and its importance.
- Provide understanding about the concept of self-awareness and emotional intelligence.
- Provide understanding about the concept of critical & creative thinking.
- Provide understanding about the process of decision making & problem solving.
- Provide understanding about the concept of team and its functioning.
- Provide understanding about the concept and importance of Social service.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Critically think and analyse.
- Understand the basic concept of NCC.
- Respect the diversity of different Indian culture.
- Practice togetherness, teamwork and empathy in all walks of their life.
- Do their own self-analysis and will work out to overcome their weakness for Better performance in all aspects of life.

SYLLABUS OF NATIONAL CADET CORPS-I

UNIT – I NCC General**(4 Weeks)**

- Aims, Objectives and Organization of NCC
- Incentives for NCC Cadets
- Duties of NCC Cadets
- NCC Camps: Types and Conduct

UNIT – II National Integration**(4 Weeks)**

- National Integration: Importance and Necessity
- Factors affecting National Integration
- Unity in Diversity
- Threats to National Security

UNIT – III Personality Development**(5 Weeks)**

- Factors
- Self-Awareness
- Empathy
- Critical and Creative Thinking
- Decision Making and Problem Solving

UNIT – IV Social Service and Community Development**(2 Weeks)**

- Basics of Social Service
- Rural Development Programmes
- NGO's
- Contribution of Youth

Practical component (if any) -**(15 Weeks)**

- Drill
- Field Craft & Battle Craft
- Map Reading
- Weapon Training
- Social Service & Community Development
- Any other Practical/Practice as decided from time to time

Suggested readings

- DGNCC Cadet's Hand Book - Common Subjects -All Wings (in English)
- DGNCC Cadet's Hand Book - Common Subjects -All Wings (in Hindi)
- DGNCC Cadet's Hand Book – Specialised Subjects –Army, Navy and Air Wing

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time.

VAC 1: PANCHKOSHA: HOLISTIC DEVELOPMENT OF PERSONALITY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Panchkosha: Holistic Development of Personality	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce Five Koshas – five levels of mind-body complex – Annamaya, Pranayama, Manomaya, Vigyanamaya and Anandamaya Kosha; for a holistic development of personality.
- To generate awareness about physical and mental wellbeing through the Indian concept of Panchkosha.
- To develop a positive attitude towards self, family and society amongst students.
- To guide students build personalities based on the understanding of Panchkosha.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Enhanced physical and mental health.
- Coping with peer pressures and stress.
- Improved concentration leading to better overall performance.
- Manage life situations through a balanced and mature approach.

SYLLABUS OF HOLISTIC DEVELOPMENT OF PERSONALITY**UNIT – I Elements of Personality****(4 Weeks)**

- PanchaKosha: Introduction
- Five aspects of Human Personality: Annamaya Kosha (Physical

body), Pranamaya Kosha (Vital life force energy), Manomaya Kosha (Psychological wellness), Vijnanamaya Kosha (Intellect), Anandamaya Kosha (Happiness and Blissfulness)

- Health: Mental and Physical

UNIT – II *Annamaya Kosha and Pranamaya Kosha*

(4 Weeks)

- Human Body and Pancha Karmendriyas
- Annamaya Kosha: Balanced diet and exercise for healthy body
- Pranamaya Kosha: Development of life force, Pranayam
- Charucharya: Social Etiquettes

UNIT – III *Manomaya Kosha and Vijnanamaya Kosha*

(4 Weeks)

- Antahkarana and its functions
- Pancha Gyanendriyas
- Manomaya Kosha : Controlling the Mana (mind)
- Vijnanamaya Kosha: Ability of discretion and decision making

UNIT – IV *Anandamaya Kosha and Beyond*

(3 Weeks)

- Anandamaya Kosha: Experience of happiness and bliss
- Self-realisation, Nature of Consciousness: Sat-Chit-Ananda

Practical component (if any) –

(15 Weeks)

- Recitation of select verses from Taitiriyopansid
- Asana
- Pranayama
- Meditation
- Visit to a Yog shivir or meditation centres
- Students are required to watch documentaries and films on the subject-related topics.
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- पंचकोश वि वेक, स्वामी परमहंस योगनन्द, <https://ndl.iitkgp.ac.in/> पर उपलब्ध
- वि वेक चूड़ामणि , आदि शंकराचार्य द्वारा लि खि त, अरवि न्द आनंद द्वारा अनुदि त,

चौखम्भा प्रकाशन, वाराणसी, 2015

- Vivek Chudamani, Adi Shankaracharya, Swami Turiyananda (Sanskrit and English), Sri Ramakrishna Math, Mylapore, 2019
- सभी के लिए योग, बी.के.एस. आर्यंगार, प्रभात प्रकाशन, 2018
- Yoga The Path to Holistic Health: The Definitive Step-by-step Guide, B.K.S. Iyengar, Dorling Kingsley, London, 2021
- The Sacred Science of Yoga & The Five Koshas, Christopher Sartain, CreateSpace Independent Pub, 2015

Suggested Readings

- PanchaKosha: The five sheaths of the human being, Swami Nishchalanand, Kindle edition.
- Upanisadvakya Mahakosa. (An Upanishadic Concordance, taken from 239 Upanishads, G. S. Sadhale (Compiled by). Chowkhamba Vidyabhawan, Varanasi, 2014
- The Pentagon of Creation: As Expounded in the Upani

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: READING INDIAN FICTION IN ENGLISH

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Reading Indian Fiction in English	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Acquaint students with Indian Fiction in English.
- Familiarise students with Indian ethos and values through Indian fiction.
- Analyze novels critically and in the context of their own lived situations.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understanding of Indian ethos and values through Indian fiction.
- Develop creative thinking through reading of fiction..
- Realise the potential of fiction in bringing out social and cultural change

SYLLABUS OF READING INDIAN FICTION IN ENGLISH

UNIT – I

(2 Weeks)

- How to Read a Novel
- Novel as Reflection of Society

UNIT – II

(7 Weeks)

- Bankim Chandra Chatterjee: Anandamath (English translation by Sri Aurobindo and Barindra K Ghosh)

Points of Discussion:

- Patriotism and Nationalism
- The song Bande Mataram
- Elements of History and Romance
- Issues of Gender
- Natural calamity
- Genre of Text and Feature Film

UNIT – III

(6 Weeks)

- Chaman Nahal: Azadi. Houghton Mifflin publication, 1975.

Points of Discussion:

- The Story of Partition
- Violence and Trauma
- Autobiographical voices in the novel
- Elements of history, politics and art
- Personal and Political

Practical component (if any) –

(15 Weeks)

- Students may be asked to do a dramatic recitation of selected parts of a novel.
- Students may be asked to organize the major events of the plot of a novel through different methods: graphically, making a plot outline or sketching a storyboard.
- Students may be asked to classify each instance of figurative language (simile, metaphor, etc.) and explain its effect on that section of the text.
- Students may share their understanding of any particular aspect of the novels through a brief write up.
- Discuss the portrayal of any major characters of the novel with reference to the central theme of the text.
- Think about and discuss Indian fiction in relation to cultural and critical contexts.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Bankim Chandra Chatterjee: Anandamath (English translation by Sri Aurobindo and Barindra K. Ghosh)

- Chaman Nahal: Azadi. Houghton Mifflin publication, 1975
- E. M. Forster: Aspects of the Novel

Suggested Reading:

- Srinivasa Iyengar, K. R. Indian Writing in English. India, Sterling Publishers, 1987.
- 2. Naik, M. K. A History of Indian English Literature. India, SahityaAkademi, 1982.
- 3. Nayar, Pramod K. The Indian Graphic Novel: Nation, History and Critique. India, Taylor & Francis, 2016.
- 4. Gopal, Priyamvada. The Indian English Novel: Nation, History, and Narration. United Kingdom, Oxford University Press, 2009.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: SCIENCE AND SOCIETY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Science and Society	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are:

- The primary objective of this course is to instil in students an appreciation for science and a scientific outlook and temper.
- The course further aims to increase awareness about fundamental scientific concepts that play an important role in our daily life using various examples and case studies.
- Pedagogy in this course should largely rely on learning by enquiry, observations, experimentation and group discussions using case studies/examples.
- Efforts should be made to instil an interest in students for science. Students should be encouraged to understand and appreciate scientific concepts and their applications rather than solely memorizing factual information.

Learning outcomes

The Learning Outcomes of this course are:

- This paper is interdisciplinary in nature and would provide students with basic exposure to scientific methods, technologies and developments that have played a significant role in the evolution of human society from ancient to modern times.
- 2. Students would also be made aware of the scientific rationale of technological developments that would enable them to make informed decisions about their potential impact on society.

SYLLABUS OF SCIENCE AND SOCIETY

UNIT – I Science and Technology – from Ancient to Modern Times (10 Weeks)

In this section, students should also be made aware about the contributions of Indian scientists since ancient times and the contributions of women in science.

Subtopics

- Philosophy of science, the scientific method, importance of observation, questions and experimental design, rational thinking, myths vs. Facts
- Science, Technology and Traditional Practices: Suggestive areas include: Water harvesting structures and Practices; Construction, architecture and design – use of natural environment-friendly designs and materials; Agriculture including domestication of plants and animals.

In this section, students should also be made aware about the contributions of Indian scientists since ancient times and the contributions of women in science.

- Science and Technology in Modern Times: Suggestive areas include: Public Health: Nutrition, Hygiene, Physical and Mental Health, Vaccines and Antibiotics, Anti-microbial resistance; Food Security: Green Revolution, White Revolution; IT Revolution, E-Governance; Clean Energy, Renewable Energy; Space Science and Exploration; Evolution, Ecology and Environment

UNIT II: Scientific Principles, and Concepts in Daily Life (5 Weeks)

Unit Description:

This section aims to encourage appreciation of the scientific method through observation, experimentation, analysis and discussions. Students are required to participate in activities and experiments. A suggestive list is given below:

Subtopics:

Suggested Activities:

- Observing and documenting flora and fauna of College campus/city.
- Visits to science laboratories in the College or neighbouring College/Institute.
- Visits to science museums, planetarium.
- Visits to biodiversity parks and nature walks.
- Participation in a citizen science project/initiative.

Suggested Experiments (minimum any four):

- Measuring the height of the college building using a stick.
- Measuring the curvature of earth, using distance and shadow length.
- Isolation of DNA (DNA Spooling)
- Observing transpiration and photosynthesis in plants
- The blood typing game (online)
- Are fruit juices, soap, carbonated drinks acidic or alkaline? (using pH strips or developing your own Litmus Test)
- Do plants learn and remember?
- Experiments on how migratory birds find their way. (Online)
- How can a mosquito sit on a water surface or a blade float on water?
- How does a submarine dip or rise in the ocean?
- How and why does the path of the sun in the sky change with the seasons?
- Identification of celestial objects with the naked eye
- Types of clouds
- Science of musical sounds
- Science of splitting of colours from white light: rainbow, CD-rom, prism, oil films.
- Lenses, mirrors and the human eye

Practical/ Practice Component : **Please Refer to Unit II.**

Essential/recommended readings

- Basu and Khan (2001). Marching Ahead with Science. National Book Trust
- Gopalakrishnan (2006). Inventors who Revolutionised our Lives. National Book Trust
- Yash Pal and Rahul Pal (2013) Random Curiosity. National Book Trust
- Hakob Barseghyan, Nicholas Overgaard, and Gregory Rupik (****) Introduction to History and Philosophy of Science
- John Avery (2005). Science and Society, 2nd Edition, H.C. Ørsted Institute, Copenhagen.
- Dharampal (2000). Indian Science and Technology in the Eighteenth Century, OIP.

Suggested Readings:

Section 1. Science and Technology – from Ancient to Modern Times:

Philosophy of science:

<https://blogs.scientificamerican.com/doing-good-science/what-is-philosophy-of-scienceand-should-scientists-care/>

http://abyss.uoregon.edu/~js/21st_century_science/lectures/lec01.html

https://wps.ablongman.com/wps/media/objects/1449/1483820/18_2.pdf

Myths vs. facts:

<https://www.sciencelearn.org.nz/resources/415-myths-of-the-nature-of-science>

History of technology:

<https://www.visualcapitalist.com/history-of-technology-earliest-tools-modernage/>

Water harvesting:

<https://worldwaterreserve.com/introduction-to-rainwater-harvesting/>

Public Health :

[https://www.ajpmonline.org/article/S0749-3797\(11\)00514-9/fulltext](https://www.ajpmonline.org/article/S0749-3797(11)00514-9/fulltext)

<https://study.com/academy/lesson/public-health-vs-medicinedifferences-similarities.html>

<https://www.deepc.org.in/video-tutorials/public-health>

Food Security:

<https://www.concern.net/news/what-food-security>

Energy:

<https://www.nrdc.org/stories/renewable-energy-clean-facts>

Space Science:

<https://www.isro.gov.in/spacecraft/space-science-exploration>

<https://www.isro.gov.in/pslv-c11-chandrayaan-1>

<https://www.isro.gov.in/chandrayaan2-home-0>

<https://www.britannica.com/science/space-exploration>

Contribution of Indian Scientists & Women Scientists:

<https://www.tifr.res.in/~outreach/biographies/scientists.pdf>

<https://indiabioscience.org/media/articles/ISTI.pdf>

<https://www.thebetterindia.com/63119/ancient-india-science-technology/>

<https://ncsm.gov.in/indian-women-in-science-technology/>

Evolution:

<https://www.livescience.com/474-controversy-evolution-works.html>

<https://www.ibiology.org/evolution/origin-of-life/>

Climate change and global warming

<https://letstalkscience.ca/educational-resources/backgrounders/introductionclimate-change>

Biodiversity

<https://india.mongabay.com/2020/09/nature-in-peril-as-biodiversity-losses-mount-alarmingly-states-the-living-planet-report/>

Genomics and Modern Medicine

<https://www.nationalgeographic.com/science/article/partner-contentgenomics-health-care>

<https://www.mja.com.au/journal/2014/201/1/impact-genomics-future-medicine-and-health>

<https://www.nature.com/scitable/topicpage/pharmacogenomics-andpersonalized-medicine-643/>

Genetically modified engineered crops

<https://www.nature.com/scitable/topicpage/genetically-modified-organismsgm-transgenic-crops-and-732/>

<https://factly.in/explainer-what-is-the-status-of-gm-crops-in-india/>

<https://www.fda.gov/food/agricultural-biotechnology/how-gmo-crops-impactour-world>

Artificial Intelligence and Robotics

<https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf>

<https://nptel.ac.in/content/storage2/courses/106105078/pdf/Lesson%2001.pdf>

Big Data Analytics

https://www.researchgate.net/publication/328783489_Big_Data_and_Big_Data_Analytics_Concepts_Types_and_Technologies

Section 2. Scientific Principles, and Concepts in Daily Life Measuring buildings, earth curvature:

<https://www.youtube.com/watch?v=hrwL3u2Z4Kg>

<https://www.youtube.com/watch?v=khRMzxONpLg>

<https://www.youtube.com/watch?v=YaPa4esJJx4>

Isolation of DNA



https://melscience.com/US-en/articles/home-dnaextraction/?irclickid=2hh2pqRY8xyLTbawUx0Mo3ENUkBwIX3pGQDJSc0&utm_source=impact&irpid=2201352&irmpname=Science%20Journal%20for%20Kids&irgwc=1

Transpiration & Photosynthesis

<https://www.youtube.com/watch?v=JQvdXX7hGqI>
<https://www.youtube.com/watch?v=U4rzLhz4HHk>
<https://www.youtube.com/watch?v=pFaBpVoQD4E>

Online game on blood typing

<https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/gamev3/1.html>

Determination of pH

https://www.youtube.com/watch?v=BEz6t_e6gpc

Plant behaviour

<https://youtu.be/KyoeCFTIXKk>
<https://youtu.be/gBGt5OeAQFk>

Migratory Birds

<https://www.scienceabc.com/nature/how-migrating-birds-geese-navigate-long-distance-earthmagnetic-field.html>

VAC 1: SOCIAL AND EMOTIONAL LEARNING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Social and Emotional Learning	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- This course aims to develop social and emotional awareness in students and initiate them towards better personal and social well-being.
- To create an awareness towards self, others, the environment and their harmonious coexistence.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will be able to become aware of oneself and the society.
- Make informed lifestyle choices and extend the self in the joy of giving.
- Develop empathy, compassion, connect with nature and evolve emotionally to create a more harmonious society.
- Cultivate sensitivity towards discriminatory practices and explore possible solutions.

SYLLABUS OF SOCIAL AND EMOTIONAL LEARNING

UNIT – I Introduction - Self-Awareness and Happiness (3 Weeks)

- Getting to Know Each Other
- What to Expect from this Course?
- Getting to Know Oneself
- What Makes One Happy/ Unhappy? Outer vs Inner Sources of Happiness, Joy of Giving

UNIT – II Social Relationships | Mindfulness (4 Weeks)

- Sharing vs Power: Peers, Family and Society
- Going Beyond Power Relationships Through Open Conversation
- The Value of Silence and Reflection
- Practice of Mindfulness

UNIT – III Identity, Self-Image, Status, Self-Worth- Digital Identity (4 Weeks)

- Identity Construction and Expression: Individual and Collective
- Accepting and Valuing Oneself
- Understanding the Gendered World
- Identifying and transcending stereotypes
- Identity Formation and Validation in the Digital World
- Discrimination and its Forms

UNIT – IV Lifestyle Choices | Stress and Its Management (4 Weeks)

- What Choices Does One Get To Make?
- Is Choice influenced? Relationships, Career Choices
- Career Pressures, Examinations
- Dealing with Disappointment, Coping Skills, Health and Fitness
- Connect With Nature: Sensitivity Towards Other Sentient Beings

Practical component (if any) – (15 Weeks)

Unit 1

Getting to Know Each Other

In this lecture, the teacher will facilitate social engagement and personal reflection through a round of introductions. This also provides an opportunity for the teacher and students to recognise the deeper meanings that lie underneath routine exercises of introduction. For example, the adjectives that people use to describe themselves are indicative of the image that they wish others to hold of them. But do they hold the same image about themselves?

Teachers may begin the class by introducing themselves. Any introductory exercise that serves as an ice breaker and creates the classroom space as one of vibrant and open discussions, may be used. Teachers should try and ensure participation of all students in this exercise.

Activities

1. Who is in your circle?

Students may be asked to draw three concentric circles on their notebooks. The central circle is for the topic, the second for 'Love', and third for 'Like'. The space outside the circles is for 'Don't like'. The class decides on one topic, such as food, movies, web series, books, music, interests, etc. Each topic is taken up in turn and students are asked to write what they love, like, and don't like in the circles and share it with others. The exercise helps students to identify with their peers in commonalities and differences. The teacher may use prompts such as 'Why do you like this show?', 'Why do you dislike this food?' etc.

2. I am...

Students are asked to complete the sentences. The teacher may take turns and ask random students to answer it or the teacher may write these on the board and ask every student to write the answer in their notebooks. Some suggested prompt sentences are:

I am excited about.....

I wish I could.....

I am wondering.....

I am feeling anxious about....

Students can choose to share some of the answers with the class. The purpose of the exercise is to bring most students to speak in class and share their honest feelings and thoughts.

3. Introduce Yourself. Know Yourself

In this exercise, the teacher asks all students to take turns to introduce themselves. It is likely that most students will talk about their names, previous qualifications and hobbies. At the end of the introductions, the teacher can identify

commonalities such as previous courses undertaken, regional identities, age, or similar common factors. The teacher may then use the following prompts to facilitate discussion:

Do these define you? Are you something more? Would you like to change any of these qualifiers?

Is there something about you that you would like to share with us? Do you ever wonder about your identity/ identities?

What to Expect from this Course?

In this class, the focus is on understanding the relevance of the course and providing a course overview. Students will be able to explore the various dimensions of their lives and develop insights about themselves and their relationships. By discussing the outline of the course and the suggested activities, the teacher shall bring to the fore the exploratory journey that the students will embark upon. The students' questions relating to the course contents will also be addressed in this lecture.

Activities

In this class, the teacher may undertake an overview of the course, discussing each week's themes briefly. The nature of assignments and evaluation can also be detailed out. The teacher may hold a discussion with students on the following:

1. Why is social and emotional learning important?
2. What can the teacher do to make the classroom a more welcoming and open space for you?
3. What would be some of the activities that you would like to undertake during the course? Such as watching movies, reading books, maintaining a reflective journal, engagement in the field, mindfulness exercises, etc.

Self Awareness and Happiness

The aim of this module is to help students develop awareness about themselves – who they are, what their strengths and limitations are, and how they can develop themselves. This will help them to learn interlinkages and distinctions between thoughts, emotions and behaviours. This module will make them aware of the differences between happiness and pleasure and help them ponder on sources of happiness.

Self Awareness

Self-awareness is the experience and understanding of one's own personality – how an individual understands his own feelings, motives, desires, and behaviour, and the triggers for the same. Hence, self-awareness can be considered to be vital for personal development. Students would thereby become more grounded and confident. This lesson will focus on the student's intrapersonal and interpersonal awareness through discussions and activities.

Activities

1. Students are asked to make a timeline of important events in their life and how each one affected them at that time. Do they see it differently today?
2. SWOT Analysis can be done by each student – Strengths, Weaknesses, Opportunities and Threats.
3. How do they envision their ideal person – What does your ideal person look like? What characteristics do they possess? Identify the gap. How do they plan to fill/reduce the gap?

Happiness

The term 'happiness' includes pleasant and positive emotions which can range from deep satisfaction and contentment to pleasure and excitement. The focus of this session would be to discuss techniques to develop the long-lasting feelings of contentment rather than momentary and short-lived emotions of excitement and pleasure. This will encourage and foster feelings of wellbeing and life satisfaction. The teacher will use activities in order to inculcate the ways of developing and sustaining happiness.

Activities

Writing a gratitude Journal – include in it what you are grateful for. Mindfulness exercises and developing a mindful way of doing things.

"As one door closes, another door opens". A discussion based on the three opportunities that they think they lost and consider what it was they gained in the process.

Unit 2

Social Relationships

In this module, students will be asked to turn their gaze towards the society in which they are located and where they form social relations. They will be asked to introspect and understand the ways in which they connect with their immediate and extended social surroundings. In this context, peers and family exercise a significant influence on the identities of adolescents and young adults. The students will be asked to assess the nature of their relationship with friends and family and explore these negotiations in the context of sharing versus power.

The teacher will help students broaden their understanding by extending the discussion to include other social relationships, beyond peers and family. They will be encouraged to think about how they are influenced and how they in turn influence the people around them. The class shall explore the importance of open conversation as a means to resolve conflicts and contradictions.

Sharing vs Power: Peers

Identity formation and development is significantly dependent on the peer group with which the individual interacts. During this class, the students may pose the following question to themselves and to each other- What is the nature of the relationships that they share with their peers? Adolescents and young adults like to conform to peer expectations. Students may explore whether relationships between peers are equal. What forces mediate these relationships? By posing examples from real life, the teacher will encourage the students to closely examine their relationships with their friends and family.

Activities

Ask the students to describe their close friends with fictitious names. They should then be asked why they are close to them and what is the one quality about their friends that they appreciate.

Divide students into groups of 5 each. This can vary depending on the class size. Each group can discuss how they were influenced by their friends in decision making processes.

The class/ group can share a story from their life about how they made a decision based on peer pressure. They should also share the result. Were they happy or unhappy about it? The findings can be discussed in the class.

Sharing vs Power: Family

The family is often considered to be a given and stable construct in which one is born or placed. As the relationships of adolescents with people outside the home grow, their interactions with their families evolve and take on a new and sometimes difficult character. Discussions and activities in the class should help the students objectively analyse their family space and the way in which they negotiate with it at different points of time. Through examples from day to day life, the teacher will help the students understand such spaces and the role they play.

Activities

Describe the ideal family. The students can think about the nature of the ideal created by them. What is the role played by siblings in your personal development?

Role play can be used to perform the different roles in a family so as to understand the different points of view within it.

Sharing vs Power: Society

The individuals generally extend the nature of their relationships with the family to the larger social world. In their pursuit to seek autonomy and independence, they may form new kinds of relationships in the larger social context. These relationships may be characterised by imbalances in power. This lecture will try to help the students strike a balance between self and society and stress the role of dialogue, sharing and cooperation.

Activities

The teacher can ask the students to describe any one constructive social role performed by them. (Any way in which they helped people around them). They can draw, speak, share a photograph or write a creative piece about it.

In the years to come what kind of role do you see yourself performing in society?

Share any one story about a person that has really influenced you? It can be about a public figure or anyone around you.

Going Beyond Power Through Open Conversation

In the previous lectures, the discussion has been around family, peer groups and society. In this session, the focus will be on the ways to build a more egalitarian society—one that is more collaborative, inclusive and takes into account different points of view. Open Conversation is suggested as a way by which acceptance, active listening and empathy can be encouraged.

Activities

The students can be asked to present a brief performance showing the way in which open conversation can help in conflict resolution.

Movies in line with classroom discussions held in the past few weeks can be shown to the students. Movie screening should be followed by a discussion.

A short story, poem or a play can be used to build on classroom discussions.

Mindfulness

This module focuses on the significance of silence, introspection and non-judgmental awareness of the present moment. These mental practices are for understanding and building humane connection with self and others. The students are sometimes unable to spare time for their inner growth. Mindfulness practices aim at self-awareness and self-acceptance for overall well being. Valuing and practicing silence helps in the process of deeper reflection and builds inner strength to face conflicts with calmness. It hones the ability to develop mental equanimity and equipoise.

The Value of Silence and Reflection

The students will learn to understand the value of silence in the noise around. The practice of silence helps in self-reflection and connecting the inner and outer worlds. It enables one to experience joy, contentment and peace. Silence is a way of understanding how to enjoy one's own company and not to confuse being alone with loneliness. The students will appreciate that silence and solitude are positive and constructive.

Activities

The students can be asked to maintain silence and watch the flow of thoughts and emotions. In the process of silence the students can identify what gives them happiness and what they can do to create happiness for others.

The students can visit natural spaces to understand how silence runs in the sounds of nature which can help them realise peace.

Practice of Mindfulness

Through this lesson, the students will understand the significance of mindfulness as a daily practice for understanding that happiness depends on the self-training of mind. The joy of living in the moment with full awareness and steadiness of mind are important for accepting and cherishing all experiences positively and non-judgmentally.

Suggested Activities

Mindful walk/trek in the garden/forest/mountains or at a monument. Mindful eating while enjoying all elements of tastes in different types of food can also be done.

The students can be engaged in groups for non-judgmental listening

The class can be divided to discuss what activities of the day they engage with full awareness and where the moments go unnoticed

Unit 3

Identity, Self-image, Status, Self-worth

The module is designed to help the learners revisit the constructs of identity, self and personhood. It builds on questions such as 'who am I', 'how do others and I see myself', 'does status and self-image affect my sense of self-worth'. Specifically, it deals with how one's identity takes shape and thereon begins to be an integral part of oneself. It encourages the students to think about what factors influence their self-worth, such as achievements and accumulations, wealth, career or popularity. The students learn to accept and appreciate self and others.

Identity Construction and Expression: Individual and Collective

This lesson is aimed to help the learners deconstruct their sense of identity and rechart the signifiers/ markers and processes which have played a pivotal role in constructing their sense of identity and self. It unfolds processes of socialisation within family, school, community and society at large have played a role in making students who they are. How do

these processes shape our notions of self-concept, self-evaluation, and self-esteem? The students will be able to become aware of their individual and collective sense of identity and self.

Activities

The teacher may ask the students to imagine one's identity in different contexts that are significant for identity construction. For instance, what does identity of being someone's 'child' entail; likewise what kind of an identity does one expect of oneself as a sibling, student and as a friend.

The teacher may ask the students to read from biographies/autobiographies of people from other cultures and discuss excerpts from the books. The teacher may elaborate the qualities of these people.

The teacher may organise a field visit with the students to different places. Ask the students to survey people from those locales about their experiences.

Accepting and Valuing Oneself

This lesson builds on the previous lesson by unpacking how concerns revolving around self- image and status may affect one's sense of self. It aims to make one aware why a challenge to

one's identity may lead to discomfort and conflict. Students will be encouraged to accept their physical appearance and identity and to value self-worth. This lesson invites them to undertake an inward journey.

Activities

The teacher may ask students to respond to different characters in a movie where challenges to their identity lead to different kinds of responses.

What will change after 10 years in terms of your identity and what according to you will not change?

The teacher may ask the students to identify an 'open space' and 'sit alone' and write a reflective essay on the theme, 'remember what makes you, you'.

Gender Roles

The objective of this module is to enable the students to differentiate between biological and psychological context of gender in order to understand how

their gendered identities are socially constructed. Gender refers to the characteristics of men and women and includes norms, behaviour and roles associated with being man or woman, girl or boy. Further, this will enable the students to become aware that their destiny need not be determined by biology.

Understanding a Gendered World

The objective of this lecture is to enable the students to understand that gender roles are taught by the process of socialization, beginning with the family. Everyday things that we do like eating, speaking, walking, our gestures and even the professions that we think we choose are all often influenced by societal norms.

Activities

The teacher may ask the students to list things associated under the heading; men and women. Once listed, the headings can be interchanged and a discussion may follow.

Ask students to bring an artefact from home, it can be a childhood picture. On the basis of the picture students can share childhood experiences. Through the narrative of their oral history students can share experiences of how they acquired gender.

Identifying and Transcending Stereotypes

In the previous lecture, students have been made aware that gender stereotypes are socially constructed, that the ways in which we interact with others and with ourselves are shaped by gender. The objective of this lecture is to explain the importance of thinking beyond the stereotypes and to reinforce that biological differences between genders should not lead to social discrimination.

Activities

Movie viewing: Students and teachers can choose any movie for discussion.

Quiz cards: On the cards the following can be written and the student can be asked to identify which is socially constructed and which refers to biology.

Men are Breadwinners, Women are homemakers.

Males have XY chromosomes, Females have XX chromosomes. Women give birth to babies, men don't.

Boys don't cry

Digital Identity

It may be constricting to identify exclusively with ideas like region, ethnicity, language, gender, nationality. For, in this increasingly interconnected world, students find themselves at the intersection of many ideas - evolving and fixed, dominant and marginalised. This rainbow of ideas provides an opportunity to appreciate the diversity in the constitution of an individual's identity. But what happens when one is given a chance to construct a digital identity for oneself? Digital platforms and social networking sites arguably provide an individual the choice to portray oneself the way one likes. Do we choose to present our authentic selves or do we prefer to present highly curated versions of ourselves? Do social media posts reflect self-respect and self-love?

Identity Formation and Validation in the Digital World

Through this session, students are expected to realise the ways in which they construct themselves digitally and how that construction is a manifestation of conformity, resistance and/or subversion, of the dominant ideologies. Students should be encouraged to reflect on what exactly they are seeking from engaging with social media. They need to think how the joy of sharing ideas may be different from the egoic need for compulsive validation.

Activities

Think of the digital filters that you use before sharing your photographs with others. Why do you think you need to do that?

We often feel happy about being validated in the form of 'likes' and positive comments on our social media posts. However, do you feel sad when that does not happen? What could be the possible reason for your mind to have this line of thought?

Digital Identities: Impact on the Self

The students will carry forward the learnings from the previous session and continue their inquiry in the realm of motivations for curating a digital self and its relation to self-esteem. They would be encouraged to engage in a non-judgemental conversation which would motivate them to inquire whether

their digital activities are a result of anxiety which may be emanating from their self-image.

Activities

Do you think the use of digital filters is disrespectful to your self? Is not using them a source of anxiety for you? Can this have anything to do with your self-esteem?

Think of situations that make you feel sad on social media. Note them down. Do you think not exposing yourself to such a situation is a solution or do you think you also need to locate the issue within yourself?

Try spending a day without doing any activity on social media like posting anything or surfing other people's accounts for their activities. At the end of the day observe how you feel.

Unit IV

Lifestyle Choices

How we choose to live and behave influences our social and emotional wellbeing. In this module we analyse our lifestyle choices relating to material and cultural consumption, relationships and career. Students will be encouraged to inquire whether our everyday choices are based on a culture of passive consumption and conformism. We will seek to explore possibilities of alternative forms of living premised on ethical consumption, altruism, simple and sustainable living.

What Choices Does One Get to Make?

In this session, the attempt will be to explore the extent to which consumerism impacts our lifestyle choices and the repercussions of these on our natural and social environment. Today we live in an era of mass consumption and consumer culture fostered by advanced technologies and global production systems. Overt materialism, wasteful and conspicuous consumption unmindful of the larger implications are key aspects of this phenomenon. In this lecture, we explore our lifestyle choices such as our physical image, attire, dietary choices, desire for dream homes and destination weddings. This would be the starting point for a re-imagination of a world based upon choices that would lead to simple and sustainable living.

Suggested Activities

Students may be asked to work through their consumption history right from their childhood. A discussion may then be initiated by asking the students to reflect on their consumption choices and their motives behind the same.

The teacher may identify a few products like tea, coffee, coca-cola, jeans etc and ask the students to trace product histories and geographies.

The students may be asked to discuss a strong desire to possess an object and then deconstruct that desire. Discussion may emphasise upon why they wanted it?

Is Choice Influenced? Relationships, Career Choices

In this lecture, we examine the extent to which lifestyle choices, regarding relationships and career, get influenced and by what factors. Do we really have a choice as regards the career that we intend to pursue? Often factors like family, gender, the need for security and stability influence our choices. Recognizing and mapping the space of freedom and unfreedom with respect to our choices is a necessary life skill that would enable a more self-aware and harmonious living.

Activities

Reflect on an instance where you may have inflicted pain on someone and also think of a moment when you felt someone was insensitive in their conduct of a relationship.

The teacher may divide the class into small groups and hold a discussion on what constitutes a successful career.

Reflect on the various career options available in your society and discuss what you would prefer to pursue and why?

Discrimination

The module is designed to help the learners understand the origin and nature of discrimination and the effects thereof. Discrimination can be on various grounds such as ethnicity, religion, caste, race, gender, disability, or place of birth. One's discriminatory actions can lead to social fragmentation. The module encourages the learners to introspect their actions and seeks to celebrate diversity.

Why and How? Forms of Discrimination

The objective of this lesson is to make learners aware of different forms of discrimination. On the one hand, an individual can be a victim of discrimination, and on the other, the same person

may harbour prejudice or discriminate against others. It is pertinent to understand our own biases and introspect our actions.

Activities

The teacher can ask students to count their friends who belong to different backgrounds. They can reflect on what they have learned by interacting with these friends.

Ask students to learn about their neighbourhood and document what groups live there, what has been the nature of their relationships.

An exercise on privilege using nothing but wadded up papers and a trash can.
Students Learn A Powerful Lesson About Privilege.
<https://youtu.be/2KlmvmuxzYE>

Stress and Its Management

This module is designed to give students an opportunity to articulate the pressures and

challenges that one experiences in life. It gives students a chance to spell out how pressure to perform well can become a source of stress. The module is aimed to equip the learners with ways of dealing with disappointments with regard to the choice of career path and with performance related stress. It brings to fore skills of coping with stress and disappointments. It also highlights the role of physical well-being in keeping oneself mentally healthy.

Career Pressures, Examinations

This lesson is designed to help students have a relook at the challenges and pressures they have recently faced or are facing on account of career choices and examinations. It gives them a space to articulate what they might have faced while making these choices. This lesson also gives them an opportunity to highlight the uncertainties and challenges they foresee in their future lives.

Activities

The teacher may ask the students to organise themselves in groups of 4-6. Each of the groups have to do a role-play around the themes on career pressures.

Show images of different people and ask the students to quickly jot down impressions. The collective answers serve as a springboard for discussions. Students may learn about their own biases through this activity.

The teacher may ask the students to identify movies where struggles related to career and performance pressure stand out.

The teacher may ask the students to share their experiences about the following:

- First few months into an academic programmes
- 2 months before examinations
- On the day of examination
- 15 days after examinations get over

Dealing with Disappointments, Coping Skills, Health and Fitness

This session aims to equip the learners with coping skills to manage stress and deal with disappointments. Furthermore, it makes them aware of the importance of health and fitness for maintaining mental health.

Activities

The teacher can ask the students to write how they come to know they are stressed and what they do when they are stressed? The teacher may engage them in a discussion on coping skills and channelize students' energies into positive ways of resolutions of conflict and stress.

The teacher may ask the students to discuss the lives of high achievers and low achievers and

how performance pressures drive their lives. Can they draw similarities and differences in the sources of stresses and how they deal with these stresses?

Ask each of the students to share their daily regime to keep themselves physically fit. The students may also share how each one mentally 'feels/experiences' when one is engaged in physical exercises.

Connect with Nature

This module is designed to strengthen bonds with nature while understanding its intrinsic value as opposed to its instrumental value. Issues of global warming

and environmental degradation are the consequences of a disconnect between humans and nature. The aim is to cultivate environmental awareness through virtues of altruistic responsibility, empathy, cohesiveness, and mutual sustainability between nature, flora-fauna, animals and humans. The students may be engaged in activities to build bridges between the inner environment (one's self) and external environment (nature). In this way, they can celebrate oneness with nature and perceive nature not as a means but an end in itself.

Sensitivity Towards Other Sentient Beings

The students, in this session, would participate in group based environmental activities as a way of building social responsibility towards all sentient beings. Any action against even a part of nature impacts the whole. Thus, it is the responsibility of all, to create a safe environment for all sentient beings to live in harmony.

Activities

Students can be encouraged for Nature walks, nature drives, treks and hikes, nature photography, adopting natural spaces in local areas, plantation drives, visiting biodiversity parks, adopting spaces for greening etc.

Visits to animal shelters can be organised to sensitise the students.

Films can be screened on environmental sustainability, environmental consciousness etc

- Any other Practical/Practice as decided from time to time

Suggested Readings

- Black, Donna Lord (2022). Essentials of Social and Emotional Learning (SEL). NJ : Wiley.
- Goleman, Daniel (2005). Emotional Intelligence. USA: Bantam.
- Swami Vivekanand. (2016). The complete works of Swami Vivekanand. Advaita Ashrama. (<https://www.ramakrishnavivekanand.info/vivekanand/complete-works.html>)

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: SPORTS FOR LIFE - I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Sports for Life - I	02	0	0	2	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are

- To imbibe the significance of sports to promote health, fitness and wellness in life.
- To understand the values of teamwork, tolerance, goal-setting and decision making.
- To learn the strategies and tactical moves while playing a sport.
- To understand the importance of physical activity in reference to 3S: strength, speed and suppleness.

Learning outcomes

The learning Outcomes of this course are

- Acquire values of cooperation, team spirit, determination, and endurance.
- Acquire good health and psychological well-being through sports participation.
- Apply the decision making-ability and goal-setting skills acquired through sports participation in everyday life.
- Acquire skills for engaging in moderate or vigorous physical activity and sports participation.
- Reduce exposure to screen time on electronic gadgets and channelising energy through sports participation.

SYLLABUS OF SPORTS LIFE 1
ONLY PRACTICAL

UNIT – I: Rules and Techniques

(4 Weeks)

Concept

- Rules of the Sport
- Techniques / skills in the sport/ Aerobic Skills

Practical

- Marking of the court / field
- Outdoor Adventure Activity
- Skills learning in sports
- Group Games / Relays
- Participation in Intramural competitions

UNIT – II: Components of Fitness

(4 Weeks)

Concepts

- Meaning and Development of Strength, Speed,
- Endurance, Flexibility and Coordinative Abilities.

Practical

- Skills learning and Participation in sports
- Group Games / Relays / Minor games
- Participation in Intramural competitions

UNIT – III: Benefits of sports and physical activity

(4 Weeks)

Concepts

- Effect of exercise on the body
- Organizing of a sports competition
- Balanced Diet

Practical

- Skills learning and participation in sports
- Group Games, / Relays /Step Aerobics
- Participation in Intramural competitions

UNIT – IV Sports in Contemporary Times

(3 Weeks)

Concepts

- Honours and Awards associated with sports and sportspersons

Practical

- Skills learning and Participation in sports
- Participation in Intramural competitions

Practical component : 30x2 (15 weeks)

The concepts are to be dealt with during the practical/practice classes: Aerobics and Physical Activity, Athletics, Archery, Badminton, Basketball, Boxing, Chess, Carrom, Cricket, Football, Handball, Hockey, Kabaddi, Kho-Kho, Swimming, Shooting, Squash, Table-Tennis, Tennis, Taekwando, Volleyball, Wushu, Wrestling etc.

Suggestive readings

- James R Morrow Jr., Dale P. Mood, James G. Disch, Minsoo Kang - Measurement and Evaluation in Human Performance-Human Kinetics Publishers (2015)
- W.Larry Kenney, Jack H. Wilmore, Devid L.Costil.(2015). Physiology of Sports and Exercise, Second Edition. USA.Human Kinetics.
- Wener W.K. Hoeger, Sharon A. Hoeger - Fitness and Wellness-Cengage Learning (2014)
- Kansal DK (2012).A practical approach to Measurement Evaluation in Physical Education & Sports selection. Sports & Spiritual Science Publications, New Delhi.
- Websites of International Sports Federations, Ministry of Youth Affairs and Sports Govt. of India

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: SWACHH BHARAT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Swachh Bharat	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of the Course are:

- To understand the developmental challenges with reference to sanitation infrastructure and practices.
- To build values of cleanliness, hygiene and waste management in diverse socio-economic contexts.
- To understand planning of social policy and programmes.
- To use waste management techniques at community level.
- To instil a sense of service towards society and the Nation.

Learning Outcomes

The Learning Outcomes of the course are:

- Understanding the significance of the Swachh Bharat Abhiyan.
- Ability to analyse and predict the sanitation challenges of India
- Determine the link between sanitation and development.
- Contribute to the Swachh Bharat Abhiyan through real time projects/fieldwork.

SYLLABUS OF SWACHH BHARAT

UNIT – I Introduction to Swachh Bharat Abhiyan

(4 Weeks)

- Gandhian philosophy of Cleanliness
- Swachh Bharat Abhiyan (SBA)
- Hygiene, Sanitation & Sustainable Waste Management
- Agencies and nodal Ministries for SBA

- Different phases of the SBA and its evaluation
- Citizens' Responsibilities: Role of Swacchagrahi

UNIT – II Swachh Bharat: Rural and Urban Facets

(8 Weeks)

- Indicators for Swachh Bharat
- Rural
 - i. Sanitation coverage across households (2014 vs. 2022)
 - ii. Open Defecation Free (ODF) Villages: Parameters
 - iii. ODF plus model: Key indicators
- Urban
 - i. Sustainable sanitation
 - ii. Waste/water and solid waste management
 - iii. Garbage Free Cities

UNIT – III Prospects and Challenges

(3 Weeks)

- Attitudes and Perceptions
- Operational and Financial issues
- Monitoring & Supervision
- Community Mobilization

Practical component (if any) –

(15 Weeks)

Suggested Activities: List of activities to be undertaken:

- Identify plastic and e-waste in and around the institution and suggest innovative technologies to minimize wastage.
- Identify events/fests that generate maximum waste and ways to minimize it.
- Visit canteen/shops and track the lifecycle of wet/dry waste in and around the institution and document the findings in the form of a Project Report.
- Conduct interviews of stakeholders to understand the level of awareness.
- Conduct a Clean Audit of the Institution and identify areas for action.
- Conduct cleanliness drives.
- Organise Swachhata Pakhwada meetings, rallies, and mobilization camps within the identified communities.
- Students may participate in the Swachh Bharat Internship programme.
- If required students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- "Swachh Bharat Mission - Gramin, Department of Drinking Water and Sanitation, Ministry of Jal Shakti"
- India 2021, Ministry of Information & Broadcasting
- <http://swachhbharatmission.gov.in/SBMCMS/swachhta-pakhwada.htm>
- <https://swachhbharatmission.gov.in/SBMCMS/about-us.htm>
- https://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/ODF_verification_checklist.pdf
- <https://sbm.gov.in/phase2dashboard/PhaseII/NationDashboard.aspx>
- <https://www.niti.gov.in/sites/default/files/2019-08/Report%20of%20Sub-Group%20of%20Chief%20Ministers%20on%20Swachh%20Bharat%20Anhiyaan.pdf>

Suggested Readings

- <https://swachhbharatmission.gov.in/SBMCMS/writereaddata/Portal/Images/pdf/brochure/Greywatermanagement.pdf>
- https://swachhbharatmission.gov.in/SBMCMS/writereaddata/Portal/Images/pdf/brochure/PWMB5_28th_June.pdf
- GoI (2020). Swachh Bharat Mission (Gramin) Phase 2: Operational guidelines. Department of Drinking Water and Sanitation, Ministry of Jalshakti.
- MoHUA (2017). Guidelines for Swachh Bharat Mission - Urban (PDF). Ministry of Housing and Urban Affairs, Government of India.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: THE ART OF BEING HAPPY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
The Art of Being Happy	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

- To synthesize the insights developed by Human Development experts, Psychologists, Anthropologists on one hand, and the intellectual traditions of Vedantic Philosophy and Indology on the other towards the experience of happiness.
- To illustrate various factors that determine the subjective experience of happiness in a cross cultural context.

Learning outcomes

- The students shall be able to evaluate the factors contributing to the phenomenon of happiness in the personal, familial and community life of an individual in different cultures in the Indian context.
- They will be able to develop healthy interpersonal relationships and wellbeing cherishing the values of Indian culture and philosophy.
- They will be able to relate to the global phenomenon of sustainable development and become sensitive to the needs of the planet.
- They will be able to apply the experience of *Aananda* at a personal level.

SYLLABUS OF THE ART OF BEING HAPPY

UNIT – I Human Ecology and Happiness Lectures

(3 Weeks)

- Definitions/Factors of Happiness: Environmental and Social

- Physical, emotional and psychological well-being for happiness
- Physiological and hormonal basis of happiness
- Coping with Stress: A life saving skill

UNIT – II Indological Theories of Happiness

(4 Weeks)

- *Panch Kosh* Theory & Idea of Well-Being
- Idea of Self and other
- Hierarchy and stages of happiness

UNIT – III Happiness: Cross-cultural Contexts

(4 Weeks)

- Culture and Happiness
- Interpersonal Relationship: Comparative Perspective
- Towards Self-Actualization

UNIT – IV Local and Global Perspective of Happiness

(4 Weeks)

- Measuring happiness: Key indicators
- Happiness Index
- India in Global Happiness Indices

Practical component (if any) –

(15 Weeks)

The course will be based on students' identification and operationalization of the concept of happiness and well-being. Students will explore the indicators and actualization of these concepts in everyday life.

- Community surveys on the facilities promoting positive mental health practices such as Yoga and Meditation Centres, Recreation clubs, and Parks for youth and senior citizens shall be carried out by the students.
- Extending help and social service by visiting old age homes/ hospitals/slum areas or any other disadvantaged groups.
- Students can undertake a field work / project independently or work as an Intern with NGOs working in the area of happiness and well-being.
- Critical appreciation of a documentary/ film based on Happiness and Well-being can be undertaken by the students.
- Workshops/ Sessions for the actualization of innate creative potential- (Music, Drawing, Calligraphy, Dramatics)

- Hands-on Happiness: Gardening, Cleaning, Washing, Cooking, etc.
- If required, students can share their experiences in the form of a Project Report.
- Students may share their experiences in the form of Audio-video presentations of 15-20 minutes.
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- Banavathy, Vinayachandra & Choudry, Anuradha. (2013). Understanding Happiness: A Vedantic Perspective. Psychological Studies. 59. 141-152. 10.1007/s12646-013-0230-x.
- Leontiev, Dmitry. (2012). Anthropology of Happiness: the state of Well-Being and the way of Joy, In Social Science, Vol 43. No 2 P93-104.
- Snyder .C.R. S.J. Lopez & J.T. Pedrotti. (2015). Positive Psychology (The Scientific and Practical Explorations of Human Strengths): Sage Publication. (Chapter 5: Subjective Well-being: The Science of Happiness and Life Satisfaction, Page 63 to 73)
- World Development Indicators 2016. (2016). United States: World Bank Publications.
- Zelenski, John. (2019) Positive Psychology: The Science of Well-Being, Carleton University, Ottawa, Canada, Sage Publications Chapter 3: Happiness; page (77 to 110)

Suggestive readings

- Baumgardner, S & Crothers, M. (2014). Positive Psychology. New Delhi: Pearson Education, India.
- Goleman, D. (2007). Social Intelligence: The new science of human relationships, RHUK
- Mathews, Gordon and Carolina Izquierdo (eds). (2010). Pursuits of Happiness: Well being in Anthropological Perspective. Berghen Books
- Seligman, M. (2002). Authentic happiness: Using the new positive psychology to realize your potential for lasting fulfilment. New York: Free Press.
- Sri Aurobindo, The Synthesis of Yoga, Part Three: The Yoga of Divine Love, Chapter 7, The Ananda Brahman, pp. 569-570

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: VEDIC MATHEMATICS - I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Vedic Mathematics - I	02	1	0	1	12 TH Pass	NIL

Learning Objectives

The Learning Objectives of the course are:

- Foster love for maths and remove its fear through Vedic Mathematics
- Enhance computation skills in students through Vedic Mathematics*
- Develop logical and analytical thinking
- Promote joyful learning of mathematics
- Discuss the rich heritage of mathematical temper of Ancient India

Learning outcomes

The Learning Outcomes of the course are

- Overcome the fear of maths
- Improved critical thinking
- Familiarity with the mathematical underpinnings and techniques
- Ability to do basic maths faster and with ease.
- Appreciate the Mathematical advancements of Ancient India.

SYLLABUS OF VEDIC MATHEMATICS - I

UNIT – I Vedic Maths- High Speed Addition and Subtraction Sessions/Lectures (5 Weeks)

- Vedic Maths: History of Vedic Maths and its Features
- Vedic Maths formulae: Sutras and Upsutras
- Addition in Vedic Maths: Without carrying, Dot Method

- Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah (All from 9 last from 10)
- Fraction –Addition and Subtraction

UNIT – II Vedic Maths- Miracle Multiplication and Excellent Division (4 Weeks)

- Multiplication in Vedic Maths: Base Method (any two numbers upto three digits)
- Multiplication by Urdhva Tiryak Sutra
- Miracle multiplication: Any three-digit number by series of 1's and 9's
- Division by Urdhva Tiryak Sutra (Vinculum method)

UNIT – III Vedic Maths-Lightening Squares and Rapid Cubes (3 Weeks)

- Squares of any two-digit numbers: Base method
- Square of numbers ending in 5: Ekadhikena Purvena Sutra
- Easy square roots: Dwandwa Yoga (duplex) Sutra
- Square root of 2: Baudhayana Shulbasutra
- Cubing: Yavadunam Sutra

UNIT – IV Vedic Maths-Enlighten Algebra and Geometry (3 Weeks)

- Factoring Quadratic equation: Anurupyena, Adyamadyenantyamanty Sutra
- Concept of Baudhayana (Pythagoras) Theorem
- Circling a square: Baudhayana Shulbasutra
- Concept of pi: Baudhayana Shulbasutra
- Concept angle (θ) 0o, 30o, 45o, 60o and 90o: Baudhayana number

Practical component : (If any) (15 Weeks)

The students are expected to demonstrate the application of Vedic Maths: Sutra and Upsutra

- Conduct workshops under the supervision of the course teacher to spread awareness on the utility of Vedic Mathematics.
- Students are required to visit nearby retail shops/local vendors to purchase stationery/vegetables/bread and butter and use tricks of Vedic maths of addition and subtraction to calculate the amount to pay and receive the difference.
- Students may share their experience with the class teacher in the form of audio-video presentations of 15 minutes.
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi 2019.
- Vedic Mathematics Made Easy, Dahaval Bathia, Jaico Publishing, New Delhi 2011
- Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
- Learn Vedic Speed Mathematics Systematically, Chaitnaya A. Patil 2018.

Suggested Readings

- A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, Wiley Eastern Limited, New Delhi.
- Enjoy Vedic Mathematics, S M Chauthaiwale, R Kollaru, The Art of Living, Bangalore.
- Magical World of Mathematics, VG Unkalkar, Vandana publishers, Bangalore.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: Yoga: PHILOSOPHY AND PRACTICE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Yoga: Philosophy and Practice	02	1	0	1	12 th Pass	NIL

Learning Objectives

The Learning Objectives of the course are:

- To learn the fundamentals of Yoga for harmonising the body, mind and emotions.
- To demonstrate the value and the practice of holistic living.
- To value the heritage of Yoga for self and society.

Learning outcomes

The Learning Outcomes of the course are:

- Understanding ways to harmonise the body and mind through Yoga.
- Disciplining the mind through practicing Yoga.
- Understanding of consciousness through practical training.

SYLLABUS OF YOGA: PHILOSOPHY AND PRACTICE

UNIT – I Yoga: *Asana*, *Prāṇāyāma* and *Dhyana*

(5 Weeks)

- History of Yoga
- Significance of Asana
- Effect of Prāṇāyāma
- Importance of Dhyana

UNIT – II Patanjali's *Yogasūtra* and *Chakra*

(6 Weeks)

- Patanjali's *Yogasūtra*: a summary
- First sutra
- Second sutra
- Chakras (psychic centres)

UNIT – III Understanding *Asana* and *Pranayama*

(4 Weeks)

- Asana: the basics
- Surya Namaskara
- Nadishodhana Pranayama

Practical component (if any)

(15 Weeks)

- Surya Namaskar
- Selected Asana
- Pranayama
- Relaxation exercises for the eyes (7 steps) neck (4 steps)
- Concentration on Bhramadhy
- Project Work (effect of everyday concentration on breath for 15 minutes: reflections to be compiled in the form of a Project report.
- Any other Practical/Practice as decided from time to time

Essential Readings

- Āsanas, Prāṇāyāma and Mudra Bandh , Swami Satyananda Saraswati, Yoga Publications Trust, Munger, Bihar, India, 2004.
- Patanjali Yogasutras, Commentary by Swami Vivekanand, Rajyoga

Suggested Reading

- Patanjali Yog Pradeep- Swami Omanand Saraswati, Gita Press, Gorakhpur, 2013.
- Science of Pranayama-Swami Sivananda, Edition by David De Angellis, 2019, All Rights Reserved.
- Udayveer Shastri Granthavali, 4, Patanjali- Yoga Darshanam, Udayavir Shastri, Govindram Hasanand, Delhi 6.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time.

VAC 1: भारतीय भक्ति परंपरा और मानव मूल्य

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
भारतीय भक्ति परंपरा और मानव मूल्य	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- भारतीय भक्ति की महान परंपरा, प्राचीनता और इसके अखिल भारतीय स्वरूप से छात्रों का परिचय कराना
- भारतीय भक्ति परंपरा के माध्यम से छात्रों में मानव मूल्यों और गुणों को जगाकर उनका चारित्रिक विकास करना और एक अच्छे मनुष्य का निर्माण करना।
- छात्रों को भारतीय नैतिक, सांस्कृतिक और सामाजिक मूल्यों के प्रति जागरूक करना।
- भारतीय भक्ति परंपरा के माध्यम से राष्ट्रीयता और अखिल भारतीयता की भावना जागृत करना।

Learning outcomes

The Learning Outcomes of this course are as follows:

- भारतीय भक्ति परंपरा के माध्यम से छात्रों में मानव मूल्यों और गुणों को विकास होगा और वे एक अच्छे और चरित्रवान मनुष्य बन सकेंगे।
- भारतीय भक्ति परंपरा के सांस्कृतिक और सामाजिक पक्षों की जानकारी हो सकेगी।
- भक्ति की प्राचीनता और अखिल भारतीय स्वरूप की जानकारी से राष्ट्रीयता और अखिल

भारतीयता की भावना जागृत और मजबूत होगी।

- प्रमुख भक्त कवियों का परिचय और उनके विचारों की जानकारी हो सकेगी।

SYLLABUS OF परंपरा और मानव मूल्य

UNIT – I भारतीय भक्ति परंपरा

(5 Weeks)

- भक्ति : अर्थ और अवधारणा
- भक्ति के विभिन्न संप्रदाय और सिद्धांत
- भारत की सांस्कृतिक एकता और भक्ति
- भक्ति का अखिल भारतीय स्वरूप

UNIT – II भारत के कुछ प्रमुख भक्त और उनके विचार

(5 Weeks)

संतति रुवल्लुवर, आण्डाल, अक्कमहादेवी, ललद्यद, मीराबाई, तुलसीदास, कबीरदास, रैदास, गुरु नानक, सूरदास, जायसी, तकुाराम, नामदेव, नरसिंह मेहता, वेमना, कंचन, नम्बियार, चतैन्य महाप्रभु, चंडीदास, सारला दास, शंकरदेव

UNIT – III मानव मूल्य और भक्ति

(5 Weeks)

मानव मूल्य का अर्थ

चयनित भक्त कवियों की जीवन मूल्यपरक कविताएँ

Practical component (if any) –

(15 Weeks)

- पाठ्यक्रम में उल्लिखित कवियों में से किसी एक कवि की रचनाओं में विभिन्न मानव मूल्यों के आधार पर प्रोजेक्ट
- वर्तमान समय में भक्ति की प्रासंगिकता को समझना; सर्वे और साक्षात्कार पद्धति के आधार पर.
- जीवन में मानव मूल्यों के प्रति पालन पर सर्वे और साक्षात्कार के आधार पर एक रिपोर्ट बनाना.

- उल्लिखित कवियों में से किसी एक कवि से संबंधित किसी मठ, आश्रम या मंदिर आदि, अथवा कोई फिल्म/ डॉक्यूमेंट्री के आधार पर रिपोर्ट बनाना.
- आवश्यक हो, तो छात्र प्रोजेक्ट रिपोर्ट के रूप में अपने अनुभव साझा करें
- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- 'भक्ति का उद्भव और विकास तथा वैष्णव भक्ति के विविधरूप, भारतीय साहित्य का समेकित इतिहास, संपादक- डॉ नगेंद्र, हिंदी माध्यम कार्यान्वयन निदेशालय, दिल्ली विश्वविद्यालय, दिल्ली, पृष्ठ संख्या 215-250
- कुछ प्रमुख कवियों के चयनित पद
- 'भक्ति आंदोलन और भक्ति काव्य', शिव कुमार मिश्र, अभिव्यक्ति प्रकाशन, इलाहाबाद, 1994
- 'मानव मूल्य और साहित्य, डॉ धर्मवीर भारती, भारतीय ज्ञानपीठ, नई दिल्ली, 1999

Suggested readings

- 'भक्ति के आयाम', डॉ. पी. जयरामन, वाणी प्रकाशन, नई दिल्ली
- 'हिंदी साहित्य का इतिहास, आचार्य रामचंद्र शुक्ल, लोक भारती प्रकाशन, इलाहाबाद
- 'मध्यकालीन हिंदी काव्य का स्त्री पक्ष', डॉ. पूनम कुमारी, अनामिका पब्लिशर्स एंड डिस्ट्रीब्यूटर्स, नई दिल्ली
- 'मध्यकालीन हिंदी भक्ति काव्य: पुनर्मूल्यांकन के आयाम', डॉ. पूनम कुमारी, अनामिका पब्लिशर्स एंड डिस्ट्रीब्यूटर्स, नई दिल्ली

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: साहित्य संस्कृति और सिनेमा**Credit distribution, Eligibility and Pre-requisites of the Course**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
साहित्य संस्कृति और सिनेमा	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- साहित्य , संस्कृति और सिनेमा के माध्यम से छात्रों का सर्वांगीण विकास करना
- छात्रों को नैतिक,सांस्कृति क और संवैधानि क मूल्यों के प्रति जागरूक करना
- भारतीय ज्ञान परंपरा,वैज्ञानि क दृष्टि कोण और तार्किक क्षमता को प्रोत्साहित करना
- साहित्य,संस्कृति और सि नेमा के माध्यम से राष्ट्र प्रेम की भावना जागृत करना
- सामूहिक कार्यों के माध्यम से सम्प्रेषण,प्रस्तुतीकरण एवं कौशल दक्षता विकसित करना

Learning outcomes

The Learning Outcomes of this course are as follows:

- साहित्य ,संस्कृति और सिनेमा के माध्यम से नैतिक,सांस्कृतिक और संवैधानिक मूल्यों की समझ वि कसि त होगी
- भारतीय ज्ञान परंपरा और नैतिक मूल्यों के प्रति सकारात्मक दृष्टिकोण बनेगा
- वैचारि क समझ एवं तार्किक क्षमता का विकास होगा
- परियोजना के माध्यम से संप्रेषण एवं प्रस्तुति करण दक्षता का विकास होगा
- छात्रों के व्यक्तित्व का सर्वा गीण विकास होगा

SYLLABUS OF साहित्य संस्कृति और सिनेमा

UNIT – I साहित्य, संस्कृति और सिनेमा का सामान्य परिचय (2 Weeks)

- साहित्य, संस्कृति और सिनेमा : परिभाषा और स्वरूप
- साहित्य , संस्कृति और सिनेमा का अंतःसंबंध

UNIT – II साहित्यिक कृतियों पर आधारित सिनेमा (6 Weeks)

- साहित्यिक कृतियों पर आधारित सिनेमा में परिकल्पना
- साहित्यिक कृतियों पर आधारित सिनेमा की प्रासंगिकता
- साहित्यिक कृतियों पर आधारित सिनेमा- आनंदमठ 1952, तीसरी कसम 1966, रजनीगंधा 1974, पद्मावत 2016

UNIT – III हिन्दी सिनेमा में सामाजिक –सांस्कृतिक मूल्यों की अभिव्यक्ति (7 Weeks)

- सामाजिक - सांस्कृतिक मूल्य
- सामाजिक - सांस्कृतिक मूल्य के शक्तिशाली उपकरण के रूप में सिनेमा
- हिन्दी सिनेमा में अंतर्निहित सामाजिक- सांस्कृतिक मूल्य – मदर इंडिया 1957, बंदिनी 1963, पूरब और पश्चिम 1970, हम आपके हैं कौन 1994, टॉयलेट: एक प्रेमकथा 2017

Practical component (if any) – (15 Weeks)

- भारतीय सांस्कृतिक मूल्यों पर आधारित लघु फिल्म हेतु पटकथा लेखन (8-10 मि नट)
- साहित्यिक रचनाओं का फिल्मांतरण (8-10 मि नट); यह सामूहिक क्रियाकलाप होगा
- राष्ट्रप्रेम, कुटुंब, शांति , पर्यावरण, जल-संरक्षण, स्वच्छता, मित्रता, सत्यनिष्ठा, कर्मनिष्ठा, समरसता में से किसी एक विषय पर मूक फिल्म निर्माण (8-10 मि नट)
- आवश्यक हो, तो छात्र प्रोजेक्ट रिपोर्ट के रूप में अपने अनुभव साझा करें
- Any other Practical/Practice as decided from time to time

Essential/Recommended readings

- 'संस्कृति क्या है (निबंध) संस्कृति ,भाषा और राष्ट्र, रामधारी सिंह दिनकर, लोक भारती प्रकाशन,2008,पृष्ठ संख्या 60-64.
- साहित्य का उद्देश्य(निबंध) ,प्रेमचंद ,एस. के.पब्लिशर्स,नई दि ल्ली,1988,पृष्ठसंख्या 7-18.
- भारतीय संस्कृति के स्वर,महादेवी वर्मा , राजपाल एंड संस प्रकाशन 2017 .
- हि ंदी सिनेमा ; भाषा ,समाज और संस्कृति (लेख), पृष्ठ संख्या 11-18 भाषा ,साहित्य ,समाज और संस्कृति खंड 6,प्रो. लालचंद राम, अक्षर पब्लिशर्स एंड डिस्ट्रीब्यूटर्स,2020
- सिनेमा और साहित्य का अंतःसंबंध (लेख) पृष्ठ संख्या 30-34,साहित्य और सिनेमा, परुषोत्तम कंु दे (संपा.) साहित्य सस्थान,2014
- साहित्यिक रचनाओं का फिल्मांतरण (लेख) पृष्ठ संख्या 206-212,लोकप्रिय सिनेमा और सामाजिक यथार्थ ,जवरीमल पारख, अनामि का पब्लिशर्स एंड डिस्ट्रीब्यूटर्स प्रा.लि., 2019

Suggested readings

- सिनेमा और संस्कृति ,राही मासूम रजा, वाणी प्रकाशन, प्रकाशन वर्ष, 2018.
- जीवन को गढ़ती फिल्में, प्रयाग शुक्ल
- सिनेमा और संसार, उदयन वाजपेयी
- साहित्य,संस्कृति और समाज परिवर्तन की प्रक्रि या(नि बंध)अज्ञेय, संपा०कृष्णदत्तपालीवाल, सस्ता साहित्य मंडल,नई दि ल्ली, 2010, पृष्ठसंख्या 25-41
- सिनेमा समकालीन सिनेमा ,अजय ब्रह्मात्मज,वाणी प्रकाशन,2006
- कल्चर इन्डस्ट्री रिकन्सि डर्ड: पृष्ठसंख्या- 98-106 कल्चरइन्डस्ट्री:थ्योडोरएडोर्नो , राउतलेज (भारतीयसंस्करण)
- दि सिग्निफिकेन्स ऑफ कल्चर इन अन्डस्टैंडिंग ऑफ सोशल चेंज इन कन्टेम्पररि इंडिया: पृष्ठसंख्या- 25-39.
- कल्चर चेंज इन इंडिया:आइडन्टिटी एंड ग्लोबलाइजेशन: योगेन्द्र सिंह .रावत पब्लिकेशन, जयपुर,भारत.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

VAC 1: सृजनात्मक लेखन के आयाम**Credit distribution, Eligibility and Pre-requisites of the Course**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
सृजनात्मक लेखन के आयाम	02	1	0	1	Pass in Class 12 th	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- सृजनात्मकता और भाषायी कौशल का संक्षिप्त परिचय कराना
- विचारों का प्रभावी प्रस्तुति करण करना
- सृजनात्मक चिंतन और लेखन क्षमता को विकसित करना
- मीडिया या लेखन की समझ विकसित करना

Learning outcomes

The Learning Outcomes of this course are as follows:

- सृजनात्मक चिंतन और लेखन क्षमता का विकास हो सकेगा
- लेखन और मौखिक अभिव्यक्ति की प्रभावी क्षमता विकसित हो सकेगी
- मीडिया लेखन की समझ विकसित होगी
- विद्यार्थी में अपने परिवेश, समाज तथा राष्ट्र के प्रति संवेदनशीलता का विकास होगा

SYLLABUS OF सृजनात्मक लेखन के आयाम**UNIT – I सृजनात्मक लेखन****(5 Weeks)**

- सृजनात्मक लेखन : अर्थ, स्वरूप और बोध

- सृजनात्मक लेखन और परिवेश
- सृजनात्मक लेखन और व्यक्तित्व निर्माण

UNIT – II सृजनात्मक लेखन : भाषिक संदर्भ

(5 Weeks)

- भाव और विचार का भाषा में रूपान्तरण
- साहित्यिक भाषा की विभिन्न छवि याँ
- प्रिंट तथा इलेक्ट्रॉनिक माध्यमों की भाषा का अंतर

UNIT – III सृजनात्मकता लेखन – विविध आयाम

(5 Weeks)

- कविता, गीत, लघु कथा
- हास्य - व्यंग्य लेखन,
- पल्लवन, संक्षेपण , अनुच्छेद

Practical component (if any) –

(15 Weeks)

- कक्षा में प्रत्येक विद्यार्थी द्वारा 'मेरी पहली रचना' शीर्षक से किसी भी विधा में लेखन
- किसी भी साहित्यिक रचना का भाषा की दृष्टि से विश्लेषण
- इकाई- 3 में उल्लिखित विधाओं में विद्यार्थी यों द्वारा लेखन एवं सामूहिक चर्चा
- प्रत्येक इकाई से संबन्धित परि योजना कार्यः
 - i. समसामयिक विषयों पर किसी भी विधा में लेखन – बदलते जीवन मूल्य, महामारी, राष्ट्र निर्माण में छात्र की भूमि का, युवाओं के कर्तव्य, पर्यावरण संरक्षण, लोकतन्त्र में मीडिया की भूमि का, ऑनलाइन शॉपिंग अथवा अन्य समसामयिक विषय
 - ii. किसी उत्सव, मेला, प्रदर्शनी, संग्रहालय और किसी दर्शनीय स्थल का भ्रमण तथा उस पर परियोजना कार्य
- प्रिंट माध्यम के खेल, राजनीति , आर्थिक और फिल्म जगत आदि से जुड़ी सामग्री का भाषा की दृष्टि से विवेचन
- इलेक्ट्रॉनिक माध्यम के समाचार, धारावाहिक, विज्ञापन आदि का भाषा की दृष्टि से विवेचन
- आवश्यक हो, तो छात्र प्रोजेक्ट रिपोर्ट के रूप में अपने अनुभव साझा करें

- Any other Practical/Practice as decided from time to time

Essential/recommended readings

- लेखन एक प्रयास, हरीश चन्द्र काण्डपाल
- रचनात्मक लेखन, सं. रमेश गौतम
- साहित्य – चिंतन: रचनात्मक आयाम, रघुश

Suggested readings

- अग्नि की उड़ान, अबुल कलाम आज़ाद
- टेलीविजन की भाषा - हरीश चन्द्र बर्णवाल, राधाकृष्ण प्रकाशन, नई दिल्ली
- छोटे पर्दे का लेखन, हरीश नवल
- काव्यभाषा : रचनात्मक सरोकार, प्रो. राजमणि शर्मा
- कविता रचना प्रक्रिया, कुमार विमल

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

विकास गुप्ता
16/9/22
REGISTRAR

UNIVERSITY OF DELHI

CNC-II/093/1(28)/2023-24/281

Dated: 06.10.2023

NOTIFICATION

Sub: Amendment to Ordinance V

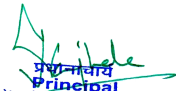
[E.C Resolution No. 14-1/-(14-1-6/-) dated 09.06.2023 and 27-1-1/ dated
25.08.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-IV, V and VI of the following departments under Faculty of Science based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23 :

- (i) Botany
- (ii) Geology
- (iii) Zoology
- (iv) Zoology Component for BSc. Life Science


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DEPARTMENT OF BOTANY
SEMESTER - IV
Category-I
BSC (Hons.) BOTANY

DISCIPLINE SPECIFIC CORE COURSE - 10: Mycology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MYCOLOGY DSC-10	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To introduce students with various fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic Importance
- To introduce students to the role of fungi in biotechnology, food industry, agriculture, human health and diseases etc.

Learning Outcomes: Upon completion of this course, the students will be able to:

- understand the world of fungi, lichens and pathogens of plants
- understand characteristics the ecological and economic significance of the fungi and lichens
- understand the application of mycology in various fields of economic and ecological significance

Unit 1: Introduction

04 hours

General characteristics; Thallus organization; Cell wall composition; Nutrition; Heterokaryosis and Parasexuality; Classification - Webster and Weber (2007) and Introduction to Phylogenetic system of classification.

Unit 2: Chytridiomycota

01 hour

General characteristics; Life cycle of *Synchytrium*, *Allomyces*

Unit 3: Zygomycota

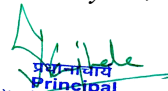
02 hours

General characteristics; Distribution; Thallus organization; Classification; Life cycle of *Rhizopus* & *Mucor*.

Unit 4: Ascomycota

05 hours

General characteristics; Distribution; Classification, Life cycles of *Saccharomyces*, *Penicillium*, *Alternaria*, *Neurospora* and *Peziza*.


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Unit 5: Basidiomycota**05 hours**

General characteristics; Distribution; Classification, Life cycle of *Puccinia graministritici*, *Agaricus*; Bioluminescence, Fairy Rings, Mushroom cultivation.

Unit 6: Oomycota**02 hours**

General characteristic (with emphasis on difference with fungi); Distribution; Classification, Life cycle of *Albugo*.

Unit 7: Myxomycota**02 hours**

General characterises (with emphasis on difference with fungi); Distribution; Types of plasmodia; Types of fruiting bodies; Life cycle of *Stemonitis*.

Unit 8: Symbiotic associations**04 hours**

Lichen - Distribution; General characteristics; Growth forms and range of thalli; Economic importance of lichens. Mycorrhiza - Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 9: Applied Mycology**05 hours**

Application of fungi in Food Industry- Fermentation, Organic acids, Enzymes, Mycoproteins; Introduction to Plant Pathology, Nematophagous fungi, Entomogenousfungi , Mycoparasites, Mycoremediation, Medical mycology and Mycotoxins.

Practicals**60 hours**

1. *Rhizopus & Mucor*: Study of asexual stage from temporary mounts and sexual stage through permanent slides.
2. *Saccharomyces*: Study of vegetative cell and buddingfrom temporary mounts.
3. *Penicillium*: Study of asexual stage from temporary mounts and sexual stage from permanent slides.
4. *Peziza*: Study of sexual stage from temporary preparation of V.S of ascocarp.
5. *Alternaria solani*: Study of symptoms of early blight of Potato. Study of asexual stages through temporary mounts.
6. *Puccinia graministritici*: Herbarium specimens of Black stem rust of wheat and barberry leaves; sections / mounts of spores (Uredospores and Teleutospores) on wheat. Permanent slides showing spore stages on both the hosts.
7. *Agaricus*: Specimens of button stage and mature basidiocarp; V.S of gills of *Agaricus*.
8. Study of Phaneroplasmodium of *Physarum* and sporangia of *Stemonitis*.
9. *Albugo candida*: Study of symptoms of white rust on *Brassica* sp.; Asexual stage study through section / temporary mounts. Sexual structures through temporary mounts / permanent slides.
10. Lichens: Study of different types of lichens - Crustose, Foliose and Fruticose. Study of Internal structure of thallus; Apothecium through permanent slides.

Suggested Readings:

1. Agrios, George N. (2005). Plant Pathology, 5th Edition, Academic Press / Elsevier.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition, John Wiley & Sons, Singapore.
3. Moore, David et. al. (2020). 21st Century Guidebook to Fungi, 2nd Edition, Cambridge University Press.
4. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi and Their Allies, Medtech Publishers.
5. Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press, UK.

Additional Resources:

1. Kavanagh, Kevin (2017). Fungi: Biology and Applications, 3rd Edition, Wiley-Blackwell.
2. Maheshwari, Ramesh (2012). Fungi: Experimental Methods in Biology, 2nd Edition, CRC Press.
3. Ownley, Bonnie and Trigiano, Robert N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rd Edition, CRC Press.
4. Watkinson, Sarah et. al. (2015). The Fungi, 3rd Edition, Academic Press / Elsevier.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 11: Ecology and Conservation

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology and Conservation DSC – 11	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To introduce the students with environmental factors affecting the plants, the basic principles of ecology and phytogeography.
- To make them understand community patterns and processes, and ecosystem functioning.

Learning Outcomes:

At the end of this course, students will be able to understand:

- the interrelationship between organisms and environment.
- methods to study vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
- evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit 1: Introduction

01 hour

Basic concepts, Interrelationships between the living world and the environment

Unit 2: Soil

05 hours

Origin & Formation; physical, chemical and organic components; soil profile; forms of water in soil

Unit 3: Water

02 hours

Importance; States of water in the environment; Atmospheric moisture; Water table

Unit 4: Abiotic interactions

03 hours

Abiotic factors and plant adaptations, variations in light, temperature & wind conditions.

Unit 5: Biotic interactions

02 hours


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Definition; types of positive and negative biotic interactions

Unit 6: Population ecology

02 hours

Characteristics of populations; population growth models and introduction to population regulation (density-dependent and independent); ecotypes; metapopulation (history, concept and applications to conservation)

Unit 7: Plant Communities

04 hours

Community characters (General account of analytical and synthetic characters); Ecotone; Succession: processes, types (Lithosere, Hydrosere, Xerosere, Psammosere)

Unit 8: Ecosystems

04 hours

Types, components, trophic organisation; food chain & food webs, ecological pyramids. models of energy flow; production and productivity; a brief outline of biogeochemical cycles (Carbon and Nitrogen)

Unit 9: Phytogeography

04 hours

Principles; Continental drift; Theory of tolerance; Endemism; Phytogeographical division of India

Unit 10: Conservation

03 hours

In-situ, ex-situ; gene banks, institutions - National & International; sacred groves, on-farm conservation.

Practicals

60 hours

1. Principle and operation of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH and detection of carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from atleast two soil samples by rapid field tests.
3. Determination of pH & dissolved oxygen from polluted and unpolluted water samples.
4. Determination of soil organic carbon and organic matter of different soil samples by Walkley & Black rapid titration method.
5. Study of ecological adaptations of hydrophytes and xerophytes (four each).
6. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants).
7. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

9. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
10. Species distribution pattern based on A/F ratio (regular, random, clumped).
11. Field visit to familiarize students with ecology/conservation of different sites.

Suggested Readings:

1. Daubenmire, R.F. (1975). Plant and Environment. London: J. Wiley and Sons Inc.
2. Kormondy, E.J. (1996). Concepts of Ecology. New Delhi, India: PHI Learning Pvt. Ltd. 4th edition.
3. Odum, E.P. (2005). Fundamentals of Ecology. New Delhi, India: Cengage Learning India Pvt. Ltd., 5th edition.
4. Sharma, P.D. (2010). Ecology and Environment. Meerut, India: Rastogi Publications. 8th edition.
5. Singh, J.S., Singh, S.P., Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. New Delhi, India: S. Chand.

Additional Resources:

1. Ambasht, R.S. and Ambasht, N.K. (2008). A text book of Plant Ecology, CBS Publishers & Distributors PVT. LTD.
2. Majumdar, R and Kashyap, R (2019). Practical Manual of Ecology and Environmental Science, New Delhi, India: Prestige Publishers
3. Singh, J.S., Singh, S.P., Gupta, S. R. (2006). Ecology, Environment and Resource Conservation. New Delhi, India: Anamaya Publications.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology. USA: An Earth Systems Approach. Oxford University Press.
5. Hanski, I.A., & Gilpin, M.E. (1997). Metapopulation biology: Ecology, genetics, and evolution. Academic Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 12: Developmental Biology of Angiosperms: Form, Anatomy & Function

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology of Angiosperms: Form, Anatomy & Function DSC-12	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To understand the basics of plant cell structure, and development, growth and organisation of the plant body.

Learning Outcomes:

Upon completion of the course, the students will

- become familiar with the structure and functions of various components of plant cell
- understand the process of cell growth and its regulation
- comprehend the structure and functions of tissues organising the various plant organs
- get acquainted with the reproductive processes involved in the life cycle of angiosperms
- be able to appreciate the interactions between the developmental pathways resulting in the differentiation of plant body
- recognise the importance of plant developmental biology in the improvement and conservation of plants.

Unit 1: Introduction to diversity of plant forms

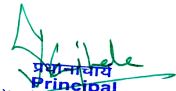
05 Hours

Historical perspective, methods/tools and techniques (fixation, sectioning, macerations); terms for describing plant cells; basic plant growth-meristems and cell differentiation; Primary and Secondary plant body (introduce terms); Classification of tissues; Simple and complex tissues, Vascular system.

Unit 2: Tissue organisation in stem

05 Hours

Organization of shoot apex -Apical cell theory, Histogen theory, Tunica Corpus theory, Neuman's Theory of Continuing Meristematic Residue, Cyto-Histological Zonation Theory; Types of vascular bundles; Structure of dicot and monocot stem; Shoot Chimeras


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Unit 3: Tissue organisation in leaf**03 Hours**

Initiation and development of leaf; leaf lamina, venation and vascular differentiation in leaf; dermal tissue system, cuticles and special epidermal cells - cuticle; epicuticular waxes; trichomes (uni-and multicellular, glandular and non-glandular, two examples of each); stomata (classification); structure of dicot and monocot leaf, Kranz anatomy

Unit 4: Tissue organisation in root**04 Hours**

Organisation of root apex -Apical cell theory, Histogen theory, Korper - Kappe theory; structure and function of root apex- quiescent centre; root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 5: Vascular Cambium**03 Hours**

Structure (Axially and radially oriented elements); function and seasonal activity of cambium; Secondary growth in root and stem, Cambial variants in secondary growth in stem: Included phloem and Phloem wedges.

Unit 6: Wood and Periderm**04 Hours**

Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Pits and plasmodesmata; Wall ingrowths and transfer cells; Ergastic substances; Development and composition of periderm; rhytidome and lenticels.

Unit 7: Adaptive and Defensive Systems**03 Hours**

Anatomical adaptations of xerophytes and hydrophytes.; Adcrustation and incrustation;

Unit 8: Secretory System**02 Hours**

Hydathodes, cavities, lithocysts and laticifers.

Unit 9: Application of Plant Anatomy**01 hour**

Applications in systematics, plant development, physiology, forensics and pharmacognosy. Dendrochronology and dendroclimatology.

Practicals**60 Hours**

1. Prepare temporary whole mounts/ sections to study organisation of apical meristem of root, shoot and vascular cambium.
2. Distribution and types of parenchyma, collenchyma and sclerenchyma through temporary preparations / digital resources/ permanent slides.
3. Prepare temporary stained mounts (maceration, sections) to observe xylem: tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
4. Study the types and features of wood: ring porous; diffuse porous; tyloses; heartwood and sapwood through specimens, permanent slides and digital resources.

5. Prepare temporary whole mounts/ sections to observe phloem: sieve tubes-sieve plates; companion cells; phloem fibres.
6. Study epidermal system: cell types, stomata types; trichomes: non-glandular and glandular through temporary whole mounts/peels/using enamel.
7. Prepare temporary whole mounts/ sections to study organisation of root: monocot, dicot, secondary growth in roots.
8. Prepare temporary whole mounts/ sections to study organisation of monocot, dicot - primary and secondary growth; phloem wedges in *Bignonia*, included phloem in *Leptadenia/Salvadora*; periderm; lenticels.
9. Prepare temporary whole mounts/ sections to study organisation of leaf: isobilateral, dorsiventral, Kranz anatomy.
10. Study the adaptive anatomy in xerophytes and hydrophytes (two each) through temporary preparations / digital resources/ permanent slides.
11. Study secretory tissues: cavities, lithocysts and laticifers through permanent slides / digital resources.
12. Project: submission of permanent slides

Suggested Reading:

1. Beck, C.B. (2010). Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK, New York, USA.
2. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
3. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
4. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
5. Mauseth, J.D. (1988). Plant Anatomy. The Benjamins/Cummings Publisher, USA.

Additional Resources:

1. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement.
2. Crang, R., Lyons-Sobaski, S., Wise, R. (2018) Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants 1st ed. Springer
3. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA
4. Evert, R.F. (2017) Esau's Plant Anatomy; Meristems, Cells and Tissues Of The Plant Body- Their Structure, Function And Development. 3rd Edn Wiley India.
5. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.
6. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE – 03 Applied Phycology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applied Phycology BOT-DSE-03	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objective:

- To gain knowledge about diversity, life forms, life cycles, morphology and economic importance of algae.

Learning Outcomes:

On completion of the course the students will be able to understand:

- use of algae for environment, human welfare and industries.
- algal culture techniques and their commercial production

Unit 1: Scope of phycology

01 hour

In emerging research areas, environment and industries.

Unit 2: Algae as food, feed and fodder

03 hours

Nutritional value of algae; Common edible algae; Algae as food, feed and fodder with suitable examples.

Unit 3: Algae in industry

06 hours

Phycocolloids (Agar-agar, Alginic acid and Carrageenan) and secondary metabolites: Sources and Applications; Pharmaceutical and Nutraceutical uses of algae; Algae in cosmetics; Diatomaceous Earth.

Unit 4: Algae in agriculture

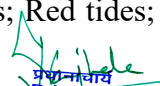
03 hours

Algae as soil conditioners and biofertilizers; Seaweed liquid extract; Seaweed powder; Algal biorefinery residues.

Unit 5: Role of Algae in environment

06 hours

Algae as pollution indicators; wasteland reclamation; Role of algae in wastewater treatment; Ecological importance of Symbiotic associations of algae; Harmful algal blooms; Red tides; Algal toxins.


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Unit 6: Algae in biotechnology and research**05 hours**

Gene sequencing and algal systematics; Algae as a model organism (*Chlamydomonas*, *Chlorella*, *Acetabularia*, *Ectocarpus*, *Porphyra*); Bioluminescent forms; Algae in nanotechnology.

Unit 7: Algae as emerging source of bioenergy**02 hours**

Biofuels (Bioethanol, Biodiesel, Biohydrogen); Algal Biorefinery.

Unit 8: Algal culture techniques and commercial production**04 hours**

Isolation, purification and sterilisation of algae; Freshwater and marine culture media (BG-11 and Provasoli ES medium); Photobioreactors and large-scale production of microalgae; Seaweed farming.

Practicals**60 hours**

1. Isolation and identification of algal species (any three) in water samples from polluted and non-polluted sources through temporary mounts.
2. Nutritional analysis (protein and carbohydrates) of *Spirulina*/ *Chlorella*/ any other available edible algae.
3. Study of algal symbiosis (*Azolla* fronds) through sectioning or tease mount.
4. Phycocolloid (Agar-agar/ Alginates/ Carrageenan) extraction (demonstration/ digital resources).
5. Microalgal culture - maintain cultures of species isolated in Experiment 1 (any three).
6. Commercial applications of algae through photographs/products (edible, cosmetics, biofuels, pharmaceutical, nutraceutical, phyco-remediation).
7. Study of algae as a model organism (any 2) through digital resources.
8. Project work on any applied aspect of algae/ Visit to any Institute or Industry (Report to be submitted).

Suggested Readings:

1. Bold, H.C. and Wynne, M.J. (1985) Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Chapman, D.J. and Chapman, V.J. (1980) Seaweeds and their uses. 3rd edn. British Library.
3. Kumar, H.D. (1999) Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
4. Lee, R.E. (2008) Phycology, 4th edition: Cambridge University Press, Cambridge.
5. Sahoo, D. (2000) Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

Additional Resources:

1. Andersen, R.A. (2005) Algal Culturing Techniques. Elsevier Academic Press.
2. Chapman, D.J. and Chapman, V.J. (1973) The Algae. 2ndedn. Macmillan, London.
3. Fleurence, J. and Levine, I. (2016) Seaweed in Health and Disease Prevention. Academic Press publications.
4. Sahoo, D (2010). Common seaweeds of India. IK International Pvt Ltd.
5. Sahoo, D. and Seckbach, J. (2015) The Algae World. Vol 26 Cellular Origin, Life in Extreme Habitats and Astrobiology. Springer, Dordrecht.
6. Van den Hoek, C. Mann, D.G. and Jahans H.M. (1995) Algae: An Introduction to Phycology. Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 04 Industrial and Environmental Microbiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Industrial and Environmental Microbiology BOT-DSE-04	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To introduce students to the concepts, principles, scope and applications of industrial and environmental microbiology.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

- understand how microbiology is applied in manufacturing of industrial products
- know about design of bioreactors
- understand the rationale in medium formulation, design for microbial fermentation, sterilization of medium and air
- comprehend the techniques and the underlying principles in upstream and downstream processing
- learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection
- understand the basic principles of environment microbiology and application of the same in solving environmental problems - waste water treatment and bioremediation
- comprehend the various methods to determine the quality of water

Unit 1: Microbes and quality of environment

04 hours

Introduction and scope of microbes in industry and environment; Distribution and isolation of microorganisms from soil, air and water.

Unit 2: Bioreactors/Fermenters and fermentation processes

08 hours

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous Fermentations; Components of a typical bioreactor, Types of bioreactors: laboratory, pilot

scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 3: Microbial production of industrial products

10 hours

Microorganisms generally regarded as safe (GRAS); Downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization; Production of industrially important products: enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin)

Unit 4: Microbial enzymes of industrial importance

03 hours

Applications of industrially important enzymes (protease, lipase, and penicillin acylase); Methods of immobilisation and its advantages.

Unit 5: Microbial flora of water

05 hours

Water pollution: various sources and control measures; Role of microbes in sewage and domestic wastewater treatment systems. Microorganisms as indicators of water quality: coliforms and faecal coliforms.

Practicals

60 hours

1. Principles and functioning of instruments: autoclave, laminar air flow, incubators, types of fermenters.
2. Preparation of different culture media (Nutrient medium/ Luria Bertani medium/Potato dextrose medium/Czapek Dox medium).
3. Hydrolysis of casein and starch by microorganisms.
4. Alcohol production by yeast using sugar/ jaggery.
5. Serial dilution method for isolation of microorganisms from water and soil and study of aero-microflora.
6. To determine the BOD of sewage water.
7. To qualitatively check the enzyme activity (phosphatase/amylase/cellulase) in soil samples.
8. To determine the microbial activity in soil by Triphenyltetrazolium chloride (TTC) assay or by measuring the CO₂ evolution.
9. Determination of coliforms in water samples using eosin methylene blue (EMB) medium.
10. Visit to any educational institute/ industry and a report to be submitted

Suggested Readings:

1. Bertrand, Jean-Claude, Caumette, P., Lebaron, P., Matheron, R., Normand, P., Sime• Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications. Amsterdam, Netherlands, Springer.
2. Joe, S., Sukesh (2010). Industrial Microbiology. S.Chand & Company Pvt. Ltd. New Delhi, Delhi.

3. Mohapatra. P.K. (2008). Textbook of Environmental Microbiology. I.K. International Publishing House Pvt.Ltd. New Delhi, Delhi.
4. Okafer, Nduka (2007). Modern Industrial Microbiology & Biotechnology. Science Publishers, Enfield, NH, USA.
5. Pelzar, M.J. Jr., Chan E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. New Delhi, Delhi: McGraw Hill Education Pvt. Ltd., Delhi.

Additional Resources:

1. Alef K, and Nannipieri P (1995). Methods in Applied Soil Microbiology and Biochemistry, First Edition Academic Press, USA.
2. Atlas, Bartha. (1997). Microbial Ecology: Fundamentals and Applications. San Francisco, SF. Pearson.
3. Casida, J.R. (2016). Industrial Microbiology. New Delhi, Delhi, New Age International Publishers.
4. Hurst C.J., Crowford R.L., Garland J.L. and Lipson D.A. (2007). Manual of Environmental Microbiology, American Society of Microbiology, USA.
5. Patel, A.H. (2008). Industrial Microbiology, Bangalore, India: McMillan India Limited.
6. Sharma, P.D. (2005). Environmental Microbiology. Meerut, UP: Alpha Science International, Ltd.
7. Stanbury, P.F., Whitaker, A., Hall, S.J. (2016). Principles of Fermentation Technology. Amsterdam, NDL:Elsevier Publication.
8. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology (9th edition). San Francisco, SF: Pearson Benjamin Cummings.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines BSc Life Sciences – Botany Component

DISCIPLINE SPECIFIC CORE COURSE – 4: Ecology and Evolution

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology and Evolution LS-BOT-DSC-04	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning objectives:

- To understand basic ecological concepts, processes, inter-relation between the living world and abiotic environment.
- To make students understand the basic concept of evolution and natural selection.

Learning outcomes:

- After successful completion of the course the student shall have adequate knowledge about the basic principles of ecology and evolution.

Unit 1: Introduction to fundamental concepts in Ecology 02 hours

Inter-relation between the living world and abiotic environment. Fundamental concepts: Abiotic and biotic components; Levels of ecological organization: species, population, community, ecosystems, biomes.

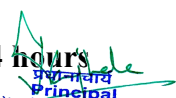
Unit 2: Ecological factors

04 hours

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types; Light, Temperature (Thermal stratification in water bodies and atmosphere) and Wind; Ecological amplitude; Leibig's law of minimum; Shelford law of tolerance.

Unit 3: Population Ecology

04 hours


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Population Characteristics (dispersion, natality, mortality, survivorship curve, age pyramids); growth rates (density-dependent/independent); Interactions: mutualism, symbiosis, commensalism, competition, parasitism, predation, ammensalism, antibiosis.

Unit 4: Plant communities

05 hours

Characters; Ecotone and edge effect; Succession; Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary and secondary)

Unit 5: Ecosystem

05 hours

Structure; niche and habitats; Food chains and food webs, Ecological pyramids production and productivity; energy flow (single channel and Y-shaped); trophic organisation; Biogeochemical cycling; Cycling of nitrogen and Phosphorous

Unit 6: Introduction to Evolution

03 hours

Origin and history of life; Macro and microevolution; Phylogeny and the tree of life.

Unit 7: Evolution of Species

04 hours

Lamarckism and Neo-Lamarckism; Darwinism – selection (natural and artificial), Neo-Darwinism; Species concept and modes of speciation.

Unit 8: Phytogeography

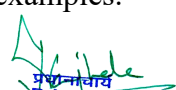
03 hours

Phytogeographical regions of India; Endemism (definition, factors and types).

Practicals

60 hours

1. Principle and operation of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH and detection of carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from atleast two soil samples by rapid field tests.
3. Study of ecological adaptations of hydrophytes and xerophytes (four each).
4. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanch*), Epiphytes (Orchids), Predation (Insectivorous plants).
5. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
7. Study of ecological speciation (allopatric and sympatric) with the help of examples.
8. Study phylogenetic relationships among taxa with the help of exercises.


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9. Construct phylogenetic tree using MEGA and interpret evolutionary relationships.

Suggested Readings:

1. Douglas J. Futuyma (1998). Evolutionary Biology (3rd Edition), Sinauer Associates.
2. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
3. Mark Ridley (2003) Evolution (3rd edition), Blackwell.
4. Odum, E.P. (2005). Fundamentals of Ecology. New Delhi, India: Cengage Learning India Pvt. Ltd., 5th edition.
5. Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Jackson, R. B. (2014). Campbell biology (Vol. 9). Boston: Pearson.

Additional Resources:

1. Rosenbaum, P.E. (2010). Volpe's Understanding Evolution. McGraw-Hill, New York.
2. Schulze, E. D., Beck, E., Müller-Hohenstein, K. (2005). Plant Ecology. Springer Science & Business Media.
3. Singh, J.S., Singh, S.P., Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. New Delhi, India: S. Chand.
4. Smith, R. L., Smith, T. M., Hickman, G. C., Hickman, S. M. (1998). Elements of ecology.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COURSES OFFERED BY DEPARTMENT OF BOTANY
Category III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management

DISCIPLINE SPECIFIC CORE COURSE (DSC 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Plant Pathology ALS BOT DSC 04	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to introduce students with various fungi, fungus like organisms, bacteria and viruses.
- to give an understanding of their characteristics, reproduction and ecology.
- to introduce students with the principles and concepts of plant pathology.
- to acquaint with various plant diseases, symptomatology, causal organisms and their control measures.

Learning Outcomes:

By studying this course, students will be able to:

- understand the world of different types of pathogens of plants.
- identify the characteristic symptoms of different groups of plant pathogens in the fields.
- understand the ecological and economical impact of plant diseases.
- identify common plant diseases and their control measures.
- understand the application and significance of integrated disease management.
- explicate the economic and pathological importance of fungi, bacteria and viruses.

Unit 1: Introduction

3 Hours

Definition, Concepts and Terminology; General symptoms; Classification of diseases.

Unit 2: Key events of Disease development**6 Hours**

Disease cycle; Host pathogen relationships; Plant defence mechanism (Structural and biochemical); Epidemiology and Disease forecasting.

Unit 3: Fungal Diseases**5 Hours**

General symptoms; Disease cycle and Control measures - Powdery mildew of Pea. Black stem Rust of Wheat; Smut of Barley (Loose and Covered smut).

Unit 4: Diseases caused by Oomycota**3 Hours**

General symptoms; Disease cycle and Control measures – White rust of Crucifers; Late blight of Potato.

Unit 5: Bacterial Diseases**3 Hours**

General symptoms; Disease cycle and Control measures - Citrus canker; Angular leaf spot of Cotton.

Unit 6: Viral Diseases**3 Hours**

General symptoms; Mode of transmission and Control measures-- Tobacco mosaic disease; Vein clearing of Bhindi.

Unit 7: Plant Disease Control**7 Hours**

Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Predation, Induced Systemic Resistance).

Practicals**60 Hours**

1. Study of White rust of crucifers, Symptoms on leaves and hypertrophy with the help of live or preserved specimens. Study of causal organism (*Albugocandida*) with the help of temporary tease/section mount. Permanent section mount of somatic and reproductive phases.
2. Study of Late blight of Potato through specimens, temporary mounts (V.S. of leaf showing infection) and permanent slides.
3. Study of Powdery mildew of Pea, Symptoms on leaves and stem of Pea with the help of live or preserved specimens. Study of *Erysiphe* asexual stage with the help of temporary tease/ section mount and sexual stage through permanent slides.
4. Study of Black stem Rust of Wheat, Symptoms on both Wheat and Barberry with the help of live or preserved specimens/photographs. Study of *Puccinia graministritici* with the help of temporary tease/section mount of Wheat . Permanent slides of somatic and reproductive phases on both the hosts.
5. Study of Smut of Barley, Symptoms of Loose and Covered smut through live or preserved specimens. Study of teliospores through temporary mount.
6. Study of Bacterial Diseases through the specimens - Citrus canker; Angular leaf spot of Cotton.

7. Study of Viral Diseases through specimens - Tobacco mosaic Disease; Vein clearing of Bhindi.
8. Study of Phylloplane Mycoflora through cellotape method.
9. Study through digital images / photographs – Chlorosis, Tuber rot, Apple scab, Mycoparasite, Predaceous fungi.

Essential/ Recommended readings:

1. Singh, R.S. (2021). Plant Diseases 10th revised edition, Medtech, New Delhi.
2. Schumann, G.L. and D'Arcy C.J. (2009). Essential Plant Pathology 2nd edition, AmericanPhytopathological Society, U.S.A.
3. Agrios, G.N. (2005). Plant Pathology 5th edition, Elsevier Academic Press, Amsterdam.
4. Oliver, R. (2023). Agrios' Plant Pathology 6th edition, Academic Press.
5. Sharma, P.D. (2014). Plant Pathology Rastogi Publications, Meerut, U.P.

Suggestive readings:

1. Gupta, R. and Chugh, G. (2022). *Plant, Microbes and Diseases*. I.K. International Pvt. Ltd., Delhi.
2. Ownley B.H. and Trigiano R.N. (2016). *Plant Pathology Concepts and Laboratory Exercises* 3rd edition, CRC Press.
3. Singh, R.S. (2017). Introduction to Principles of Plant Pathology, 5th edition, Medtech, New Delhi.
4. Tronsmo A.M., Munk L., Anika D., Tronsmo A., Yuen J and Collinge D.B. (2020). *Plant Pathology and Plant Diseases*. CABI Publishing, U.S.A.

Note:Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**POOL OF DISCIPLINE SPECIFIC CORE
FOR B.SC. PROGRAMME IN APPLIED LIFE SCIENCES WITH
AGROCHEMICALS AND PEST MANAGEMENT**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 02)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Crop Genetics and Plant Breeding ALS BOT DSE 02	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- to develop an understanding of the concepts of plant breeding and its applications.
- to provide adequate knowledge on the natural breeding systems of different agriculturally important plant and strategies employed for crop improvement.
- to impart skills on plant genome analysis and gene mapping using DNA markers and their use in increasing efficiency of plant breeding.
- to understand the genetic basis of hybrid vigour and development of hybrid varieties.
- to make students familiar with the concept of varietal release and rights of a farmer and plant breeder.

Learning Outcome:

By studying this course, the students will be able to:

- gain knowledge on the importance of plant breeding for developing new cultivars and use of breeding strategies for improvement of crop plants.
- understand the concept of gene pool and germplasm resources that are fundamental to crop improvement.

- explicate the breeding methods for commercially important crop plants.

Unit 1: Introduction

(2 Hours)

Importance of plant breeding and its history; Breeding systems in crop plants; Self-incompatibility, male sterility and apomixis, Important achievements in plant breeding.

Unit 2: Sources of Variation

(4 Hours)

Plant genetic resources- their management and conservation, utilization of gene pools in breeding programs. Chromosome manipulation- induced mutations, haploidy, polyploidy, somatic hybridization, somaclonal variation.

Unit 3: Conventional Breeding Methods

(8 Hours)

Selection methods for self-pollinated, cross-pollinated and vegetatively propagated crop plants; Hybridization for self-pollinated, cross-pollinated and vegetatively propagated crop plants-procedure, advantage and limitations.

Unit 4: Heterosis Breeding

(3 Hours)

Genetic and molecular basis of heterosis (hybrid vigour); Development of hybrid varieties through exploitation of hybrid vigour. Inbreeding depression.

Unit 5: Molecular Genetics and Plant Breeding

(10 Hours)

Molecular markers as tools in plant breeding; Principle of genetic linkage; Concept of genetic distance; Development and choice of mapping populations (F₂, NILs, RILs, BC etc); Linkage map construction; Quantitative traits - Principles and methods of QTL mapping, QTL Introgression; Marker-assisted breeding- Gene tagging; Marker-aided selection (foreground and background selection); Elimination of linkage drags; Marker assisted recurrent selection (MARS). Novel Plant Breeding Tools (TALEN's, CRISPR-Cas9, Base editing).

Unit 6: Intellectual Property Rights and Varietal Release

(3 Hours)

IPR, Patenting; Breeder's Right; Release of New Varieties-Trials & their evaluation, Prerelease, Notification and its Release; Plant variety protection; Farmer's Right.

PRACTICAL

(60 Hours)

1. Introduction to open/controlled pollinations in field and laboratory (Breeders kit; temporal details of anthesis, anther dehiscence, CMS, stigma receptivity, emasculation, bagging).

2. Analysis of the breeding system of chosen crop species by calculating pollen:ovule ratio.
3. Calculation of Index of self-incompatibility (ISI).
4. Study of dominant/ codominant nature of different molecular markers.
5. Assessment of phenotypic diversity in different accessions of given plant material using morphological markers.
6. Assessment of genetic diversity and construction of dendrogram using molecular markers.
7. Phenotypic screening of a mapping population/ land races for biotic stress resistance and calculating the log of percentage severity and symptom score.
8. Study of floral biology, emasculation and hybridization techniques in self-pollinated and cross-pollinated crops.
9. Estimation of heterosis, inbreeding depression and heritability.
10. Project: Case study based on gene mapping.
11. Field trip to plant breeding station.

Essential/recommended readings

1. Acquaah, G. (2012). *Principles of Plant Genetics & Breeding*. 2nd edition. Hoboken, NJ, Wiley.
2. Allard, R.W. (1999). *Principles of Plant Breeding*. John Wiley, New York.
3. Singh, B.D. (2022). *Plant Breeding: Principles and Methods*, 12th edition. New Delhi, Delhi: Kalyani Publishers.
4. Frey, K. J. (1982). *Plant Breeding II*. Kalyani Publishers, New Delhi.

Suggestive readings:

1. Chopra, V.L. (2023). *Plant Breeding: Theory and Practice* 2nd Restructured Edition, New India Publishing Agency, New Delhi.
2. Poehlman J. M. and Sleper D. A. (1995). *Breeding Field Crops*, 4th Ed. Panima Publishing Corporation, New Delhi.
3. Welsh, J. R. (1981). *Fundamentals of Plant Genetics and Breeding*. John Wiley and Sons, New York.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE (BOT-GE-16)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Health & Disease Diagnostics BOT-GE-16	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- understand the challenges and importance of plant pathogen diagnosis
- understand methods for reducing/minimizing risk of the spread of pathogens and pests.
- understand principles and tools for early warning systems to protect plant health.

Learning Outcomes:

At the end of this course, students will be able to:

- diagnose the cause of a plant disease and identify the causal agent
- select appropriate methods and strategy for control and mitigate spread.

Unit 1: Introduction to Plant Diseases

04 Hours

Definition; History of Plant Pathology, Concept and basic components of disease; Causes and classification of diseases; Disease cycle; Significance of plant diseases.

Unit 2: Plant Disease Diagnosis

06 Hours

Koch's Postulates; Plant disease symptoms and types (Necrosis, Hypertrophy and Hyperplasia, Hypoplasia); General symptoms of viral, bacterial and fungal plant diseases; Methods of plant disease diagnosis- Histochemical, Serological and PCR techniques.

Unit 3: Plant Disease Epidemiology

05 Hours

Epidemics and factors affecting the development of epidemics; Epidemic assessment and Disease forecasting; Tools of epidemiology geographic information system (GIS), Global Positioning System (GPS), Geostatistics, Remote sensing.

Unit 4: Plant Diseases

11 hours

Causal organism, symptoms, disease cycle and management of the plant disease caused by bacteria, virus and fungi: Tobacco Mosaic, Yellow Vein mosaic of Bhendi, Citrus Canker, Angular leaf spot of Cotton, White rust of crucifers, Late & early blight of potato, Rust of wheat, Smut of Cereals.

Unit 5: Management of Plant Diseases

04 Hours

Concept of integrated disease management (IDM); strategies for IDM- regulatory, cultural, physical, chemical and biological.

Practicals

60 hours

1. Preparation of Fungal Medium (Potato Dextrose Agar | Czapek Dox), Study of Instruments (Laminar Air flow, Autoclave, Incubator) & sterilization techniques.
2. Isolation pathogen from an infected plant sample.
3. Symptoms of Citrus canker and Angular leaf spot of Cotton through specimens / photograph.
4. Powdery mildew of pea: Symptoms and study of asexual and sexual stage of causal organism (*Erysiphe polygoni*) with the help of temporary tease /section/permanent slides.
5. Symptoms of Tobacco Mosaic Virus and Yellow Vein Mosaic of Binde through specimens / photographs.
6. White Rust of Crucifers - Symptoms and study of asexual and sexual stages of *Albugo candida* from tease /section/permanent slides.
7. Late blight of potato. Symptoms
8. Early blight of potato - Symptoms and study of asexual stage of *Alternaria solani* through temporary tease mounts
9. Black stem rust of wheat: Symptoms on both wheat and barberry. Types of spores of *Puccinia gormanistrutici* wheat and barberry by temporary tease/section mount /permanent slides.
10. Symptoms of Loose and covered smuts of barley.

Suggested Readings:

1. Cooke, B.M., Jones, D.G., Kaye, B. (2007) The Epidemiology of Plant Diseases, 2nd ed. Springer.
2. Madden, L.V., Hughes, G. and Bosch, F van den (2017). The Study of Plant Disease Epidemics, APS Publications.
3. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi and their Allies. (2nd Edition), Medtech Publishers, Delhi.
4. Sharma, P.D. (2014). Plant Pathology. Rastogi Publications, Meerut.
5. Singh R.S. (2018). Plant Diseases. 10th Edition Medtech, New De

Additional Resources:

1. Agrios G.N. (2005). Plant Pathology. 5th Edition, Elsevier.
2. Gupta, V.K. and Sharma, R.C. (2020) Integrated Disease Management and Plant Health, Scientific Publishers, India
3. Kapoor, A.S. and Banyal, D.K. (2012). Plant Disease Epidemiology and Management, AbeBooks.

GENERIC ELECTIVE (BOT-GE-17)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Environmental Monitoring and Ecosystem Restoration BOT-GE-17	4	2	0	2	Class XII pass with science	Nil

Learning Objectives:

- The course will train students on methods for conducting environmental monitoring protocols.
- It will provide experiential learning in conducting quality check experiments on soil, water and air.
- The course will develop understanding on different aspects of ecosystem restoration and processes through monitoring system.

Learning Outcomes:

At the end of this course, students will be able to:

- understand the problem of environmental degradation
- assessment of quantitative and qualitative parameters used in environmental monitoring of air, soil and water.
- understand the strategies and methods for ecosystem restoration, including physico-chemical and biological indicators.
- understand degraded and restored sites through field visits.

Unit 1: Introduction

03 Hours

Ecosystem degradation, Magnitude/ Scale of degradation (National and Global Scenario); influence of climate change in Ecosystem degradation (extreme and erratic natural events)

Unit 2: Factors of environmental degradation

03 Hours

Factors responsible for degradation of soil, water, air and loss of biodiversity; natural and anthropogenic-forest fires, landslides, floods, deforestation, overgrazing, soil erosion, mining, landfills, etc.

Unit 3: Ecosystem Restoration

06 Hours

Definition; UN decade on Ecosystem Restoration; Bradshaw's Concept: Restoration, Rehabilitation and Reclamation (replacement); Role of Sustainable Development Goals (SDGs), REDD+, Joint Forest Management; Relevance for people, nature and climate.

Unit 4: Environment Monitoring

09 Hours

Indicators of land degradation: Soil- alkalinity, salinity, organic carbon and soil health; Water- pH, Hardness, BOD, COD and Heavy metals content; Air- PM 10 , PM 2.5 , SO₂ , NO_x, ozone), Air Quality Index (AQI); Bioindicators/ Biomonitors (plants, animals and microbes).

Unit 5: Role of Plants and Microbes in Ecosystem Restoration

09 Hours

Brief account of remediation technologies: bioremediation, phytoremediation (phytoextraction, rhizofiltration, phytovolatilization, phytostabilization etc); Role of associations of Grasses-AMF, Legumes-Rhizobium in restoring degraded land/ mined out areas; Role of macrophytes in wetland restoration; Role of green spaces including parklands and avenue plantations in amelioration of air quality.

Practicals

60 hours

1. Field visit to degraded ecosystem/ natural ecosystem/restored ecosystem.
2. Analyze the soil and water samples from polluted and unpolluted sites for their pH
3. Analyze carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field tests in soil samples from degraded and healthy sites.
4. Determine the organic matter in soil samples by Walkley and Black's rapid titration method.
5. Determine the dissolved oxygen of water samples of polluted and nonpolluted sites by Winkler's method.
6. Determine the BOD and COD content of water samples of polluted and nonpolluted sites.
7. To collect, collate and analyze Air Quality Index (AQI) data, Water Quality data of various locations from DPCC/CPCB website collected from real-time monitoring stations.
8. Study of bioindicators (plant, animal and microbes).

Suggested Readings:

1. Bagyaraj, D.J. and Jamaluddin (2016) Microbes for Restoration of Degraded Ecosystems, New India Publishing Agency
2. Majumdar R., Kashyap R (2020). Practical Manual of Ecology and Environmental Science, Prestige
3. Ricklefs, R. E., Miller, G. L., (2000). Ecology, 4th edition W.H. Freeman.
4. Sharma, P. D. (2017). Ecology and Environment, 13th Edition. Meerut: Rastogi Publications.
5. Smith, T. M., Smith, R. L. (2012). Elements of Ecology 8th Edition. Pearson.

Additional Resources:

1. Central Pollution Control Board (CPCB) Air and Water: <https://cpcb.nic.in/real-time-data/>
2. Managing Ecosystems in The Context of Climate Change Mitigation: A review of current knowledge and recommendations to support ecosystem-based mitigation actions that look beyond terrestrial forests <https://www.cbd.int/doc/publications/cbd-ts-86-en.pdf>
3. National Clean Air Programme (NCAP) 2018. https://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf
4. Real Time Ambient Air Quality Data (DPCC). <https://www.dpccairdata.com/dpccairdata/display/index.php>
5. Restoration for People, Nature and Climate, <https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf>
6. Champion, H. G., and S. K. Seth. A revised classification of forest types of India. Manager Publication, Government of India, Delhi (1968).

Note:Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER-V

BSC. (HONS.) BOTANY

DISCIPLINE SPECIFIC CORE COURSE – 13: Molecular Biology of the Cell

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Biology of the Cell – DSC 13	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objective:

- To gain comprehensive knowledge about of genetic material, central dogma, genetic code, DNA replication, transcription, modification of transcript, translation and regulation of gene expression.

Learning Outcomes: At the end of this course the student will understand:

1. structure and function of nucleic acids at molecular level.
2. the concept of central dogma and genetic code.
3. molecular details of DNA replication and its types.
4. cellular processes of transcription and translation including modification of transcripts and polypeptides/proteins
5. mechanisms regulating gene expression.

Unit 1: Nucleic acids as carriers of genetic information

02 Hours

Discovery of nucleic acids, Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod & McCarty, and Fraenkel-Conrat's experiment.

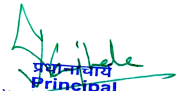
Unit 2: Structure and organisation of the genetic material

03 Hours

DNA double helix structure (Chargaff's rule; Watson and Crick model); salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation (only melting profile- T_m), types of RNA (mRNA, rRNA, tRNA, small RNAs). split genes (Phillip Sharp)

Unit 3: Central Dogma and Genetic Code

04 Hours


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Beadle and Tatum's one gene one enzyme hypothesis; The Central Dogma, Genetic code and its salient features, Experiments for deciphering Genetic code (Experiments by Nirenberg & Matthaei, and Har Gobind Khorana). Adaptor hypothesis by Crick; Baltimore and Temin's discovery of reverse transcription

Unit 4: Replication of DNA

06 Hours

Delbruck's Dispersive mechanism model; Bloch and Butler's conservative replication model; Messelson and Stahl's semi-conservative replication model; Mechanism - initiation, elongation and termination; Enzymes and other proteins involved in DNA replication; General principles – bidirectional, semiconservative and semi-discontinuous replication (Replisome), RNA priming (Primase & Primosome); Various modes of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear dsDNA. Replication of the 5' end of linear chromosome (end-replication problem & Telomerase).

Unit 5: Mechanism of Transcription

05 Hours

Transcription process in prokaryotes (Initiation, Elongation and Termination); structure and function of RNA polymerase enzyme; concept of promoters and transcription factors; comparison between prokaryotic and eukaryotic transcription; concept of post-transcriptional modifications (introduction to eukaryotic mRNA processing: 5' capping; Splicing and alternative splicing; 3' poly A tailing).

Unit 6: Mechanism of Translation

05 Hours

Translation in prokaryotes: Initiation, Elongation and Termination; concept of charging of tRNA and role of aminoacyl synthetases; ribosome structure and assembly (prokaryotes and eukaryotes); comparison between prokaryotic and eukaryotic translation; post-translational modifications (phosphorylation, glycosylation).

Unit 7: Gene Regulation

05 Hours

Gene regulation in prokaryotes: Operon concept; inducible & repressible systems; regulation of lactose metabolism in *E. coli* (inducible system, positive & negative control); regulation of tryptophan synthesis (Repression-De-repression and concept of Attenuation) in *E. coli*. Gene regulation in eukaryotes: concept of gene silencing by DNA methylation and RNA interference.

Practicals

60 hours

1. Isolation of plasmid and genomic DNA from *E. coli* and quantification using agarose gel electrophoresis
2. Isolation of genomic DNA from plant samples (atleast two different genera / species) using CTAB method and quantification using agarose gel electrophoresis
3. Quantification of unknown DNA by diphenylamine reagent (colorimetry).

4. To estimate the generation time of *Escherichia coli* (prokaryote) and budding yeast (eukaryote) by spectrophotometric measurement and plotting growth curve as an indirect method to study DNA replication
5. To study control of replication in budding yeast with the help of specific inhibitors (beta-lactams:-Clavulanic acid, Ceftazidime, Piperacillin, Ceftriaxone etc) and studying budding frequency.
6. To study control of transcription in *Escherichia coli* with the help of prokaryotic (Rifampicin) and eukaryotic (Actinomycin-D) transcription inhibitors and plotting growth curve
7. To study control of translation in *Escherichia coli* with the help of prokaryotic (Kanamycin / Streptomycin) inhibitors using an IPTG-inducible system.
8. To understand the regulation of lactose (*lac*) operon (positive & negative regulation) and tryptophan (*trp*) operon (Repression and De-repression & Attenuation) through digital resources/data sets.

Suggestive readings:

1. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, & Darrell Killian (2019). Concepts of Genetics. Pearson; 12th edition.
2. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
3. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics. John Wiley, 7th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

Additional Resources:

1. Griffiths, A.J.F., John Doebley J., Peichel, C., Wassarman D.A. (2020). Introduction to Genetic Analysis. W H Freeman & Co; 12th edition
2. Micklos D A., Freyer G.A. (2003) DNA Science: A First Course (2nd Edition), Cold Spring Harbor Laboratory; Greg A., CSHL Press, USA

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 14: Reproductive Biology of Angiosperms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Reproductive Biology of Angiosperms – DSC 14	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To understand the scope of reproductive biology, development and structure of male and female reproductive units of the flower, organization of male and female gametophytes, pre-fertilization, fertilization and post-fertilization events.
- To understand the processes and significance of pollen--pistil interactions, apomixis and polyembryony.
- Significance of seed as a diaspore.

Learning Outcomes:

Upon completion of the course, the students will become familiar with:

- The significance and scope of reproductive biological studies in crop production and conservation. Structure and function of anther and ovule, male and female gametophyte.
- The significance of associations of MGU, FGU and double fertilization; embryo and endosperm development, genomic imprinting.
- Pollination and seed dispersal mechanisms, apomixis and polyembryony as alternate pathways of angiosperm reproduction.
- Experiential learning through field trips, scientific photography, videography and documentary preparation. The students will also learn to write scientific reports and present scientific data.

Unit 1: Introduction

01 Hour

Introduction about Reproductive biology and its scope; significant contributors to the field; structure of flower.

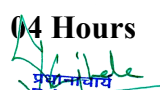
Unit 2: Anther and Pollen

05 Hours

Anther wall: Structure and functions, microsporogenesis, microgametogenesis; Pollen wall: Structure and functions, Number Position Character (NPC), pollen viability and storage, Male Germ Unit (MGU) – structure and significance.

Unit 3: Pistil

04 Hours


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General structure and types of pistil and ovules; megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac; cell specification; Female Germ Unit – structure and significance.

Unit 4: Pollination

04 Hours

Types (Self, cross, geitonogamy, xenogamy), significance; Structure of the stigma and style; Pollen-pistil interactions- capture, adhesion, hydration, pollen tube penetration; Path of pollen tube in the pistil; Role of synergids in pollen tube attraction; Double fertilization; Polytubey block

Unit 5: Self-Incompatibility

04 Hours

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility (in brief): mixed-pollination, intraovarian and in vitro pollination and fertilization, modification of stigma surface, parasexual hybridization.

Unit 6: Endosperm

02 Hours

Types (2 examples each), development, structure and functions; Genomic imprinting

Unit 7: Embryo

04 Hours

General pattern and comparison of development of dicot and monocot embryo (initial apical cell and basal cell polarity, globular embryo with radial polarity, mature embryo); Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo, haustorial systems: Embryo patterning.

Unit 8: Seed

02 Hours

Structure and importance of seed as diaspore, as storage organ; germination and seedling formation.

Units 9: Polyembryony and apomixis

02 Hours

Introduction, types, causes and applications.

Unit 10. Applications of Reproductive biology

02 Hours

Haploid embryos - concept and significance; crop productivity, conservation

Practicals

60 hours

- Anther: Wall and its ontogeny, tapetum (amoeboid and glandular), Microspore mother cell, spore tetrads, uninucleate, bicelled and dehiscent anther; Temporary stained mounts of T.S. anther to study the organization.
- Pollen: General morphology, pseudomonads, polyads, pollinia (slides/digital resources, fresh material); Ultrastructure of pollen wall (micrograph); Pollen viability: tetrazolium test/FDA; Germination: calculation of percentage germination in different media using hanging drop/sitting method.
- Temporary mounts of pollen grains cleared with 1N HCl/KOH to study germ pores; Ultrastructure of male germ unit (MGU) through micrographs.

- Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; tenuinucellate and crassinucellate; Special structures: endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/digital resources).
Female gametophyte: developmental sequence of monosporic embryo sac only; Ultrastructure of Female Germ Unit.
- Pollination: Adaptations; bagging experiment; **project on pollination.
- Intra-ovarian pollination; Test tube pollination (through digital resources).
- Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
- Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.
- Seed dispersal mechanisms (adaptations through live specimens), **project on seed dispersal

** The projects can be on pollination/ seed dispersal or on any other topic based on the syllabus. It can be a write-up with visuals. The students can also make a digital project submission in the form of a documentary of 5-10 min.

Suggested Readings:

- Bhojwani S.S., Bhatnagar S.P. & Dantu P.K. (2015). The Embryology of Angiosperms, 6th Edition. By VIKAS PUBLISHING HOUSE. ISBN: 978-93259-8129-4.
- P. Maheshwari, (2004). An introduction to the embryology of Angiosperms. Tata McGraw-Hill Edition, ISBN: 0-07-099434-X.
- Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag. ISBN: 13:978-3-642-69304-5
- Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer. ISBN: 978-1-4612-7054-6.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Mangla, Y., Khanduri, P., Gupta, C.K. 2022. Reproductive Biology of Angiosperms: Concepts and Methods. Cambridge University Press ISBN 978-1-009-16040-7.
- Tandon R, Shivanna KR, Koul M Reproductive Ecology of Flowering Plants: Patterns and Processes 1st ed. 2020 Edition ISBN 978-9811542091. Springer Verlag
- Kapoor, R., Kaur, I. Koul M. 2016. Plant Reproductive Biology and Conservation IK International Publishing House Ltd. India ISBN: 9789382332909

Additional Resources:

- Shivanna, K.R., Tandon, R. (2020). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
- Shivanna, K. R., & Rangaswamy, N. S. (2012). *Pollen biology: a laboratory manual*. Springer Science & Business Media.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 15: Plant Physiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Physiology – DSC 15	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning objective:

- To introduce the basic principles of plant structure and function and its application in related fields.

Learning outcomes: On completion of the course the students will be able to:

- understand the structure and function of plants
- comprehend and compare various tissue systems in plants and their role
- realise the importance of water, soil and atmosphere in the life of organisms
- appreciate the ability of plants to sense the environment and adapt
- interpret and evaluate the significance of regulator molecules in controlling life forms
- apply the principles of plant physiology to solve problems in related fields

Unit 1: Plant-water relations

04 Hours

Water potential and its components, water absorption by roots, water movement via symplast, apoplast and aquaporins, root pressure, guttation, ascent of sap, cohesion-tension theory, transpiration, factors affecting transpiration, anti-transpirants

Unit 2: Mineral nutrition

04 Hours

Essential and beneficial elements, macro- and micro-elements, criteria for essentiality, roles of essential elements, chelating agents, phytosiderophores, mineral nutrition in hydroponics and aeroponics.

Unit 3: Nutrient uptake

05 Hours

Transport of ions across cell membrane, passive absorption, simple and facilitated diffusion (carrier and channel proteins), Fick's law, active absorption, proton ATPase pump, electrochemical gradient, ion flux, uniport, co-transport (symport, antiport)

Unit 4: Translocation in the phloem

03 Hours

Composition of phloem sap, phloem loading and unloading, Pressure-Flow Model, source-sink relationship

Unit 5: Plant growth regulators**08 Hours**

Chemical nature (basic structure, precursor), physiological roles, bioassays and applications of Auxins, Gibberellins, Cytokinins, Abscissic Acid, Ethylene; Other growth regulators - Jasmonic Acid, Brassinosteroids, Nitric Oxide. Mechanism of action of Auxin. Introduction to interactions among plant growth regulators.

Unit 6: Physiology of photo-sensory molecules**03 Hours**

Discovery, chemical nature, mode of action and role of phytochrome, cryptochrome and phototropin in photomorphogenesis

Unit 7: Physiology of flowering**02 Hours**

Concept of florigen, photoperiodism, CO-FT Model of flowering, vernalization.

Unit 8: Seed dormancy**01 hour**

Seed dormancy -causes and methods to induce and/or overcome dormancy

Practicals**60 Hours**

9. Determination of osmotic potential of plant cell sap by plasmolytic method.
10. Determination of water potential of potato tuber cells by weight method.
11. Determination of water potential of potato tuber cells by falling drop method.
12. Study of effect of light on the rate of transpiration in excised leafy twig.
13. Calculation of stomatal index and stomatal frequency from the lower surface of leaves of a mesophyte and a xerophyte.
14. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and a xerophyte (lower surface).
15. To study the effect of different concentrations of ABA on stomatal closure.
16. To study the effect of light and dark on seed germination.
17. To study induction of amylase activity in germinating barley grains.
18. To study the effect of ethylene on fruit ripening.
19. To study the effect of auxin on rooting.

Suggested Readings:

6. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
7. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development, 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
8. Kochhar, S.L., Gujral, S.K. (2020). Plant Physiology: Theory and Applications. New Delhi, Delhi: Foundation Books, 2ndEdn. Cambridge University Press India Pvt, Ltd.

Additional Resources:

- Bajracharya, D. (1999). Experiments in Plant Physiology: A Laboratory Manual. New Delhi, Delhi: Narosa Publishing House.
- Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer Nature, Singapore Pvt. Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVES (BOT-DSE-05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Pathology BOT-DSE-05	4	2	0	2	Class XII pass with Biology/ Biotechnology	

Learning Objectives:

- To introduce students with the phytopathology, its concepts and principles\
- To acquaint with various plant diseases, causal organisms and their control

Learning Outcomes: Upon completion of this course, the students will be able to:

- Understand the economic and pathological importance of fungi, bacteria and viruses
- Identify common plant diseases and their control measures

Unit 1: Introduction

03 Hours

Definition of disease and its components (disease pyramid); Classification of diseases (on the basis of pathogens; geographical distribution; extent of occurrence); History and significance of Phytopathology (with special reference to India); Eminent plant pathologists and their contributions (Anton de Bary; E.J. Butler; Louis Pasteur; PMA Millardet; E.F. Smith; Adolf Mayer; K.C. Mehta, J.F. Dastur ; B.B. Mundkur; R.N. Tandon).

Unit 2: Basic concepts of Plant Pathology

04 Hours

Definitions (Pathogenesis; Pathogen; symptoms; etiology); Types of pathogens and their Symptoms (Fungus, Oomycetes, Bacteria, Virus, Nematode, Phytoplasma); Koch's Postulates; Disease cycle (Components) - Epidemiology and forecasting of Plant diseases.

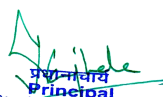
Unit 3: Host- -Pathogen relationship

04 Hours

How pathogens attack plants (brief concept on mode of penetration; post-penetration and colonization). Plant defence mechanisms (Constitutive and induced, structural and biochemical).

Unit 4: Fungal diseases

05 Hours


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Causal Organism, Symptoms, Disease Cycle and control: Powdery mildew of Pea; Ergot of Rye; Apple scab, Early blight of potato, red rot of sugarcane, Black, Yellow and Brown rust of Wheat; Smut of Barley (Loose and Covered Smut).

Unit 5: Oomycete Diseases

02 Hours

Causal organism, symptoms, disease cycle and control: Late Blight of Potato; White Rust of Crucifers; Downy mildew of Grapes.

Unit 6: Bacterial Diseases

01 Hours

General symptoms; Disease cycle and Control measures - Citrus canker; Angular leaf spot of Cotton.

Unit 7: Viral Diseases

01 Hours

General symptoms; Mode of transmission and Control measures-Tobacco mosaic disease; Vein Clearing of Bhindi

Unit 8: Nematode Diseases

01 Hours

General symptoms, Disease cycle and Control measures-Root knot disease of Brinjal.

Unit 9: Plant Disease Control

07 Hours

Plant quarantine and its significance; Methods of disease control: Physical (Heat treatment, drying, radiation and regeneration); Chemical methods (foliar spray; dust, seed treatment; soil treatment; treatment of wounds). Types of fungicides - Inorganic (Bordeaux mixture, Fixed copper; Sulphur, Lime Sulphur); Organic (Dithiocarbamates, quinones); Systemic fungicides and their mode of action (Oxanthin, Strobilurins, Benzimidazole, Pyrimidine). Cultural practices (Host eradication, sanitation, crop rotation, Polythene traps, Mulches) Biological Control (Antibiosis, hyper - parasitism, Hypovirulence, Predation, Induced systemic Resistance).

Unit 8: Plant Disease Control

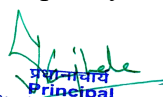
02 Hours

Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Hypovirulence, Predation, Induced Systemic Resistance).

Practicals

60 hours

4. Study of Late blight of Potato through specimens, temporary mounts (V.S. of leaf showing infection) and permanent slides.
5. Study of Black stem Rust of Wheat: Symptoms on wheat and barberry. Observe uredospores and teleutospores on V.S. wheat leaf/ to study stem spore stages of *Puccinia graministritici* with the help of temporary tease/section mount of wheat. Permanent slides of somatic and reproductive phases on both the hosts.
6. Study of smut of barley, symptoms of loose and covered smut and temporary spore mount.
7. Study of Powdery mildew of pea, Symptoms with the help of live or preserved specimens. Study of *Erysiphe* asexual and sexual stages with the help of temporary tease/section mount/ permanent slides.
8. Study of symptoms of Red rot of sugarcane, W.M. of conidia through temporary tease mount.


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9. Study symptoms of bacterial diseases: Citrus canker, Angular leaf spot of Cotton.
10. Study symptoms of viral diseases: Tobacco mosaic Disease, Vein clearing of *Abelmoschus esculentus*/*Ageratum* sp.
11. Study of nematode diseases: Root knot disease of Brinjal.
12. Isolation of seed borne mycoflora by moist chamber method technique.
13. Study of biocontrol agents: Nematophagous fungi; *Trichoderma* sp.
14. The students should submit specimens of any two plant diseases studied by them.

Suggested Readings:

7. Agrios, G.N. (2005) *Plant Pathology* 5 th edition: Elsevier Academic Press, Amesterdam.
8. Sharma, P.D. (2014) *Plant Pathology* Rastogi Publications, Meerut, U.P.
9. Singh, R.S. (2018) *Plant Diseases*. 10th Edition Medtech, New Delhi.

Additional Readings:

- Ownley, Bonnie and Trigiano, Robert N. (2017). *Plant Pathology: Concepts and Laboratory Exercises*, 3rd Edition, CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (BOT-DSE-06)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Natural Resource Management BOT-DSE-06	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- Natural Resources are materials from earth which support life and significantly meet the needs of people. The paper aims to describe the different types of natural resources and their management. Students will study about the importance of each natural resource and how and why they are threatened in current times. They will also be taught about sustainably using our resources

Learning outcomes: At the end of this course, students will be able to:

13. understand the different resources available in nature
14. learn the importance of each resource along with the threats to these resources
15. gain an in-depth understanding of management of these resources and also restoration of natural ecosystems
16. study the importance of sustainable practices
17. gain an insight into various initiatives taken the world over to save our natural resources.
18. understand the concept of clean energy and management of waste

Unit 1: Natural Resources

01 Hours

Definition, fundamental concepts and types

Unit 2: Sustainable Utilization

04 Hours

Concept, goals, approaches (economic, ecological, socio-cultural)

Unit 3: Land Resources

06 Hours

Forests (definition, threats, management); Agricultural practices and their impact; Soil degradation (causes, management and remediation/restoration strategies)

Unit 4: Water Resources

04 Hours


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Freshwater, Marine, Estuarine, Wetlands – Threats and Management

Unit 5: Biological Resources

03 Hours

Biodiversity – Levels, Significance, Threats, Management

Unit 6: Energy

02 Hours

Clean energy strategies – Solar, Wind, Hydro, Tidal, Geo-thermal, Bio-energy

Unit 7: Climate Change

04 Hours

Impact, adaptation and mitigation (Land, Soil, Water, Biodiversity, Air)

Unit 8: Contemporary practices

04 Hours

EIA, GIS, Energy Audits, Waste Management, Ecosystem Restoration, Carbon footprint

Unit 9: National and International Initiatives

02 Hours

International Solar Alliance; Ramsar Convention; Basel Convention; Carbon Neutral Goals; Net-zero Coalition; Clean Development Mechanism; CAMPA (Compensatory Afforestation Fund Management and Planning Authority); Carbon Credits; REDD+ project, Renewable Energy Certificates

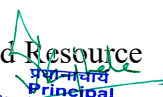
Practicals

60 hours

5. Comparison of pH (pH meter) and salinity (Electrical Conductivity) of various soil samples.
6. Comparison of field capacity of various soil samples.
7. Comparison of pH (pH meter) and TDS (TDS meter) of various water samples.
8. Comparison of salinity (titrimetric method) of various water samples.
9. Calculation and comparison of BOD and COD of various water samples from given data.
10. Comparison of species diversity in various communities by Shannon-Wiener Index.
11. Measurement of dominance of woody species by DBH method in the college campus.
12. Project (any one of the following):
 6. Rainwater harvesting (site visit)
 7. Ecological restoration (site visit)
 8. Energy audit
 9. Seed germination and seedling growth in garden and contaminated soils
 10. Composting
 11. Any other
13. Field visit/s to any degraded ecosystem (landfill, polluted water body, invaded forest) or any ongoing restoration project site.

Suggestive readings:

- Vasudevan, N. (2006). Essentials of Environmental Science. New Delhi, India: Narosa Publishing House.
- Singh, J. S., Singh, S.P. and Gupta, S.R. (2006). Ecology, Environment and Resource


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Conservation. New Delhi, India: Anamaya Publications.

- Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. New Delhi, India: Prentice Hall of India Private Limited.

Additional resource:

10. <https://moef.gov.in/en/division/forest-divisions-2/campa/compensatory-afforestation-fund-management-and-planning-authority-campa/>
11. <https://www.un.org/en/climatechange/net-zero-coalition>
12. <https://www.recregistryindia.nic.in/>
13. <https://static.investindia.gov.in/National%20Policy%20on%20Biofuels.pdf>
14. <https://cri.nccf.in/>
15. <https://www.investindia.gov.in/team-india-blogs/carbon-financing-india>
16. <https://www.un-redd.org/>
17. Ecosystem Restoration for People, Nature and Climate <https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf>
18. Managing Ecosystems In The Context Of Climate Change Mitigation: A review of current knowledge and recommendations to support ecosystem-based mitigation actions that look beyond terrestrial forests <https://www.cbd.int/doc/publications/cbd-ts-86-en.pdf>
19. Jordan III, W. R., Gilpin, M. E., Aber, J. D. (1987). Restoration Ecology: a synthetic approach to ecological research. Cambridge, Great Britain: Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COURSES OFFERED BY DEPARTMENT OF BOTANY

Category II

**Botany Courses for Undergraduate Programme of study with Botany as one of the
Core Disciplines
(B.Sc. Life Sciences with Botany as one of the Core discipline)**

DISCIPLINE SPECIFIC CORE (LS-BOT-DSC-05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Physiology and Metabolism LS-BOT-DSC-05	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

4. To make students realize how plants function, the importance of water, minerals, phytohormones, and role of light in plant growth and development;
5. To understand mechanisms of carbon assimilation, nitrogen metabolism, phloem transport and translocation.

Learning Outcomes: At the end of this course, students will be able to:

- correlate physiological and metabolic processes with functioning of the plants.
- establish the link between theoretical principles and experimental evidence.

Unit 1: Plant-water relations

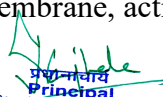
03 hours

Water potential and its components, pathway of water movement, ascent of sap (include root pressure and guttation), transpiration and its significance, stomatal movements – only ion theory.

Unit 2: Mineral nutrition

03 hours

Classification of mineral elements: Essential elements (macro- and micronutrients) and beneficial elements, General role of essential elements, transport of ions across membrane, active and passive transport (brief account of carriers, channels and pumps).


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Unit 3: Translocation in phloem**02 hours**

Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 4: Plant growth regulators**04 hours**

Physiological roles and bioassays of auxins, gibberellins, cytokinins, ethylene and ABA.

Unit 5: Plant response to light and temperature**02 hours**

Photoperiodism - discovery (SDP, LDP, day neutral plants), concept of florigen; phytochrome (discovery and physiological role), vernalization.

Unit 6: Enzymes**02 hours**

Classification, Structure and properties, mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Carbon metabolism**06 hours**

Photosynthetic pigments (chlorophyll *a* and chlorophyll *b*, xanthophyll, carotene); photosystem I and II, Light reactions (electron transport and photophosphorylation), Dark reactions: C₃ pathway; C₄ and CAM pathways (no chemical structures); photorespiration. Metabolite pool and exchange of metabolites, synthesis and degradation of sucrose and starch.

Unit 8: Respiration**02 hours**

Basic differences in animal and plant respiration, Cyanide resistant respiration.

Unit 9: Nitrogen metabolism**04 hours**

Nitrate assimilation (NR and NiR), biological nitrogen fixation in legumes (nodulation and role of dinitrogenase) Ammonia assimilation: GS-GOGAT, reductive amination and transamination.

Unit 10: Stress physiology in plants**02 hours**

ROS, RNS and anti-oxidative defence strategies.

Practicals**60 hours**

- Determination of osmotic potential of plant cell sap by plasmolytic method.
 - To study the effect of the environmental factor light on transpiration by excised twig.
 - Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
 - To study the activity of catalase and study the effect of pH on the activity of enzyme.
 - To Study Hill's reaction.
 - To study the effect of light intensity on O₂ evolution in photosynthesis.
 - Comparison of the rate of respiration in any two parts of a plant.
 - To separate photosynthetic pigments by paper chromatography.
 - Bolting / Effect of auxins on rooting.
 - To demonstrate the delay of senescence by cytokinins/ effect of ethylene on fruit ripening
20. To study the phenomenon of seed germination (effect of light and darkness).
21. To demonstrate Respiratory Quotient (RQ)

Suggested Readings:

- Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development, International 6th edition, Oxford University Press, Sinauer Associates, New York, USA.
- Bajracharya, D. (1999). Experiments in Plant Physiology: A Laboratory Manual, Narosa Publishing House, New Delhi.
- Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition, Wiley India Pvt. Ltd, New Delhi.

Additional Resources:

- Jones, R., Ougham, H., Thomas, H., Waaland, S. (2013). *The molecular life of plants*. Chichester, England: Wiley-Blackwell.
- Kochhar, S.L. & Gujral, S.K. 2020. Plant Physiology: Theory and Applications, 2nd Edition. Cambridge University Press, UK.
- Bhatla, S.C., Lal, M.A. (2018). *Plant Physiology, Development and Metabolism*. Singapore: Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COURSES OFFERED BY DEPARTMENT OF BOTANY

Category III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management

DISCIPLINE SPECIFIC CORE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Plant Physiology and Metabolism ALS BOT DSC 05	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to understand the fundamental concepts of plant physiology and metabolism.
- to identify the role of water, minerals, hormones, and light in plant growth and development.
- to understand the basic biochemical mechanisms and mineral nutrition of plants.
- to identify the criteria for the essentiality of elements.
- to understand the role of hormones in plant growth and development.
- to examine the commercial applications of growth regulators.
- to understand the physiology of flowering and senescence.
- to understand the mechanisms of photosynthesis and respiration.
- to examine the biological nitrogen fixation in plants.

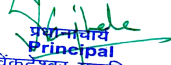
Learning Outcomes:

By studying this course, students will be able to:

6. comprehend the physiological processes that occur in plants, including the role of water, minerals, hormones, and light in plant growth and development.
7. acquaint the basic biochemical mechanisms of plants, including photosynthesis, respiration, nitrogen metabolism, and chemical regulation of growth and development.
8. comprehend the process of biological nitrogen fixation, reproductive physiology and senescence of plants.
9. develop practical skills in plant physiology and metabolism.

Unit 1: Plant-water relations

(3 Hours)


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Water potential and its components, pathway of water movement, ascent of sap, transpiration and its significance, factors affecting transpiration, root pressure and guttation.

Unit 2: Mineral Nutrition (3 Hours)

Essential elements, Macro- and micronutrients, Criteria for essentiality of elements, Methods of studying mineral requirement (Hydroponics, Aeroponics)

Unit 3: Translocation in Phloem (3 Hours)

Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 3: Chemical Regulation of Growth and Development (3 Hours)

Role of hormones in plant growth and development, Commercial applications of growth regulators, Growth retardant and its usefulness

Unit 4: Reproductive Physiology and Senescence (3 Hours)

Photo-periodism and flowering response, Photo-perception and critical photoperiod, Phytochrome and its role in flowering, Vernalization and senescence.

Unit 5: Photosynthesis (7 Hours)

Historical contributions of Blackman, Emerson, and Hill, Photosynthetic pigments (chlorophyll-a and b, xanthophyll, carotene), Photosystem I and II, reaction center, antenna molecules, Electron transport and mechanism of ATP synthesis, C₃ pathway, C₄ and CAM plants (in brief, no pathways), Photorespiration.

Unit 6: Respiration (5 Hours)

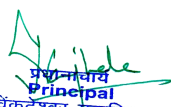
Glycolysis, Anaerobic respiration, TCA cycle, Oxidative phosphorylation, Glyoxylate cycle, RQ

Unit 7: Nitrogen Metabolism (3 Hours)

Biological nitrogen fixation - nodulation in detail, Nitrate and ammonia assimilation.

PRACTICAL (60 Hours)

2. To determine the osmotic potential of plant cell sap by plasmolytic method.
3. Calculate stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Study Hill's reaction.
5. To study the effect of the environmental factor light on transpiration by excised twig.
6. Study the effect of light intensity on O₂ evolution in photosynthesis.
7. Compare the rate of respiration in any two parts of a plant.


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8. To study the activity of catalase and the effect of pH and heavy metals.
9. Demonstrate the effect of auxin on rooting.
10. Demonstration of Bolting.
11. Demonstration of root respiration.
12. Demonstration of suction due to transpiration
13. A field visit to Hydroponics and Aeroponics facilities.

Essential/ Recommended readings:

6. Hopkins, W. G., Huner, N. P. A. (2009) *Introduction to Plant Physiology*, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd
7. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018) *Plant Physiology and Development International* 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
8. Kochhar, S.L., Kaur, S. and Gujral, S.K. (2020) *Plant Physiology: Theory and Applications*. New Delhi, Delhi: Foundation Books, imprint of Cambridge University Press India Pvt, Ltd.

Suggestive readings:

6. Bajracharya, D. (1999) *Experiments in Plant Physiology: A Laboratory Manual*. New Delhi, Delhi: Narosa Publishing House.
7. Bhatla S.C. and Lal, M.A. (2018) *Plant Physiology, Development and Metabolism*, Springer.
8. Salisbury F.B. and Ross C.W. (1992) *Plant Physiology*, 4th edition, Wadsworth Publishing Company, California.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSE for
B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest
Management

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core Course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology of Plants ALS BOT DSE03	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

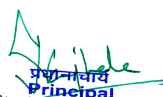
The learning objectives of this course are as follows:

12. to acquaint the students with internal basic structure and cellular composition of the plant body.
13. to correlate structure with important functions of different plant parts.
14. to study of various tissue systems and their development and functions in plants
15. to have knowledge of the flowering and fruiting, reproduction process, role of pollinators, ovule and seed development.

Learning Outcomes:

By studying this course, students will be able to:

11. gain knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
12. get an insight of various aspects of growth, development of the tissues and differentiation of various plant organs.
13. gain the knowledge of basic structure and organization of plant parts in angiosperms and its correlation with morphology and functions.
14. get acquainted with pollen development and pollination, ovule development and fertilization, endosperm development and its importance.


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Unit1: Meristematic and permanent tissue: (4 Hours)

Meristems and derivatives- structural organization of shoot and root apices; permanent tissue: simple and complex tissues.

Unit 2: Dermal System (2 Hours)

Epidermis, stomata, trichomes and glands

Unit3: Organs (4 Hours)

Structure of dicot and monocot root, stem and leaf

Unit 4: Secondary Growth (4 Hours)

Vascular cambium – structure and function, Secondary growth in root and stem, periderm.

Unit 5: Anther (4 Hours)

Structure and development, microsporogenesis, Pollen Development, structure of pollen and pollen wall (Basic Concepts).

Unit 6: Ovules (4 Hours)

Structure and types, megasporogenesis and mega gametogenesis, mature embryo sac.

Unit 7: Pollination and Fertilization (4 Hours)

Pollination mechanisms and adaptations; double fertilization; sexual incompatibility- basic concepts

Unit 8: Endosperm and Embryo (3 Hours)

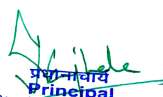
Types and function of endosperm, embryogenesis, dicot and monocot embryo

Unit 9: Seed development (1 Hours)

Basic concepts of seed development

PRACTICAL (60 Hours)

1. Study of root and shoot apex through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma, sclerenchyma and their types); Macerated xylary elements, Phloem (Permanent slides/ Photographs/ Digital resources)
3. To cut transverse section of stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Study of secondary growth in *Helianthus* stem.
4. To cut transverse section of root: Monocot: *Zea mays*; Dicot: *Cicer*; Study of secondary growth in *Helianthus* .
5. Study of the structure of Dicot and Monocot leaf.
6. Study of anther structure (young and mature).
7. Calculation of percentage of germinated pollen in a given medium through hanging drop/sitting drop method.
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.


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9. Female gametophyte: Mature embryo sac (photographs). Ultrastructure of mature egg apparatus cells through electron micrographs.
10. Dissection of embryo and endosperm from developing seeds.

Essential/ Recommended readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). *Embryology of Angiosperms*, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Mauseth, J.D. (1988). *Plant Anatomy*. San Francisco, California: The Benjamin/Cummings Publisher.
3. Franklin, E. R. (2006). *Esau's Plant Anatomy: Meristems, Cells, And Tissues of the Plant Body: Their Structure, Function, and Development*. New Jersey, U.S.: John Wiley & Sons, Inc., Hoboken.
4. Shivanna, K.R. (2003). *Pollen Biology and Biotechnology*. Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Suggestive readings:

1. Raghavan, V. (2000). *Developmental Biology of Flowering plants*. Netherlands, Europe: Springer.
2. Johri, B.M. (1984). *Embryology of Angiosperms*. Netherlands, Europe: Springer-Verlag.
3. Bhojwani S.S., Dantu P.K. and Bhatnagar, S.P. (2015) *The Embryology of Angiosperms*, 6th edition. Vikas Publication House Pvt. Ltd. New Delhi.
4. Tayal, M.S. (2021). *Plant Anatomy*, 4th Edition. Meerut, U.P.: Rastogi publications.
5. Crang, R., Lyons-Sobaski, S., and Wise, R., (2018) *Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants*, 1st Edition, Springer Nature Switzerland AG.

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POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE (BOT-GE-18)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Genetic Engineering Technologies & Applications BOT-GE-18	4	2	0	2	Class XII pass with Science	Nil

Learning Objectives:

- To illustrate the use of modern techniques for the manipulation and analysis of DNA sequences
- 9. To understand the applications of recombinant DNA technology for the generation of commercial biotechnological products of diverse usage.
- 10. To gain knowledge about biosafety and ethical concerns associated with recombinant DNA technology.
- 11. To train students in strategizing research topics employing genetic engineering techniques.

Learning Outcomes: At the end of this course students would be able to:

- understand methods and techniques involved in manipulation and analysis of nucleic acids, gene cloning and creation of genetically modified organisms (GMOs).
- understand the commercial application of rDNA technology in research, agriculture and human health
- comprehend biosafety and ethical issues associated with rDNA technology

Unit 1: Introduction

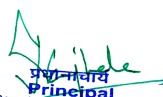
01 Hours

Introduction to rDNA technology and gene cloning.

Unit 2: Enzymes and Vectors in genetic engineering

07 Hours

Restriction endonucleases, exonucleases, polymerases, RNases, kinases, ligases; Plasmids (pBR322, pUC18, pUC19); Lambda based vectors and derivatives (Insertion vectors, replacement vectors, cosmids, phagemids); Artificial Chromosomes (YACs, BACs); Bacterial transformation, strategies for selection and screening (α complementation, antibiotic resistance); Plant Transformation vectors (Ti plasmid), Protein Expression Vectors for use in *E. coli*; introduction to marker and reporter genes (GUS, GFP).


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Unit 2: Gene transfer methods**04 Hours**

Agrobacterium mediated transformation, Electroporation, Microinjection, Particle Bombardment, PEG mediated

Unit 3: DNA libraries construction and screening**04 Hours**

Procedures for construction of genomic and cDNA libraries, screening methods for locating the desired gene (Replica plating, Complementation screening, heterologous gene probe-based hybridizations)

Unit 4: PCR, nucleic acid hybridization and DNA sequencing**08 Hours**

PCR technique and its applications, RT-PCR, qPCR, Hybridization based assays (Southern and Northern blotting), Sanger's di-deoxy chain termination method of sequencing – gel-based electrophoresis (semi-automated) and capillary-based gel electrophoresis (automated sequencing).

Unit 5: Applications of rDNA technology**06 Hours**

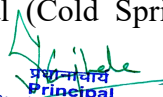
Applications in basic research (identify, map, clone, and sequence genes and to determine their functions); applications in agriculture (biotic and abiotic stress tolerant transgenic plants, improved Nitrogen fixation, and plant growth); applications in human health (Disease diagnosis (heritable diseases and acquired infectious diseases) and therapeutics (production of recombinant vaccines, protein therapies: production of Insulin, Interferons, and human growth hormone). Human genome project and sequencing of plant genomes by taking *Arabidopsis* genome as an example. Safety and Ethical Issues related to rDNA research.

Practicals**60 hours**

- Isolation of genomic/plasmid DNA from bacteria.
- Quantification of extracted DNA by DPA (Diphenylamine) method.
- Restriction digestion and AGE (Agarose gel electrophoresis) of DNA.
- Restricting Mapping of linear and circular DNA.
- Study of direct and indirect gene transfer methods by photographs: Electroporation, Microinjection and Particle Bombardment, Ti-plasmid mediated gene transfer.
- Demonstration of techniques by photographs: PCR, RT-PCR, qPCR, Southern and Northern blotting and hybridization.
- Study of applications of rDNA technology by photographs: recombinant insulin, interferon and human growth hormone, Bt Cotton, Golden rice, and Flavr Savr tomato.
- Demonstration of working of equipments used in rDNA technology: Thermocycler, Laminar air flow cabinet, Autoclave, Incubator shaker, Refrigerated centrifuge.

Suggested Readings:

11. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).


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12. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011).
13. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6thedn. Washington, U.S.: ASM Press.
14. Snustad, D.P., Simmons, M.J. (2019). Principles of Genetics, 7th edition. Chichester, England: John Wiley and Sons.
15. Brown, T. A. 2020. Gene Cloning & DNA Analysis: An Introduction. 8thedn. UK: Wiley Blackwell.
16. Primrose, S. B., Twyman, R. (2009). Principles of gene manipulation and genomics. Wiley. com.
17. Howe, C. J. (2007). Gene cloning and manipulation. Cambridge University Press.

Additional Resources:

1. M. M. Burell. (1993) Enzymes of Molecular Biology, Humana Press.
2. H.M. Eun. (1996) Enzymology: Primer for Recombinant DNA Technology, Academic Press.
3. S. B. Primrose, R. Twyman. (2006) Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (BOT-GE-19)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Molecular Biology BOT-GE-19	4	2	0	2	Class XII pass with Science	Nil

Learning Objectives:

- To gain the knowledge of structure and functions of DNA and RNA

Learning Outcomes:

Students would have understanding of

- understanding of nucleic acid, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
- Processing and modification of RNA and translation process, function and regulation of expression.

Unit 1: Nucleic Acids as genetic material

02 Hours

Discovery of Nuclein by Fredrich Miescher; Experiments by Griffith, Hershey and Chase, Avery, McLeod and McCarty and Fraenkel Conrat.

Unit 2: Structure of Nucleic acids- the blueprint of Life

04 Hours

Building blocks of nucleic acid: Ribose sugar, Purine, Pyrimidine, phosphate; Watson and Crick's model of DNA, DNA types (A,B,Z type), Comparison of RNA structure and types (tRNA, mRNA and rRNA); nucleosome- chromatin structure; Euchromatin and heterochromatin.

Unit 4: Central Dogma of Life

04 Hours

Concept of Central dogma; Salient features of genetic code, deciphering the genetic code (Contribution of Nirenberg, Matthei and Ochoa, H.G. Khorana).

Unit 3: Replication

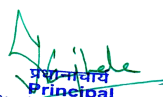
05 Hours

Semi-conservative mode of DNA replication; replication of linear and circular DNA (Theta and Rolling circle model); mechanism and role of key enzymes in replication; role of telomerase enzyme in eukaryotic DNA replication; reverse transcription.

Unit 5: Transcription

05 Hours

Comparative account of transcription in Prokaryotes and eukaryotes; post-transcriptional processing of pre-mRNA in eukaryotes (3', 5' end modifications and general mechanism of splicing involving spliceosomes).


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Unit 6: Translation

05 Hours

Comparative account of prokaryotic and eukaryotic ribosome structure and translation; inhibitors of protein synthesis (antibiotics).

Unit 7: Gene regulation

05 Hours

Gene regulation in Prokaryotes- Operon concept: inducible and repressible operon; regulation of lactose (lac) and tryptophan (trp) in *Escherichia coli*; attenuation regulation.

Practicals

60 hours

6. DNA isolation from cauliflower head by spooling method.
7. Study experiments establishing nucleic acid as genetic material: Griffith's, Avery et al, Hershey & Chase's and Fraenkel Conrat's experiments (through photographs)
8. Study DNA packaging (photographs/paper models).
9. Study modes of DNA replication: Meselson and Stahl's experiment, Rolling circle and Theta model of replication and semi-discontinuous, semi conservative replication (photographs).
10. Study structure of tRNA, prokaryotic RNA polymerase and eukaryotic RNA polymerase II (photographs/paper models).
11. Study RNA modification: Assembly of Spliceosome machinery, Splicing mechanism in group I & group II introns (photographs/paper models).
12. Study gene regulation mechanism in prokaryotes: lactose (lac) operon and tryptophan (trp) operon (photographs).
13. Finding the T_m of different DNA samples from the photographs of DNA melting profile provided. Problem solving for calculating the GC content.

Suggested Readings:

- Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach, 5th edition. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA.
- Karp, G. (2010). Cell Biology, 6th edition. New Jersey, U.S.A.: John Wiley & Sons
- Snustad, D.P., Simmons, M.J. (2012). Principles of Genetics, 6th Edition. New Delhi, Delhi: John Wiley & Sons
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, 10th edition. San Francisco, California: Benjamin Cummings

Additional Resources:

6. Hardin, J. and Lodolce, J.P. (2021). Becker's World of the cell, 10th edition, Pearson

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSC. (HONS.) BOTANY
SEMESTER - VI
Category-I

Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE - 16: Plant Biotechnology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Biotechnology DSC-16	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning objective:

- to provide knowledge of techniques used in plant biotechnology and their application.

Learning outcomes: At the end of the course the students will be able to:

- understand basic concepts, principles and methods in plant biotechnology.
- explain the use of acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural applications.

Unit 1: Introduction to Biotechnology

02 Hours

Historical timeline; sectors of Biotechnology, brief overview of techniques and methods in Biotechnology.

Unit 2: Plant Tissue Culture

08 Hours

Historical perspective (Major contributions of Haberlandt, Laibach, White, Reinert and Steward, Murashige and Skoog, Cocking, Guha and Maheshwari, Bhojwani, Morel and Martin); types and composition of media: roles of nutrients (major and minor), vitamins, hormones and others (coconut water, activated charcoal); plasticity and totipotency; regeneration: organogenesis (direct and indirect) and embryogenesis (somatic and zygotic); protoplast isolation, culture and fusion; tissue culture applications (micropropagation, androgenesis, haploids, triploids, cybrids, production of virus-free plants).

Unit 3: Recombinant DNA technology

07 Hours

Restriction Endonucleases (History, Types I - IV, biological roles and applications); modifying enzymes and their applications (nucleases, ligases, alkaline phosphatase, polynucleotide kinase), introduction to prokaryotic and eukaryotic cloning vectors: pBR322, pUC18, pUC19, BACs, Lambda phage, YACs. Gene Cloning: Restriction digestion of DNA, elution of DNA from agarose gels, ligation, bacterial transformation and selection of

recombinant clones (alpha complementation, antibiotic selection, restriction enzyme based selection)

Unit 4: Genetic transformation of Plants

05 Hours

Methods of gene transfer to plants: *Agrobacterium*-mediated transformation (Ti plasmids, development of binary vectors), Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; selection of transgenic plants: selectable marker genes (Positive selection markers – antibiotic- and herbicide-resistance conferring genes) and reporter genes (Luciferase, GUS, GFP); Introduction to genome editing.

Unit 5: Applications

08 Hours

Pest resistant (Bt-cotton) and herbicide resistant plants (RoundUp Ready™ soybean); Transgenic crops with improved quality traits (Flavr Savr™ tomato, Golden™ rice); Improved horticultural varieties (Moondust carnations); Bioremediation (Superbug); Edible vaccines; Biosafety of transgenic plants.

Practicals

60 hours

4. Preparation of Murashige & Skoog's (MS) medium.
5. Initiation of axenic cultures- seed sterilisation and inoculation
6. Micropropagation (shoot induction) using leaf and/or nodal explants of tobacco/*Datura*/ *Brassica* etc.
7. Study of anther culture, embryo and endosperm culture, somatic embryogenesis using digital resources.
8. Preparation of artificial seeds.
9. Induction of callus and analysis of effects of growth regulators (Auxin and Cytokinin) on *in vitro* regeneration using tobacco leaf explant.
10. Preparation of chemically competent cells of *E. coli*.
11. Transformation of *E. coli* with plasmid DNA by heat shock method.
12. Restriction digestion and gel electrophoresis of plasmid DNA.
13. Construction of restriction map of circular and linear DNA from the data provided.
14. Visit to a research laboratory.

Suggested Readings:

5. Slater, A., Scott, N. W. & Fowler, M. R. (2010) Plant Biotechnology: The Genetic Manipulation of Plants. 2ndedn. New York, USA: Oxford University Press Inc.
6. Snustad, D.P., Simmons, M.J. (2010) Principles of Genetics, 5th edition. Chichester, England: John Wiley and Sons.
7. Brown, T. A. (2020) Gene Cloning & DNA Analysis: An Introduction. 8thedn. UK: Wiley Blackwell.
8. Primrose, S. B. & Twyman, R.M. (2006). Principles of Gene Manipulation and Genomics. 7thedn. Victoria, Australia: Blackwell Publishing.
9. Bhojwani, S.S., Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.

Additional Resources:

9. Bhojwani, S.S. and Dantu, P.K. (2013). Plant Tissue Culture: An Introductory Text. Springer New Delhi Heidelberg New York Dordrecht London

10. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6thedn. Washington, U.S.: ASM Press.
11. Bhojwani, S.S., Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
12. Stewart, C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and Applications. New Jersey, U.S.: John Wiley & Sons Inc.
13. Glick, B.R., Pasternak, J. J. & Patten C. (2010). Molecular Biotechnology: Principles and Applications. 4thedn. Washington, U.S.: ASM Press.
14. Glick, B.R., & Patten C. (2017). Molecular Biotechnology: Principles and Applications. 5thedn. Washington, U.S.: ASM Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 17: Plant Biochemistry and Metabolism

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Biochemistry and Metabolism DSC - 17	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To understand different pathways of metabolism in plant cells.
- To understand how various metabolic pathways work in a synchronized manner.

Learning Outcomes: At the end of the course the student will:

6. know the details of carbon assimilation, oxidation, synthesis of ATP- the energy currency of the cell, nitrogen fixation and lipid metabolism.
7. understand the role of enzymes in regulating metabolic pathways for molecules like carbohydrates, lipids and proteins.
8. understand the coordination of various biochemical reactions with reference to cell requirement and its economy.

Unit 1: Concepts in Metabolism

01 Hour

Introduction, anabolic and catabolic pathways, coupled reactions

Unit 2: Enzymes

04 Hours

Structure, classification and mechanism of action, Michaelis-Menten equation (no derivation), enzyme inhibition (competitive, non-competitive and uncompetitive), allosteric regulation and covalent modulation, factors affecting enzyme activity.

Unit 3: Carbon Assimilation

07 Hours

Concept of light, absorption and action spectra, photosynthetic pigments (no structural details), PSI, PSII antenna molecules and reaction centres, LHC, photochemical reaction, photosynthetic electron transport, photophosphorylation (cyclic and non-cyclic)

Dark reactions: CO₂ reduction in C₃, C₄ pathways and CAM, photorespiration

Unit 4: Carbohydrate Metabolism**02 Hours**

Metabolite pool and exchange of metabolites, synthesis and degradation of sucrose and starch (no structural details)

Unit 5: Carbon Oxidation**06 Hours**

Glycolysis, fate of pyruvate- aerobic, anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, Krebs cycle and its regulation, amphibolic role of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration

Unit 6: ATP Synthesis**02 Hours**

Mechanism of ATP synthesis-substrate level phosphorylation, oxidative and photophosphorylation, chemiosmosis, ATP synthase

Unit 7: Lipid Metabolism**04 Hours**

Triglycerides: synthesis, degradation through alpha and beta -oxidation, glyoxylate cycle

Unit 8: Nitrogen Metabolism**04 Hours**

Nitrate assimilation (NR and NiR), biological nitrogen fixation in legumes (nodulation and role of dinitrogenase) Ammonia assimilation: GS-GOGAT, reductive amination and transamination.

Practicals**60 Hours**

1. Study the activity of urease and the effect of substrate concentration on its activity.
2. Study the effect of pH on the activity of catalase enzyme.
3. Chemical separation of photosynthetic pigments (liquid-liquid partitioning).
15. Study Hill reaction by dye reduction method.
16. Study the law of limiting factors.
17. Compare the rate of respiration in three different parts of a plant.
18. Study the activity of Nitrate reductase in leaves of two different plants.
19. To study the activity of lipases in germinating oil seeds and explain mobilization of lipids during germination.
20. To study the fluorescence in isolated chlorophyll pigments.
21. To study the absorption spectrum of photosynthetic pigments.
22. To study respiratory quotient (RQ).

Suggested Readings:

14. Nelson, D.L., Cox, M.M. (2017). Lehninger Principle of Biochemistry, 7th edition. New York, NY: W.H. Freeman, Macmillan learning.
15. Taiz, L., Zeiger, E., Moller, I. M. & Murphy, A. 2018. Plant Physiology and Development, International 6thedn, Oxford University Press, Sinauer Associates, New York, USA.

16. Hopkins, W.G., Huner, N. (2008). Introduction of Plant Physiology, 4th edition. New Jearsey, U.S.: John Wiley and sons.
17. Jones, R., Ougham, H., Thomas, H., Waaland, S. (2013). The molecular life of plants. Chichester, England: Wiley-Blackwell.

Additional Resources:

19. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants, 2nd edition. New Jearsey, U.S.: Wiley Blackwell.
20. Kochhar, S.L. & Gujral, S.K. 2020. Plant Physiology: Theory and Applications, 2nd Edition. Cambridge University Press, UK.
21. Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 18: Advanced tools & Analytical Techniques in Plant Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced tools & Analytical Techniques in Plant Biology DSC- 18	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To gain the knowledge on various techniques and instruments used for the study of plant biology

Learning Outcomes: At the end of this course, students will be:

- competent in the basic principles of major techniques used in study of plants
- understand principles and uses of light, confocal, transmission and electron microscopy, centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques

Unit 1: Imaging and related techniques

06 Hours

Electron microscopy: Transmission and Scanning electron microscopy, cryofixation, negative staining, shadow casting, freeze-fracture, freeze-etching; Chromosome banding, FISH, GISH, chromosome painting.

Unit 2: Fractionation methods

04 Hours

Centrifugation: types of rotors, differential and density gradient centrifugation, sucrose density gradient, ultracentrifugation, caesium chloride gradient; marker enzymes for analysis of cellular fractions.

Unit 3: Radioisotopes

04 Hours

Types of radioisotopes; types of emissions (alpha, beta, gamma radiations); half-life; use of radioisotopes in biological research; auto-radiography; pulse-chase experiment; Biosafety measures and disposal of radioactive material

Unit 4: Spectrophotometry

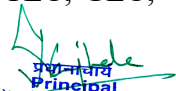
02 Hours

Principles and applications of UV, Visible and IR spectrophotometry

Unit 5: Chromatography

05 Hours

Principles and applications of Paper chromatography, Column chromatography, TLC, GLC,


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HPLC, Ion-exchange chromatography, Molecular sieve chromatography, Affinity chromatography.

Unit 6: Techniques for detection and analysis of nucleic acids and proteins 09 Hours

PCR – design of PCR primers, enzymes used for PCR, cloning of PCR products; DNA polymorphism and its applications (RFLP, AFLP, SSR, SNPs); RNA isolation and analysis, cDNA synthesis and qRT-PCR; Extraction of proteins, PAGE (Native and denaturing); Blotting and hybridization techniques: Southern (Radioactive and Non-radioactive), Northern and Western; DNA sequencing – Sanger's dideoxy sequencing; ELISA.

Practicals

60 hours

1. Study of microscopic techniques using digital resources (freeze-fracture, freeze-etching, negative staining, FISH, chromosome banding).
2. Isolation of chloroplasts by differential centrifugation.
3. Separation of nitrogenous bases by paper chromatography.
4. Separation of sugars by thin layer chromatography
5. Separation of chloroplast pigments by column chromatography (demonstration)
6. Amplification of DNA by PCR and visualization of PCR products.
7. Detection of DNA polymorphism (SSR based DNA fingerprinting).
8. Gel based and capillary based DNA sequence data analysis.
9. Estimation of protein concentration by Bradford method.
10. PAGE to study overexpression of proteins/ Separation of proteins by PAGE.
11. Blotting techniques: Southern, Northern and Western using digital resources.

Suggested Reading:

18. Hofmann, A., & Clokie, S. (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.
19. Gerald Karp, Janet Iwasa, Wallace Marshall (2019). Karp's Cell and Molecular Biology, 9th Edition: Wiley
20. O' Brien, T.P. and Cully M.E (1981). The Study of Plant Structure. Principles and selected Methods, Termarcaphi Pty. Ltd., Melbourne.

Additional Resources:

1. Cooper, G.M., Hausman, R .E. (2009). The Cell: A Molecular Approach, 5th edition. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -07): Recombinant DNA Technology and Proteomics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Recombinant DNA Technology and Proteomics BOT-DSE-07	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives: This course structure is designed to:

- familiarize the students with the essential knowledge and technical skills/ methodology involved in creating recombinant DNA molecules.
- provide knowledge on generating modified organisms, synthesize a product or modify a biological process by tailoring and/or incorporating DNA from one organism into another.

Learning outcomes:

After completion of the course students will:

7. be able to identify, locate, isolate and functionally characterize DNA sequences/genes.
8. Get familiarized with technologies used to create recombinant DNA.
9. be able to design strategies adopted to generate genetically modified organisms for various applications.
10. be aware of the application of recombinant DNA in pharmaceuticals, agriculture, environment management, etc.

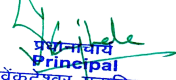
Unit 1: Enzymes in recombinant DNA technology

04 hours

Nucleases: DNAses, RNAses, Restriction endonucleases (discovery, classification, isoschizomers and cleavage action), exonucleases, polymerases (DNA, RNA, Reverse transcriptase, *Taq* polymerase), ligases, kinases, alkaline phosphatase.

Unit 2: Cloning vectors

04 hours


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Plasmids (basic features and types - pBR322, pUC18, pUC19, TA vectors), lambda vectors (insertion and replacement vectors), M13, cosmids and phagemids, pBluescript II; Artificial chromosomes as vectors (BACs, YACs). Expression vectors and shuttle vectors, YeP; strategies for over-expression of proteins

Unit 3: Isolation and cloning of target DNA

03 hours

PCR, Strategies: isolation/generation of target sequence (restriction-based and PCR-based), generation of compatible cohesive ends, linkers and adaptors.

Unit 4: Creating and screening DNA libraries

03 hours

Construction of genomic and cDNA libraries, screening and identification of target sequence by DNA hybridization and immunological methods.

Unit 5: Introduction of DNA into host cell

06 hours

Preparation and transformation of competent bacterial cells (heat shock and electroporation). DNA delivery into plant cells and protoplasts: *Agrobacterium* mediated (disarmed Ti plasmid), electroporation, microinjection, liposomes and biolistic methods). Selection and identification of transformants (alpha-complementation, antibiotic resistance and reporter genes (GUS and GFP).

Unit 6: Protein purification and Identification

03 hours

Chromatography-based methods (ion exchange chromatography and affinity chromatography), antibody-based methods (ELISA and Western blotting).

Unit 7: Proteomics

04 hours

Introduction to proteomics: gel-based methods (Native and SDS PAGE, 2D gel electrophoresis, differential gel electrophoresis), mass spectrometry.

Unit 8: Applications

03 hours

Application of recombinant DNA technology and Proteomics in medicines (insulin, vaccines), agriculture (insecticide delta endotoxin, golden rice, antisense strategy in tomatoes).

Practicals

60 hours

15. Plasmid DNA isolation using Bacterial cultures.
16. Agarose Gel electrophoresis of plasmid DNA
17. Quantification of DNA by spectrophotometry
18. Extraction of protein and its Quantification by Lowry's method

19. Constructing Restriction map of linear and circular DNA using the data provided
20. Study of recombinant DNA techniques through photographs (Biolistic technique, electroporation, microinjection, PCR, western blotting, artificial chromosomes YAC, BAC, Cosmid, Phagemid, Ti plasmid)
21. Demonstration of SDS-PAGE and affinity Chromatography

Suggested reading:

- Brown, T. A. (2016) Gene Cloning an Introduction: Chapman & Hall.
- Zlatanova, J. and Van Holde, K.E. (2016) Molecular Biology Structure and Dynamics of Genomes and Proteomes: Taylor and Francis; .
- Glick, Bernard R, Jack J. Pasternak, Patten Cheryl L. 2018. Molecular Biotechnology; principles and applications of recombinant DNA, ASM Press, Washington.
- Lovric, J., 2011. Introducing Proteomics. Wiley-Blackwell
- S.B. Primrose, R. M. Twyman, R.W.Old. 2001. Principles of Gene manipulation: Blackwell Science; 2001

Additional reading:

- Banks, K (2022) Introduction to Proteomics. Larsen & Keller Education
- Kreuzer, H. Massey, A (1996) Recombinant DNA and Biotechnology; A guide for teachers; ASM Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE (DSC-6.): Economic Botany and Biotechnology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Economic Botany and Biotechnology LS-DSC-BOT - 6	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To understand the economic importance of plants as cash crops - cereals, legumes, spices, non-alcoholic beverages, oils and fibres.
- To understand the concepts and applications of the techniques of Plant Tissue Culture and Recombinant DNA Technology in enhancing economic value of plants

Learning Outcomes: At the end of the course the students will have:

- knowledge of the nutritive and commercial / medicinal value of various plants and plant parts used as sources of carbohydrates, proteins, spices, oil and beverages.
- practice the methods / techniques of Plant Tissue Culture and apply tools of Biotechnology in improvement of crops for economic potential.

Unit 1: Origin of Cultivated Plants

02 hours

Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2: Cereals and millets

04 hours

Wheat, Rice and Maize: Origin, description of the part used, economic importance. Major and minor millets (Pearl millet, Sorghum, Kodo millet and Finger millet).

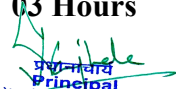
Unit 3: Pulse crops

02 Hours

General account and economic importance with special reference to chickpea and pigeon pea.

Unit 4: Spices

03 Hours


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General account, part used and economic importance with special reference to cardamom, clove and black pepper.

Unit 5: Beverage

02 Hours

Tea; morphology, types, processing, uses.

Unit 6: Oils and Fats

02 Hours

General account; Classification, Difference between essential oils and fatty oils, uses (Sunflower, Soybean, Mint)

Unit 7: Fibre Yielding Plants

02 Hours

Classification of fibres. Cotton and Jute, description of part used and uses.

Unit 8: Plant Tissue Culture Technology

05 Hours

Introduction; nutrient media; aseptic and culture conditions, organogenesis (direct and indirect) and somatic embryogenesis; androgenesis, embryo culture, endosperm culture, protoplast culture Applications: micropropagation, generation of somaclonal variants, synthetic seeds and germplasm conservation.

Unit 9: DNA Recombinant Technology

08 Hours

Introduction, Blotting techniques (Southern and Northern); PCR; Molecular DNA markers (RAPD, RFLP) and DNA fingerprinting in plants. Genetic Engineering Techniques: Gene cloning vectors (pUC18, Ti plasmid); enzymes (nuclease, polymerase, kinase, ligase); screening for gene of interest by DNA probe hybridisation, Insertion of genes into plant (*Agrobacterium* mediated, biolistics); selection of recombinants by selectable marker and reporter genes (GUS). Applications: Bt cotton, Golden rice, Flavr-Savr tomato, Edible vaccines.

Practicals:

60 Hours

- Study of economically important plants through: specimens (Millets, Pigeon pea, Chickpea, Tea, and Cotton), Sections (Wheat, Maize, Black pepper, Clove), Micro-chemical Tests (Wheat, Soybean, Groundnut and Cotton).
 - Principle and working of equipment used in Tissue culture: Laminar air flow cabinet, Autoclave.
 - Preparation of culture medium (MS medium), sterilisation and inoculation of explants (Demonstration)
 - Study of Micropropagation, Anther culture, Somatic embryogenesis, Endosperm and Embryo culture
 - Study of Molecular techniques: PCR, Blotting techniques
22. Extraction and separation of DNA.
23. Visit to any tissue culture/biotechnology laboratory

Suggested reading:

14. Bhojwani, S.S., Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.
15. Bhojwani, S. S. and Dantu, P. K. (2013). Plant Tissue Culture: An Introductory Text. Springer

16. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications. Washington, U.S.: ASM Press.
17. Kochhar, S.L. (2011). Economic Botany in the Tropics, 4th edition. New Delhi, Delhi: MacMillan Publishers India Ltd.
18. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, Springer
19. Wickens, G.E. (2012) Economic Botany: Principles and Practices. Springer

Additional Resources:

11. Park, S. (2021). Plant Tissue Culture: Techniques and Experiments, 4th Edition. Elsevier
12. Ranabhatt, H. and Kapur, R. (2018). Plant Biotechnology {Woodhead Publishing}
13. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition {CBS / Oxford & IBH}
14. Smith, R. H. (2013). Plant Tissue Culture: Techniques and Experiments, 3rd Edition {Elsevier}.
15. Stewart, C. Neal (2016). Plant Biotechnology and Genetics, 3rd Edition {Wiley-Blackwell}
16. Trigiano, R. N., Dannis, J. Gray (2019). Plant Tissue Culture, Development, and Biotechnology {CRC Press}

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category - III
B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management

DISCIPLINE SPECIFIC CORE COURSE (DSC 06)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Biotechnology: Concepts and Applications ALS BOT DSC 06	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to give students knowledge of techniques used in plant biotechnology and its applications.
- to explore the use of biotechnology to generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
- to understand the biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals, food industry, agriculture, horticultural and ecology. This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.
- to perform the techniques currently used to generate information and detect genetic variation.

Learning Outcomes:

By studying this course, students will be able to:

- comprehend the basic concepts, principles and processes of plant biotechnology.
- apply the acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural fields.
- use the basic biotechnological techniques to explore molecular biology of plants.
- explain the use of biotechnological techniques for plant improvement and biosafety concerns.

Unit 1: Introduction to Biotechnology

(2 Hours)

Historical timeline; Brief overview of techniques and methods in Biotechnology, sectors of Biotechnology.

Unit 2: Plant Tissue Culture

(8 Hours)

Historical perspective (Haberlandt, Laibach, White, Reinert and Steward, Murashige, Cocking, Guha and Maheshwari, Bhojwani, Morel and Martin); Composition of media; Nutrients (major and minor), vitamins and hormones; Plasticity and Totipotency; Regeneration: Organogenesis (Direct and Indirect) and Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, haploids, triploids, cybrids, production of virus-free plants).

Unit 3: Recombinant DNA Technology and Genetic Transformation (12 Hours)

Restriction Endonucleases (History, Types I - IV, biological role and applications); Modifying enzymes and their applications (nucleases, ligases, alkaline phosphatase, polynucleotide kinase) Introduction to prokaryotic and eukaryotic cloning vectors: pBR322, pUC 18, pUC19, BACs, Lambda phage, YACs. Gene Cloning: Restriction digestion of DNA, ligation, bacterial transformation and selection of recombinant clones; Methods of gene transfer to plants: *Agrobacterium*-mediated transformation (Ti plasmids), Direct gene transfer by Electroporation, Microinjection, Microprojectile

bombardment; Selection of transgenic plants: selectable marker genes (Positive selection markers – antibiotic- and herbicide-resistance conferring genes) and reporter genes (Luciferase, GUS, GFP).

Unit 3: Applications of Transgenic Technology

(8 Hours)

Pest resistant (Bt-cotton) and herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato. Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Edible vaccines; Introduction to genome editing; Biosafety of transgenic plants.

PRACTICALS

60 hours

1. Preparation of nutrient media for plant cell cultures- Murashige & Skoog's (MS) medium and B5 medium.
2. Initiation of axenic cultures (seed sterilisation and inoculation)
3. Micropropagation (shoot induction) using leaf and/or nodal explants of tobacco/*Datura*/ *Brassica* etc.
4. Study of anther culture, embryo and endosperm culture, somatic embryogenesis using digital resources/ photographs.
5. Preparation of artificial seeds.
6. Isolation of plasmid DNA.
7. Induction of callus and analysis of effects of growth regulators on *in vitro* regeneration using tobacco as a model plant
8. Preparation of competent cells and transformation of *E. coli* by heat shock method.
9. Restriction digestion and gel electrophoresis of plasmid DNA.
10. Construction of restriction map of circular and linear DNA from the data provided.
11. Visit to a Research laboratory.

Essential/recommended readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Bhojwani, S.S., Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.

3. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6thedn. Washington, U.S.: ASM Press.
4. Brown, T. A. 2020. Gene Cloning & DNA Analysis: An Introduction. 8thedn. UK: Wiley Blackwell.
5. Slater, A., Scott, N. W. & Fowler, M. R.(2010) Plant Biotechnology: The Genetic Manipulation of Plants. 2ndedn. New York, USA: Oxford University Press Inc.
6. Primrose, S. B. and Twyman, R.M. (2013) Principles of Gene Manipulation and Genomics. 7thedn. Wiley-Blackwell Publishing.

Suggested Readings :

1. Stewart, C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and Applications. New Jersey, U.S.: John Wiley & Sons Inc.
2. Snustad, D.P., Simmons, M.J. (2010). Principles of Genetics, 5th edition. Chichester, England: John Wiley and Sons.
3. Bhojwani, S.S. and Dantu, P.K. (2013). Plant Tissue Culture: An Introductory Text. Springer New Delhi Heidelberg New York Dordrecht London

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**POOL OF DISCIPLINE SPECIFIC CORE
FOR B.SC. PROGRAMME IN APPLIED LIFE SCIENCES WITH
AGROCHEMICALS AND PEST MANAGEMENT**

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre- requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Systematics ALS BOT DSE 04	4	2	0	2	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to gain knowledge about the basics of plant systematics.
- to get an insight into the interrelationships of plant systematics and allied subjects.

Learning Outcomes:

By studying this course, students will be able to:

- understand technical terminology used in plant taxonomy.
- apply the terminologies to describe, identify and classify the flowering plants.
- search and analyze taxonomic information from internet-based scientific databases and other resources.
- comprehend and compare various systems of classification.
- recognize diversity in local/regional flora.

Unit 1: Introduction**(1 Hour)**

Plant identification, Classification, Nomenclature, Biosystematics.

Unit 2: Identification**(4 Hours)**

Field inventory, Herbarium Techniques, Functions of Herbarium, Important herbaria and botanical gardens of the world and India, Virtual Herbarium, E-flora: Flora, Monographs, Journals.

Unit 3: Systematics-An Interdisciplinary Science**(5 Hours)**

Evidence from cytology, phytochemistry [Alkaloids, Phenolics, Glycosides, (in brief)] and molecular data (cp.DNA, mt-DNA, nuclear DNA, PCR amplification, sequence data analysis)

Unit 4: Taxonomic Hierarchy**(2 Hours)**

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological & evolutionary)

Unit 5: Botanical Nomenclature**(7 Hours)**

Principles and rules (ICN); Ranks and names; Typification, Author citation, Valid publication, Rejection of names, Principle of priority and its limitations; Names of hybrids and cultivated plants.

Unit 6: Basic Terms and Concepts of Phylogeny**(4 Hours)**

Cladistics: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades and grades). Methodology of Cladistics, Methods of illustrating evolutionary relationships (phylogenetic tree, cladogram).

Unit 7: Systems of Classification**(7 Hours)**

Major contributions of Parasara, Charaka, Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Cronquist, Bremer and MW Chase; Classification systems of Benth and Hooker (up to series) and Engler and Prantl (up to series); Angiosperm Phylogeny Group (APG IV) Classification (major clades).

PRACTICAL

(60 Hours)

1. To prepare at least 2 herbarium specimens and identify them using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's classification).
2. Description of taxa using semi-technical terms and identification of the families according to Bentham and Hooker's classification.

Note: Any twelve families from the following list to be studied with at least two specimens (or one where limitations exist).

List of Suggested Families (*mandatory)

Acanthaceae, Rubiaceae, *Apiaceae, Apocynaceae, *Asteraceae, *Brassicaceae, *Euphorbiaceae, *Fabaceae, *Lamiaceae, Liliaceae, *Malvaceae, Moraceae, *Poaceae, *Ranunculaceae, *Solanaceae.

Essential/recommended readings:

1. Simpson, M. G. (2019). *Plant systematics*. 3rd Edition, Academic press.
2. Singh, G. (2019). *Plant Systematics- An Integrated Approach*. 4th edition. CRC Press, Taylor and Francis Group.
3. Pandey, A. K., Kasana, S. (2021). *Plant Systematics*. 2nd Edition. CRC Press Taylor and Francis Group
4. <http://www.mobot.org/MOBOT/research/APweb/>
5. Maheshwari, J. K. (1963). *The flora of Delhi*. Council of Scientific & Industrial Research.
6. Maheshwari, J. K. (1966). *Illustrations to the Flora of Delhi*. Council of Scientific & Industrial Research.
7. Harris, J. G., Harris, M. W. (2001). *Plant Identification Terminology: An Illustrated Glossary*. Spring Lake, Utah: Spring Lake Pub. Spring Lake, Utah.

Suggestive Readings:

1. The Angiosperm Phylogeny Group, Chase, M.W., Christenhusz, M.J.M, Fay M.F., Byng, J.W., Judd, W.S., Soltis, D.E., Mabberley, D.J., Sennikov, A.N., Soltis, P.S., Stevens, P.F. (2016). *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV*. Botanical journal of the Linnean Society 181 (1): 1-20.
2. <https://www.mobot.org/MOBOT/research/APweb/treeapweb2s.gif>
3. <https://www.digitalatlasofancientlife.org>
4. <http://apps.kew.org/herbcat/navigator.do>
5. <https://efloraofindia.com/>
6. <https://powo.science.kew.org/>
7. Page, R.D.M., Holmes, E.C. (1998). *Molecular Evolution: A Phylogenetic Approach*. Blackwell Publishing Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE (BOT-GE-20)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Genomics, Proteomics and Metabolomics BOT-GE-20	4	2	0	2	Class XII Pass with Science	Nil

Learning Objectives:

22. Build the concepts of genomics, proteomics and metabolomics.
23. Understand the role of model organisms in genomics studies
24. Familiarization of tools used in genomics and proteomics.

Learning Outcomes: At the end of this course, students will be able to:

7. understand the implications of genomic, transcriptomic, proteomic and metabolomic studies in an organism.
8. assimilate logic and reasoning behind choice of model organisms for genomics study.

Unit 1: Introduction to genomics

02 Hours

Recapitulating basics of prokaryotic and eukaryotic genomes; basic concept of structural and functional genomics.

Unit 2: Model organisms in genomics

02 Hours

Features of important model organisms used in genomics study (*Escherichia coli*, *Saccharomyces cerevisiae*, *Caenorhabditis elegans*, *Arabidopsis thaliana*)

Unit 3: Sequencing strategies

04 Hours

Sequencing: basic principle-Sanger's method; classical approaches for sequencing large genomes (whole genome shot gun method viz. WGS, clone by clone sequencing); Next generation sequencing (NGS) ; Concept of third generation sequencing

Unit 4: Genome sequencing Projects

04 Hours

Human genome project (brief history and significance); *Arabidopsis* genome project; rice genome project; applications of genomics in agriculture and human health

Unit 5: Transcriptomics**03 Hours**

Concept: EST sequencing; Gene expression studies by Microarrays and RNAseq.

Unit 6: Introduction to proteins and proteomics**06 Hours**

Proteins as structural and functional unit of life; basics concept of protein structure (primary, secondary, tertiary, and quaternary), peptide bonds; brief introduction of major post-translational modifications (phosphorylation, glycosylation); introduction to enzymes; introduction to proteomics and its applications.

Unit 7: Tools for proteome analysis**05 Hours**

Separation and isolation of proteins from plant tissue; purification of proteins by chromatographic techniques (column chromatography, ion exchange and affinity chromatography); separation of total cellular proteins by electrophoresis: SDS-PAGE, western blotting and ELISA.

Unit 8: Metabolomics**04 Hours**

Concept of metabolomics; classes of metabolites (primary and secondary metabolites in plants); Experimental methods and instruments used in metabolomics- HPLC, GC; applications of metabolomics.

Practicals**60 hours**

- Genomic DNA extraction from cauliflower heads
- Select 10 different organisms (5 prokaryotic and 5 eukaryotic) whose genomes have been completely sequenced and categorize them based on taxonomy, find their genome size and locate the database where their genome sequence is hosted.
- Demonstration of gene expression studies through photographs: microarrays and RNA seq.
- Demonstration of Sanger's DNA sequencing principle.
- Interpretation and reading of DNA sequence chromatograms.
- Experiment to demonstrate activity of Amylase.
- Estimation of protein concentration through Lowry's methods/Bradford assay.
- Demonstration of separation of proteins using SDS-PAGE (demonstration).
- Study of proteins by Western blotting technique (digital resources/demonstration).
- Demonstration of ELISA through kit.

Suggested readings:

15. Brown, T. A. (2020). Gene Cloning & DNA Analysis: An Introduction. 8thedn. UK: Wiley Blackwell.
16. Glick, B.R., Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6thedn. Washington, U.S.: ASM Press.
17. Griffiths, A.J.F., Doebley, J., Peichel, C, Wassarman D. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
18. Liebler, D.C. (2002). Introduction to Proteomics: Tools for New Biology, Humana Press.
19. Primrose, S. B. Twyman, R.M. (2006). Principles of Gene Manipulation and Genomics. 7thedn. Victoria, Australia: Blackwell Publishing.
20. Twyman R. (2013) Principles of Proteomics, Taylor & Francis Books.
21. Watson J.D. (2017) Molecular Biology of the Gene. Pearson publishers.

22. Westermeier, R., Naven, T., Hopker, H.R. (2008). Proteomics in Practice: A guide to successful experimental design, 2nd edition, Wiley Blackwell.
23. Wood, P.L., (2021) Metabolomics. Springer Protocols.

Additional resources:

- Banks, K (2022) Introduction to Proteomics. Larsen & Keller Education
- Campbell, A.M. and Heyer, L.J (2006). Discovering Genomics, Proteomics and Bioinformatics, Pearson publishers.
- Bhattacharya, S.K. (2019) Metabolomics: Methods & Protocols. Springer Protocols/Humana Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF GEOLOGY
SEMESTER – IV
BSC (H) Geology
Category - I

DISCIPLINE SPECIFIC CORE COURSE -10 (DSC-10) – : Geomorphology (L3, P1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
(DSC-10) Geomorphology (L3, P1)	4	3	0	1	12 th pass with science	Studied Earth System Science and Equivalent

Learning Objectives

The course on geomorphology is intended to provide students basic scientific knowledge Earth surface process and evolution of the landforms. Students will be taught about the basic and fundamentals of geomorphology to comprehend the process and evolution of landscapes through time.

Learning outcomes

After going through this course, students will develop basic skills and understanding about the key concepts of geomorphology, i.e., systems (morphological, cascading, process-response), threshold, magnitude and frequency, unifying concepts such as conservation of mass and energy in geomorphic systems, sediment routing, equilibrium and steady state. They will be able to use the knowledge to identify various landforms and processes in different environments i.e., glacial, fluvial, aeolian, coastal regions. They will also be able to examine the landforms at primary scale. They will be able to analyse the morphometric parameters of a basin. They will develop skills to prepare a geomorphic map using topographic sheets and Google Earth images.

SYLLABUS OF DSC-10 (Credits: 4)

Theory: 45 hours, Practical: 30 hours

UNIT – I (9 hours)

Detailed content

Introduction to Geomorphology: Concepts in geomorphology, Geosphere-Hydrosphere-Biosphere; Unifying concepts

UNIT – II (9 hours)

Detailed contents

Morphological features of Earth: Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features. Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya)

UNIT – III (9 hours)

Detailed contents

Earth Surface Processes: Surficial processes and geomorphology; Weathering and associated landforms, Hill slopes Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities.

UNIT – IV (9 hours))

Detailed contents

Methods and techniques: Dating Methods, measuring rates; Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development.

UNIT – V (9 hours)

Detailed contents

Overview of Indian Geomorphology. Introduction to Extra-terrestrial landforms

Practical Component- (30 Hours)

Reading topographic maps, Concept of scale, Preparation of a topographic profile, Preparation of longitudinal profile of a river, Preparing Hack Profile and Calculating Stream length gradient index, Morphometry of a drainage basin - Calculating different morphometric parameters, Preparation of geomorphic maps.

Essential/recommended readings

M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.

Suggestive readings

Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.

Paul R. Bierman and D.R. Montgomery (2014): Key Concepts in Geomorphology. W.H. Freeman and Company Publishers.

M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

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DISCIPLINE SPECIFIC CORE COURSE : DSC-11- Hydrogeology (L3, P1)

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
(DSC-11) Hydrogeology (L3, P1)	4	3	0	1	12 th Pass with Science	Studied Stratigraphy, Earth System Science or Equivalent

Learning Objectives

Main objective of the course is to make students comprehend about the nature, occurrence and movement of groundwater in geological context. To develop basic understanding about ground water exploration and management.

Learning Outcomes:

After completing the course, the students will get a basic understanding of aquifers and groundwater systems. The students will be able to comprehend the groundwater flow dynamics and well hydraulics, enhancing their numerical skills for development of groundwater resources. Learners will gain expertise in fundamentals of groundwater exploration helping them to identify groundwater sources in field. The students will be able to analyse and compare the groundwater quality. This would help them to categorise the use of groundwater for various purposes. Learners will be skilled with fundamentals of water balance, groundwater resource estimation and groundwater resource management practices.

SYLLABUS OF DSC- 11

Theory (45 Hours)

UNIT – I (9 hours)

Detailed contents

Introduction and basic concepts: Scope of hydrogeology and its societal relevance. Hydrologic cycle: precipitation, run-off, infiltration and subsurface movement of water. Hydrogeological formations: Aquifer; Aquitard; Aquiclude; Aquifuge. Vertical distribution of subsurface water. Types of aquifers, aquifer properties, anisotropy and heterogeneity of aquifers. Introduction to geologic formation as aquifers.

UNIT – II (9 hours)

Detailed contents

Groundwater flow: Darcy's law and its validity (discussions on laminar and turbulent groundwater flow), intrinsic permeability and hydraulic conductivity, Groundwater flow rates and flow direction.

UNIT – III (9 hours)

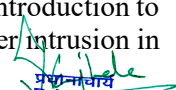
Detailed contents

Well hydraulics and Groundwater exploration: Basic Concepts of well hydraulics (drawdown; specific capacity etc). Elementary concepts related to: equilibrium conditions for water flow to a well in confined and unconfined aquifers, estimation of permeability in field and laboratory. Introduction to non-equilibrium groundwater flow condition. Surface-based groundwater exploration methods.

UNIT – IV (9 hours)

Detailed contents

Groundwater chemistry: Physical and chemical properties of water and water quality. Introduction to methods of interpreting groundwater quality data using standard graphical plots. Sea water intrusion in coastal aquifers.


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UNIT – V (9 hours)

Detailed contents

Groundwater management: Basic concepts of water balance studies, issues related to groundwater resources development and management. Groundwater level fluctuations. Rainwater harvesting and artificial recharge to groundwater.

Practical Component- (30 Hours)

Preparation and interpretation of water level contour maps and depth to water level maps. Preparation and analysis of hydrographs for differing groundwater conditions. Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams). Simple numerical problems related to: estimation of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

Essential/recommended readings

Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw- Hill Pub. Co. Ltd.

Suggested readings

Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.

Raghunath, H.M. 2007. Groundwater, Third Edition, New Age International Publishers.

Shekhar Shashank . 2017a. Aquifer Properties. E-PG Pathshala, UGC, MHRD, Govt. of India.

Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

Shekhar Shashank. 2017b. Darcy's law. E-PG Pathshala, UGC, MHRD, Govt. of India.

Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

Shekhar Shashank. 2017c. Assessment of groundwater quality. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

Syed Tajdarul Hassan. 2017a. Introduction to Hydrology. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

Syed Tajdarul Hassan. 2017b. Hydraulic Head, Fluid Potential, Reynolds number and Pumping Tests-I. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

Syed Tajdarul Hassan. 2017c. Hydraulic Head, Fluid Potential, Reynolds number and Pumping Tests-II. E-PG Pathshala, UGC, MHRD, Govt. of India. Available on: <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

DISCIPLINE SPECIFIC CORE COURSE– 12 (DSC-12): Geology of India (L3, P1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-12 Geology of India (L3, P1)	4	3	0	1	12th Pass with Science	Studied Earth System Science, Concepts of Stratigraphy, Structural Geology, and Mineralogy or Equivalent

Learning Objectives

The course on Geology of India is to provide students a comprehensive understanding about the overall geology of the Indian subcontinent through stratigraphic approach. Students will be taught about the geological history of the Indian subcontinent spanning from Archean to Quaternary times. They will be motivated to learn the role of tectonics, climate and sea level in framing the geological history of India through time.

Learning Outcomes:

After completion of the course, students will have understanding of stratigraphic sub-divisions of India from Archaean to Cenozoic times. They will acquaint with depositional environments, paleogeographic setting and tectonic evolution of various Indian sedimentary basins and their fossils and mineral assets. They will understand the major mass extinction events, its effect on various faunas and their recovery after mass extinction.

SYLLABUS OF DSC-12

Theory (45 Hours)

UNIT – I (9 hours)

Detailed contents

Introduction to geology of India: Physical and tectonic subdivisions of Indian subcontinent

UNIT – II (9 hours)

Detailed contents

Major sub-divisions Indian Geology: Distribution of stratigraphic units in the Peninsula and in the Himalayas. Stratigraphy, geographic distribution, lithological characteristics, fossil contents and economic importance.

UNIT – III (9 hours)

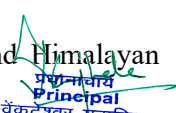
Detailed contents

Precambrian and Phanerozoic successions of India: Precambrian basement rocks of Dharwar, Aravalli-Bundelkhand, Bastar, Singhbhum, central provinces of northeastern India; Proterozoic mobile belts in northwestern, central, eastern and southern Indian peninsular regions and in the extra-peninsula; Proterozoic basins including: Vindhyan, Cuddapah, Kurnool, Bhima, and Kaladgi. Marine Paleozoic formations of India: Tethyan regions, Lesser Himalayan region. Marine Mesozoic formations of India: Himalayan and Peninsular region.

Gondwana sequences of India. Cenozoic formations in western, eastern, southern and Himalayan regions. Deccan Traps, Rajmahal Traps.

UNIT – IV (9 hours)

Detailed contents


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Stratigraphic boundary problems: Precambrian-Cambrian boundary; Permian-Triassic boundary; Cretaceous-Tertiary boundary

UNIT – V (9 hours)

Glacial Events: Major glacial events in the Earth's history, stratigraphic implication of the sea-level changes in the Quaternary period and their significance in Indian subcontinent.

Practical Component- (30 Hours)

Study of rocks in hand specimens from the known stratigraphic horizons, Drawing various paleogeographic maps and tectonic maps of sedimentary basins. Study of different Proterozoic supercontinent reconstructions, Interpretation of various stratigraphic logs and their correlation.

Essential/recommended readings

Wadia, D.N. 1957. Geology of India, 3rd Ed., McMillan, London.

Ravindra Kumar, 1985. Fundamentals of historical geology and stratigraphy of India. Wiley Eastern Ltd., Delhi.

Ramakrishnan, M. & Vaidyanathan, R. (2008) Geology of India. Volume 1 & 2, Geological Society of India, Bangalore.

Suggestive readings

Wadia, D.N. 1957. Geology of India, 3rd Ed., McMillan, London.

Naqvi, S.M. and Rogers, J.J. 1986. Precambrian Geology of India. Clarendon Press.

Ravindra Kumar, 1985. Fundamentals of historical geology and stratigraphy of India. Wiley Eastern Ltd., Delhi.

Common Pool of Discipline Specific Electives

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-2 Introduction to Field Geology (L2, P2)	4	2	0	2	12th pass with science	Studied Earth System Science and Structural Geology or Equivalent

Learning Objectives

This course on Introduction to Field Geology is intended to provide students of geology about the basic techniques of observation and description of various primary and secondary rock structures and landforms during geological fieldwork. They will learn and develop skills to extract information about an area through the investigation of topographic maps and techniques of field geology.

Learning outcomes

After completion of this course, students will develop the technique of carrying out the field work in different geological terrains. Specifically, they will be able to locate themselves in field Identify sedimentary structures in field, measure grain size in the field, prepare lithologs, identify structures in the field, and prepare and interpret profiles from the topographic maps and how to prepare a field report.

SYLLABUS OF DSE-2

Theory (30 hours)

UNIT – I (6 Hours)

Detailed Content

Rock Particles and Fragments: characters of larger rock fragments, pebbles etc.; Shape and surface markings; Dimensions of Particles and fragments; composition; shape; angular particles; subangular particles; rounded particles;

UNIT – II (6 Hours)

Detailed Content

Sedimentary Structures: process of formation and their interpretation; laminae, bed, ripple marks, wave marks, rill marks, mud cracks, slump marks, cross-stratifications etc. Importance of litholog (theory)

UNIT – III (6 Hours)

Detailed Content

Deformed rocks: Tilted and folded strata; Principal kinds of folds or flexures; Types of folds; Strike, dip, plunge and pitch; Classification of faults; kinds of displacement; principal evidences of faulting; relation of folds and faults; Topographic expression of folds and faults.

UNIT – IV (6 Hours)

Detailed Content

Landforms in various environment: Fluvial landforms, coastal landforms, aeolian landforms, and glacial landforms.

UNIT – V (6 Hours)

Detailed Content

Topographic maps and profile sections: Contours; spacing of contours; scale; direction; requisite data on a completed contour map. Techniques used in examination of outcrops.

Practical Component- (60 Hours)

In the practical class, all components of the field geology and measurement techniques will be demonstrated and practised in the field. The practical classes of this course will be conducted at a go through field visit (10 days) in a suitable geological terrain in India. This will cover- Measuring large grain sizes in the field (Grid method), Identification of sedimentary structures, Preparation of litholog, Identification of landforms (glacial/fluvial/coastal/aeolian), Identification of folds and faults; evidences of faulting, Construction of a profile section; Enlargement of profile section, Measurement of slope from the topographic map, Location in the toposheet thorough GPS/bearing, Measurement of dip, strike, trend, plunge, pitch, Identification of bedding, flow banding, metamorphic foliation.

Essential

Field Geology by F.H. Lahee, CBS Publishers

Basic geological mapping, R. Lisle, Wiley-Blackwell, 2014

Recommended readings

Sedimentary Rocks in the field, M. Tucker, Wiley-Blackwell, 2011

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-3 Paleoseismology (L3, P1)	4	3		1	12th pass with science	Studied Earth System Science and Structural Geology or Equivalent

DSE-3:

Paleoseismology (L3, P1)

Credit: 4

Theory (45 hours), Practical (30 hours)

Learning Objectives

The goal of this course is to provide students an understanding about: Geological techniques to study the pre-instrumental earthquakes and its application to Seismic Hazard Assessment. What do past earthquakes look like in the geologic record in different environments? To estimate the magnitude of past and future earthquakes using trench logs and geochronology as a case study from different seismically active regions of the world, e.g., Himalaya, Japan, New Zealand, etc. Learn the deformation on short- and long-term time scales.

Learning outcomes

After going through this course, students will understand how the Earth deforms from individual earthquakes to systems of faults to the construction of mountain ranges. They can able to map the active faults and their recurrence time of earthquake and seismic hazard in a seismically active area.

SYLLABUS OF DSE-3

Theory (45 hours)

Unit-1 (9 hours)

Detailed Content

Landscape Response to Tectonics: Introduction to Seismicity, its causes and nucleation, Introduction to geodesy and short-term deformation. Earthquakes in the Indian Subcontinent. Tectonic landforms. Climate-Tectonic interaction in landscape evolution. Erosion and uplift in orogenic settings. Active tectonics and rivers.

Unit-2 (9 hours)

Detailed Content

Introduction to Paleoseismology: The Scope of Paleoseismology, Evidences to identify past earthquakes- Primary and Secondary evidences, On-fault and Off-fault structures, Recurrence time of earthquake, Slip-rate Determination and Magnitude Estimation, Development of Paleoseismology. Distinguishing Paleoseismic Features from Non-Seismic or Non-Tectonic Features.

Unit-3 (9 hours)

Detailed Content

Paleoseismic Investigation Techniques: Geomorphic expressions of fault, Surveying and Mapping Paleoseismic Landforms. Trenching, logging and sampling the fault scarps. Stratigraphic and Structural evidences of Paleoeearthquakes. Quaternary Dating techniques- 14C, OSL, TL, etc. exposures dating.

Unit-4 (9 hours)

Detailed Content

Paleoseismology of different Tectonic Environments: Introduction to paleoseismic investigations in Contractional, Extensional, and Strike-Slip Tectonic Settings. Surface Rupture studies in Himalaya. Interpreting the Paleoseismic History by Retro-deformation. Introduction to Long term deformation study, Quaternary and Neogene Geomorphic Responses to Tectonics- the Himalayan case.

Unit-5 (9 hours)

Detailed Content

Applications on different time scale: Seismic Hazard Assessment, Estimating Paleo-earthquake Magnitude and Recurrence Cycle, Fault Segmentation.

Practical Component- (30 Hours)

Exercises covering various practical based problems on paleoseismology and tectonic events, past earthquakes, and to assess magnitude and recurrence of the seismic events and futures perspectives.

Essential/Recommended readings

James P. McCalpin (editor), 2009, Paleoseismology (2nd edition), Elsevier/Academic Press: Burlington, MA, 629 pp.

Robert S. Yeats, Kerry E. Sieh, and Clarence R. Allen, 1997, Geology of Earthquakes, Seismological Research Letters 68(5).

Recommended readings

Jayangondaperumal, R., Thakur, V. C., Jeevivek, V., Rao, P. S., & Gupta, A. K. (2018), Active Tectonics of Kumaun and Garhwal Himalaya. Singapore: Springer.

Douglas W. Burbank and Robert S. Anderson, 2012, Tectonic Geomorphology (2nd edition), Wiley-Blackwell: UK, 454 pp.

William B. Bull, 2008, Tectonic Geomorphology of Mountains: A New Approach to Paleoseismology, Wiley-Blackwell: Malden, MA, 328 pp.

William B. Bull, 2009, Tectonically Active Landscapes, Wiley-Blackwell: Malden, MA, 320 pp.

Edward A. Keller and Nicholas Pinter, 2002, Active Tectonics: Earthquakes, Uplift, and Landscape (2nd edition), Prentice Hall: Upper Saddle River, NJ, 362 pp.

COMMON POOL OF GENERIC ELECTIVES

Credit distribution, Eligibility and Pre-requisites of the Course GE-4

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
GE-4 Natural Hazards and Mitigation (L3, T1)	4	3	1	0	12th Pass	Nil

Learning Objectives

The main objective of this course is to teach students how to evaluate risks and implement mitigation strategies. This course introduces students to the concept of disaster risk reduction and gives a foundational understanding of natural hazards around the world with a focus on India. This course also lays the foundation for advanced study in climate change impacts, environment science, sustainability, and disaster management.

Learning outcomes

After going through this course, student will know the genesis of major natural hazards of the world, the impact of climate change and understand the disaster management system of India. The students will be able to assess the risk of natural hazards to a specific place and suggest the basic disaster risk reduction measures and emergency plan.

SYLLABUS OF GE-4

Theory (45 hours)

UNIT – I (9 Hours)

Detailed contents

Introduction to natural hazards: Concept of hazards, vulnerability, exposure, risk and disaster. Major natural and manmade hazards and their impact.

UNIT – II (9 hours)

Detailed contents

Hydrometeorological hazards: Floods, storms/cyclone, cloudburst, heat and cold waves, genesis of hydrometeorological hazards, extreme events.

UNIT – III (9 Hours)

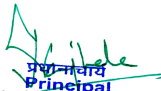
Detailed contents

Geological hazards: Geological processes and hazards. Different forms of mass movement: landslide, subsidence, debris flow; Volcanic hazards: major volcanic eruption; Earthquake and secondary hazard: Tsunami, snow avalanche.

UNIT – IV (9 Hours)

Detailed contents

Climate change and pandemic: Climate change, global warming, sea-level rise, impact of climate change on natural resources; Global climate agreements. Pandemics; other natural hazards.


 प्र. न. वा. प्र.
 Principal

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 कला भवन-16, दिल्ली / Dhula Kuan, New Delhi-21

UNIT – V (9 Hours)

Detailed contents

Hazard mitigation: Hazard zonation; Early warning system; Engineering measures. Hazard/disaster profile of India. Disaster management cycle; Different stakeholder in disaster management; Disaster mitigation structure in India; Emergency plan.

Tutorial (30 hours)

Students in small batches or groups will be assigned different exercises about the natural hazards and resolve the key issues to handle and mitigate.

Essential/recommended readings

Edward Bryant (2005). Natural Hazards. Cambridge University Press

Smith, Keith, (2013). Environmental hazards: assessing risk and reducing disaster: Routledge Taylor & Francis Group. London.

Suggestive readings

Edward Bryant (2005). Natural Hazards. Cambridge University Press

Smith, Keith, (2013). Environmental hazards: assessing risk and reducing disaster: Routledge Taylor & Francis Group. London.

Stephen Marshak, (2013). Essential of Geology, W W Norton & Co Inc, New York

Edward A. Keller; Duane E. DeVecchio (2014). Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. Routledge.

Bell, F.G., 1999. Geological Hazards, Routledge, London.

David C. Alexander (1993). Natural Disasters. CRC Press

DEPARTMENT OF GEOLOGY
SEMESTER – V
BSC (H) Geology
Category - I

DISCIPLINE SPECIFIC CORE COURSE - DSC – 13: Economic Geology (L3, P1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 13: Economic Geology (L3, P1)	4	3	0	1	12th pass with science	Studied Earth System Science and Equivalent

Learning Objectives

This course on economic geology is provide basic knowledge and leaning to students to about morphology, structure, mineralogy, petrology and geochemistry of various ore deposits, and to help them to develop a basic idea and comprehension of different ore forming processes.

Learning outcomes

After going through this course students will develop basic understanding and skill about the characteristics and distribution of mineral resources and the knowledge on different ore-bearing geological systems. They will learn about the different processes that are responsible for producing different types of ores corresponding to different tectonic settings. They will learn about the different major ore bodies that have been identified in different parts of the India.

SYLLABUS OF DSC-7

Theory (45 hours)

UNIT – I (9 hours)

Detailed content

Introduction to ore geology: Economic and academic definitions/terminologies of ore geological components. Ore minerals and their uses. Morphology and style of ore mineralization. General textures and structures

UNIT – II (9 hours)

Detailed contents

Basic principles of an ore deposit formation: Geochemical behaviour of elements in ore geological systems. Concept of source-transporting agent-driving mechanism-trap

UNIT – III (9 hours)

Detailed contents

Ore forming processes: Magmatic ore forming processes. Hydrothermal ore forming processes. Sedimentary ore forming processes. Surficial and supergene ore forming processes

UNIT – IV (9 hours))

Detailed contents

Basic mineral economics and policies: Introduction to mineral economics related to metal and non-metallic commodities. Application of mineral economics to understand mineral commodity markets. An assessment of the mineral economics for the public and corporate policies.

UNIT – V (9 hours)

Detailed contents

Distribution of major metallic and non-metallic ore deposits in India

Practical Component- (30 Hours)

Identification of common ore minerals by physical and optical properties

Essential/recommended readings

Robb, L., 2020. Introduction to ore-forming processes. John Wiley & Sons.

Evans, A.M., 2009. Ore geology and industrial minerals: an introduction. John Wiley & Sons

Suggestive readings

Robb, L., 2020. Introduction to ore-forming processes. John Wiley & Sons.

Evans, A.M., 2009. Ore geology and industrial minerals: an introduction. John Wiley & Sons.

Bateman, A.M. and Jensen, M.L. 1990. Economic Mineral Deposits. John Wiley & Sons.

Misra, K., 2012. Understanding mineral deposits. Springer Science & Business Media.

Ramdohr, P., 2013. The ore minerals and their intergrowths. Elsevier.

Sarkar, S.C. and Gupta, A., 2012. Crustal evolution and metallogeny in India. Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC – 14: Engineering Geology ((L3, P1)

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 14: Engineering Geology (L3, P1)	4	3	0	1	12 th pass with science	Studied Stratigraphy, Earth System Science or Equivalent

Learning Objectives

The main objective of this course is to provide a basic introduction on the role of geology in slope stability and civil engineering projects. It is aimed to provide various insights of topography, lithology and geological structures to ensure the stability and economy of engineering projects.

Learning outcomes

After going through this course, students will know the basic geological and geotechnical requirements for the site selection of engineering projects. They will be able to characterize the rock-mass strength of the site for various engineering projects and suggest the necessary support system. They will be able to identify the primary causative factors of the slope failure and suggest the preliminary mitigation measures. They will be able to investigate the various geological factors to assess environmental impacts of any engineering project.

SYLLABUS OF DSC- 14

Theory (45 Hours)

UNIT – I (9 hours)

Detailed contents

Introduction to engineering geology: Principles and scope of engineering geology: material, material fabrics and environmental factors. Geological and geotechnical investigations.

UNIT – II (9 hours)

Detailed contents

Engineering properties of geological material: Rock strength; Rock aggregates; Significance of rock as construction material; Rock mass: discontinuities, Rock mass classification; Soil: strength, standard penetration test and engineering bedrock.

UNIT – III (9 hours)

Detailed contents

Engineering structures: dams, tunnels and roads: Engineering structures: Dams, tunnels, road, their types, acting forces, ground conditions; tunnelling methods; geological considerations for site selection.

UNIT – IV (9 hours)

Detailed contents

Slope failure and mitigation measures: Concept of slope failure mechanism; Landslide types and causes, landslide mapping; Engineering treatment of slope and foundations: grouting, retaining walls, rock bolting and other support mechanisms.

UNIT – V (9 hours)

Detailed contents

Site investigation and assessment for engineering structures: Site investigation and characterization; Reconnaissance survey; Environment impact assessment (EIA); Detailed project report (DPR)

Practical Component- (30 Hours)

Merits, demerits & remedial measures based upon geological cross sections of project sites. Computation of Index properties of rocks and soil. Concept, significance and computation of Rock Mass Classification schemes like Rock Structure Rating (RSR), Rock Mass Rating (RMR)/ Tunnelling Quality Index (Q)/Rock Quality Designation (RQD).

Essential/recommended readings

Krynin, D.P. and Judd, W.R. (1957). Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).

Gangopadhyay, S. (2013). Engineering geology. Oxford University Press.

Suggestive readings (if any)

Krynin, D.P. and Judd, W.R. (1957). Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).

Gangopadhyay, S. (2013). Engineering geology. Oxford University Press.

Goodman, R.E. (1993). Engineering Geology: Rock in engineering constructions. Wiley& Sons, N.Y.

Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.

Bell, F.G. (2007). Engineering Geology, Butterworth-Heinemann.

Anbalagan, R. Singh, B, Chakraborty, D. and Kohli, A. (2007) “A field Manual for Landslide investigations”. DST, Government of India, New Delhi.

Duncan C. Wyllie and Christopher W. Mah. (2004). Rock Slope Engineering. CRC Press. London.

David George Price (2009). Engineering Geology: Principles and Practice. Springer-Verlag Berlin Heidelberg

DISCIPLINE SPECIFIC CORE COURSE– DSC – 15: Geological Mapping (L2, P2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 15: Geological Mapping (L2, P2)	4	2	0	2	12th Pass with science	Studied Earth System Science, Structural Geology, and Mineralogy or Equivalent

Learning Objectives

This course on geological mapping to provide basic skills to carry out geological fieldwork in different terrains and prepare a geological map with all aspects related to lithology, structures, deformation patterns. Which is essential for basic understanding of geoscience and any detailed exploration activity.

Learning Outcomes

After going through this course, students will develop the following skills and knowledge about: How to identify a rock and broadly define its composition? How to identify and measure lithological and/or structural details of rocks at the outcrop/hand-specimen scale? How to plot the data on a base map/toposheet to create a lithological and/or structural map of the terrain? How to appreciate the possible origin of the rock and their genetic process. How to reconstruct the geological history of the terrain?

SYLLABUS OF DSC-15

Theory (30 hours)

UNIT – I (6 hours)

Introduction to toposheets and maps: Concepts of scale, contour density, numbering system. Global Positioning Systems, their types and uses. Choosing a suitable geological traverse.

UNIT – II (6 hours)

Outcrop geology: Pattern of beds in a undulating topography – rule of V. Identification of rock types, and their classification based on field criteria. Textural features of different rocks through field study and microscopy. Preparation of lithologs.

UNIT – III (6 hours)

Basic concept of structural measurements: Measurement of Strike, dip, trend, plunge, pitch etc. at the outcrop in the field. Distinguishing characters of planar and linear structures in the outcrop scale. Overprinting nature of folds/ metamorphic foliations etc.

UNIT – IV (6 hours)

Folds: Identification and structural measurement of a fold in the field. Geometric classification of a fold based on field data. Understanding the outcrop pattern of a fold in non-ideal sections

UNIT – V (6 Hours)

Faults: Distinguishing criteria of a fault in the field. Understanding the slip pattern of faults in an outcrop. Measuring the orientation of different planar and linear structures associated with a fault.

Practical Component- (60 Hours)

In the practical class, all the aforesaid techniques of measurement and identification will be demonstrated and practised in the field. The practical classes of this course will be conducted at a go through field visit (10 days) in a suitable geological terrain

Essential/recommended readings

Lahee F. H. (1962): Field Geology. McGraw Hill

Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.

Lisle, R.J., Brabham, P., Branes, J. 2011. Basic Geological mapping, Wiley

Suggestive readings

Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley

Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.

Common Pool of Discipline Specific Electives

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-3 River Science (L3, P1)	4	3	0	1	12th pass with science	Studied Earth System Science and Structural Geology or Equivalent

Learning Objectives

This course on river science is intended to provide student with basic science and understanding of the life cycle of a river especially in relation to societal development. It is to provide them knowledge and comprehension about the processes of erosion and transportation of sediments and its connection with the landforms.

Learning outcomes

After going through this course, students will be able to gain a thorough understanding of the evolution of a river. They will develop an understanding of stream hydrology concepts such as river hydrographs, river discharge, and flood frequency. Students will be able to comprehend the movement of sediments from source to sink. Students will develop the basic skills to identify different types of drainage networks and the impact of catchment morphometry and shape on the hydrological parameters of the river. Students will be able to analyze river profiles and explain their anomalies. They will be able to calculate the stream power and perform flood frequency analysis.

SYLLABUS OF DSE-3

Theory (45 hours)

UNIT – I (9 Hours)

Detailed Content

Stream hydrology: Basic stream hydrology. Physical properties of water, sediment and channel flow. River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis; Flood frequency analysis

UNIT – II (9 Hours)

Detailed Content

River basin: Sediment source and catchment erosion processes; Sediment load and sediment Yield; Sediment transport processes in rivers; Erosion and sedimentation processes in channel.

UNIT – III (9 Hours)

Detailed Content

Drainage: Drainage network; Quantitative analysis of network organization – morphometry Role of drainage network in flux transfer. Evolution of drainage network in geological time scale.

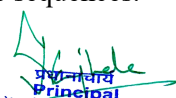
UNIT – IV (9 Hours)

Detailed Content

Rivers in time and space: River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers; Channel patterns in stratigraphic sequences. Different classification approaches in fluvial geomorphology and its applications.

UNIT – V (9 Hours)

Detailed Content


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Channels and Landscapes: Bedrock channels, Bedrock incision process; River response to climate, tectonics and human disturbance; Bedrock channel processes and evolution of fluvial landscapes. Fluvial hazards: Integrated approach to stream management. Introduction to river ecology.

Practical Component- (30 Hours)

Exercises based on River visit during weekend, Stream power calculation, Longitudinal profile analysis, Hydrograph analysis, and Flood Analysis

Essential/Recommended readings

Fryirs and Brierly (2013) Geomorphology and river management. Wiley-Blackwell Pub.

Julien, P.Y. (2002) River Mechanics. Cambridge University Press.

Recommended readings

Bridge, J.S., (2003) Rivers and Floodplain: Forms, Processes and Sedimentary Record. Blackwell Science.

Gibling, M.R., (2021) River Planet. Dunedin Press.

Wohl, E., (2010) Mountain Rivers Revisited. American Geophysical Union.

OR

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-3 Introduction to Geophysics (L3, T1)	4	3	1	0	12 th pass with science	Studied Earth System Science and Structural Geology or Equivalent

DSE-3:

Introduction to Geophysics (L3, T1)

Credit: 4

Theory (45 hours), Tutorial (30 hours)

Learning Objectives

This course on introduction to geophysics is intended to provide basic scientific knowledge to students to understand the interrelationship of geology and geophysics, which is essential to know the geodynamic behavior of the Earth and its interior. Students will be taught about the basic concepts in geophysics, different types of geophysical exploration methods, and geophysical anomalies to appreciate the geodynamics of the Earth and its resources.

Learning outcomes

After going through this course, students will be able to have an elementary knowledge and comprehension about the geophysical methods and their application to understand and explore Earth and its interior. They will also develop basic skills about the geophysical anomalies and their relation to geological process that are essential for any detailed exploration activity.

Theory (45 hours),

UNIT – I (9 Hours)

Detailed content

Basic concepts of geophysics: Interrelationship between geology and geophysics, Role of geophysics in explaining geodynamical features of the earth.

UNIT – II (9 Hours)

Detailed content

Exploration geophysics: General and Exploration geophysics: Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications; Concepts and Usage of corrections in geophysical data

UNIT – III (9 Hours)

Detailed content

Geophysical surveys: Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques; Scales of survey,

UNIT – IV (9 Hours)

Detailed content

Geophysical Methods: Application of Geophysical methods. Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics, internal structure of the Earth based on major discontinuities in seismic velocities.

UNIT – V (9 Hours)

Detailed content

Geophysical anomalies: Correction to measured quantities, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration. Integrated geophysical methods: Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

Tutorials (30 Hours)

Students in small batches or groups will be assigned to resolve different types geophysical problems concerning calculating the free air and Bouguer anomalies, determining the gravity anomaly arising due to density contrast in the subsurface, calculating paleolatitude and paleopole, numerical problems on resistivity survey, Problems on seismic survey.

Essential/Recommended readings

Kearey, P., Brooks, M. and Hill, I., 2002. *An Introduction to Geophysical Exploration*. Third Edition. Blackwell Publishing.

Lowrie, W. (2007). *Fundamentals of geophysics*. Cambridge University Press.

Mussett, A.E. and Khan, M.A., 2000. *Looking into the Earth: An Introduction to Geological Geophysics*. Cambridge University Press.

Bhimasankaram, V.L.S. (1990). *Exploration Geophysics - An Outline* by, Association of Exploration Geophysicists, Osmania University, Hyderabad.

Dobrin, M.B. (1984) *An introduction to Geophysical Prospecting*, McGraw-Hill, New Delhi.

Recommended readings

Bhimasankaram, V.L.S. (1990). *Exploration Geophysics - An Outline* by, Association of Exploration Geophysicists, Osmania University, Hyderabad.

Dobrin, M.B. (1984) *An introduction to Geophysical Prospecting*, McGraw-Hill, New Delhi.

Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics* (Vol. 1), Cambridge University press.

OR

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-2 Application of thermodynamics in petrology (L3, P1)	4	3	0	1	12th pass with science	Studied Earth System Science and Structural Geology or Equivalent

Learning Objectives

The course intends to provide the concept of various thermodynamic parameters and application of the laws thermodynamics in different petrological systems. It attempts to demonstrate the effect of pressure temperature and chemical compositions in controlling stability of different mineral associations in open and closed systems. The course intends to demonstrate the application of thermobarometers in natural systems.

Learning Outcome

After completing the course, students will learn to calculate the free energy of the system. Students will learn to construct the stability fields of different mineral associations through Gibb's free energy minimization. Student will be able to apply the thermobarometers and will be able to calculate the pressure temperature conditions of stability of different magmatic, metamorphic and economically valuable mineral associations.

Theory (45 hours)

UNIT 1 (9 hours)

Introduction to thermodynamics, Irreversible and Reversible Processes, Thermodynamic Systems and variables, Energy in the form of heat and work, First law of thermodynamics, enthalpy, entropy, second and third law of thermodynamics, concept of free energy, Gibbs equation: thermodynamic potentials, free energy of formation at any temperature and pressure, equilibrium condition in closed system.

UNIT 2 (9 hours)

Free energy surface in G–T–P space, Clausius–Clapeyron equation, Schreinemakers rules, petrogenetic grid, Concept of stability (phase) diagrams, Phase rule, Free energy of solutions, ideal and non-ideal solutions, fugacity and activity, equilibrium constant,

UNIT3 (9 hours)

Temperature and pressure dependence of equilibrium constant, Geothermometry, geobarometry, mineral reactions among solid solutions, computer-generated phase relations, Introduction to pseudosections.

UNIT 4 (9 hours)

Partial melting and fractional crystallisation in magmatic systems along different gradients, modelling the role of magmatic processes in controlling the major, trace and REE budget in the crust, modelling the effect of composition on phase stability.

UNIT 5 (9 hours)

Thermodynamics of open system, Mass and heat transfer, effect of fluid ingress and composition of fluid in controlling the stability of different phases.

Practical (30 hours)

Calculation of free energy of formation at any temperature and pressure, Plotting univariant lines in P–T diagrams, Geothermo-barometric calculation, construction of pseudosections, use of mass balancing techniques on natural rocks

Essential/Recommended readings

Philpotts, A.R. and Ague, J.J., 2022. *Principles of igneous and metamorphic petrology*. Cambridge University Press.

Spear, F.S., 1993. Metamorphic phase equilibria and pressure-temperature-time paths. *Mineralogical Society of America Monograph*, 799.

Ganguly, J., 2008. *Thermodynamics in earth and planetary sciences* (p. 501). Berlin: Springer.

COMMON POOL OF GENERIC ELECTIVES

Credit distribution, Eligibility and Pre-requisites of the Course GE-5

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
GE-5 Concepts of Sustainability (L3, T1)	4	3	1	0	12 th Pass	Nil

Learning Objectives

The course on concepts of sustainability is aimed at providing students with knowledge-based concepts to understand the challenges of global sustainability and motivate them to think about solutions to these challenges. This course is also intended to encourage students to discuss and propagate issues of sustainability with others and create awareness.

Learning outcomes

After completing this course, students should be able to understand the major challenges and opportunities in the area of global sustainability. Develop an understanding of the system concept and the interconnectivity of humans and nature. They will be able to communicate issues related to sustainability. Critically analyze problems and solutions related to global sustainability.

SYLLABUS OF GE-5

Credits 4

Theory (45 hours)

UNIT – I (12 Hours)

Detailed contents

Basic concept of sustainability: Introduction to Sustainability; basic concepts Human Population – Past and Future trends

UNIT – II (12 hours)

Detailed contents

Ecosystems: Extinctions and Tragedy of Commons; Climate and Energy; Water Resources and Agriculture

UNIT – III (9 Hours)

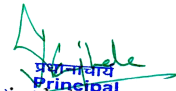
Detailed contents

National and international issues about sustainability: National Resources Accounting, Environmental Economics and Policy, Measuring Sustainability

UNIT – IV (12 Hours)

Detailed contents

Major challenges about sustainability: Systems interconnectivity among Primary Sustainability challenges Sustainability Solutions: Some examples


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 धौला कुर्गो, नई दिल्ली / Dhoola Kuan, New Delhi-21

Tutorials (30 Hours)

Students learning the concepts of sustainability will be divided in small batches or groups and assigned critical exercises and problems to resolve major issues of sustainability of national and international importance.

Essential/recommended readings

Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.

Suggestive readings

Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.

Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

DEPARTMENT OF GEOLOGY
SEMESTER – VI
BSC (H) Geology
Category - I

DISCIPLINE SPECIFIC CORE COURSE - DSC – 16: Remote Sensing and GIS (L3, P1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 16: Remote Sensing and GIS (L3, P1)	4	3	0	1	12 th pass with science	Studied Earth System Science and Equivalent

Learning Objectives

This course is intended to provide basic understanding of remote sensing, geographic information system and photogrammetry. The course also aims to familiarize the students with utilization of geo-processing tools in the field of geosciences.

Learning outcomes

After completing this course, the students will understand the basics of remote sensing and GIS techniques and their applications in various fields of the Earth Sciences. They will be able to utilize open source image processing and GIS software to make basic image correction and thematic maps. They will be able to integrate the GNSS and field-based data with the GIS to create maps for further analysis.

SYLLABUS OF DSC-16

Theory (45 hours)

UNIT – I (12 hours)

Detailed content

Fundamentals of remote sensing: Concept of remote sensing, electromagnetic spectrum, atmospheric windows, remote sensing system, sensors and scanners, remote sensing platforms, image resolution, data procurement, data formats- raster and vector, digital image processing.

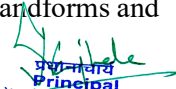
UNIT – II (12 hours)

Detailed contents

Photogeology: Types and acquisition of aerial photographs, concept of scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion. Elements of air photo interpretation, identification of the primary and secondary structures of rocks, lithology, landforms and surface processes.

UNIT – III (11 hours)

Detailed contents


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 धौला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

Geographic Information System (GIS): Introduction to GIS, datum, coordinate systems and projection systems, spatial data models and data editing. Introduction to digital elevation model (DEM) analysis. Spatial and Temporal interpolation of datasets.

UNIT – IV (10 hours))

Detailed contents

Global navigation satellite systems (GNSS): Introduction to GNSS, GPS, GPS signals. Integrating GNSS data with GIS; GNSS applications in earth system sciences and disaster studies.

Practical Component- (30 Hours)

Introduction to QGIS software, plugins in QGIS, data procurement, creating FCC from raw data, Registration of satellite images, Image enhancement, Classification of images (Visual interpretation), Classification of images (Supervised and Unsupervised), Identification of geological structures, landforms and surface processes. Stereo viewing of images. Vector data editing, Generating slope map, aspect map and drainage network map, Spatial interpolation of datasets, Introduction to GPS.

Essential/recommended readings

Gupta, R.P. Remote Sensing Geology, Springer

Bhatta, B., Remote Sensing and GIS, 2nd Edition, Oxford.

Joseph, G., and Jeganathan, C., Fundamental of Remote Sensing, University Press, Hyderabad.

Suggestive readings

Gupta, R.P. Remote Sensing Geology, Springer

Joseph, G., and Jeganathan, C., Fundamental of Remote Sensing, University Press, Hyderabad.

Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.

Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.

Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer-Verlag.

Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.

Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC – 17: Fuel Geology ((L3, P1)

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 17: Fuel Geology (L3, P1)	4	3	0	1	12 th pass with science	Studied Stratigraphy, Earth System Science, Structural Geology or Equivalent

Learning Objectives

The course on fuel geology is intended to provide basic scientific knowledge and understanding about the natural fossil fuels i.e., petroleum and coal to students of geology. Because use of petroleum resources and its exploration is the most powerful driving forces shaping our modern world.

Learning outcomes

After completion of this course students will be able to understand and comprehend the processes involved in generation of hydrocarbons and the formation of coal and the exploration methods. Students will also have a comprehension about the conventional and non-conventional fuels and their demand through time.

SYLLABUS OF DSC- 17

Theory (45 hours)

UNIT – I (9 hours)

Detailed contents

Coal: Definition and origin of Coal; Classification of coal; Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal, Proximate and Ultimate analysis.

UNIT – II (9 hours)

Detailed contents

Coal as a fuel: Coal Bed Methane (CBM): global and Indian scenario; Underground coal Gasification; Coal liquefaction

UNIT – III (9 hours)

Detailed contents

Petroleum: Chemical composition and physical properties of crudes in nature; Origin of petroleum; Maturation of kerogen; Biogenic and Thermal effect. Van Krevelen diagram

UNIT – IV (9 hours)

Detailed contents

Oil migration: Primary and secondary. Role of capillary pressure and Buoyancy. Reservoirs and Traps: Reservoir rocks: general attributes and petrophysical properties

UNIT – V (9 hours)

Detailed contents

Classification of reservoir rocks - clastic and chemical. Hydrocarbon traps: definition, Structural, Stratigraphic and Mixed. Time of trap formation and time of Hydrocarbon accumulation. Cap rocks - definition and general properties. Plate tectonics and global distribution of hydrocarbon reservoir.

Practical Component- (30 Hours)

Study of hand specimens of coal. Reserve estimation of coal. Section correlation and identification of hydrocarbon prospect. Panel and Fence diagrams

Essential/recommended readings

Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.
Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

Suggestive readings (if any)

Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.
Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jinasa Publishing House
North, F.K., 1985 Petroleum Geology
Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum
prospectivity of the continental margins of India (Vol. 59). Newnes.

DISCIPLINE SPECIFIC CORE COURSE– DSC – 18: Paleoceanography and Paleoclimate (L3, P1)

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC – 18: Paleoceanography and Paleoclimate (L3, P1)	4	3	0	1	12th pass with science	Studied Earth System Science, Structural Geology, and Mineralogy or Equivalent

Learning Objectives

The course is intended to make students aware about the climate changes through geological time periods, the chaotic nature of the Climate System, its behaviour at various time scales, and its influence on biotic system. Students will also be introduced to futuristic approaches and projections of the Inter-Governmental Panel of Climate Change, and scientific issues related to climate change. As the Oceans cover 70 percent of the Earth's surface understanding the evolution of oceans through time is essential to understand their role in controlling the earth's climate at various time scales.

Learning Outcomes:

After completing the course, the student will be able to comprehend the role of Oceans in controlling the Earth's climate at various time scales. The students will be able to independently interpret the proxy record generated from various paleoclimate archives. Archives. The student will develop an overall understanding of the Ocean-Climate linkages, Tectonics -climate linkages and modern climate change.

SYLLABUS OF DSC-18

Theory (45 hours)

UNIT – I (9 hours)

Detailed contents

Weather, Climate, Components of climate, Climate classification. Insolation, short and long-term changes in Insolation.

UNIT – II (9 hours)

Detailed contents

Aerosols: Definition, origin, role in climate change. Greenhouse gases: Introduction, causes of changing concentration, role in climate change.

UNIT – III (9 hours)

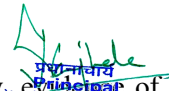
Detailed contents

Origin and evolution of Oceans. Closing and opening of Ocean Gateways and the resultant effect on climate. Climate of the Arctic and Antarctica through the ages. Bipolar See Saw, Polar Amplifications. Ice core studies and climate change. Oceanic sediments, Terrigenous, biogenic sediments, and their distribution.

UNIT – IV (9 hours)

Detailed contents

Sea-level: factors affecting sea-level changes, Short and long-term sea-level variability, evidence of sea-level change from marine sediments. Ocean-climate linkage. Effect of topography on climate. Natural variability in climate. Human influence on climate change.


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UNIT – V (9 hours)

Detailed contents

Historical evidence of climate change. Effects of climate change on mankind. Sampling methods for retrieving archives of climate/oceanographic change. Various dating methods of the marine cores., merits and demerits of various dating methods Paleoclimatic/paleoceanographic reconstruction from archives. Elemental and isotopic analysis for paleoclimatic/paleoceanographic reconstruction, Instruments used for paleoclimatic/paleoceanographic studies. Modeling climate change, IPCC climate change projections.

Practical Component- (30 Hours)

Processing of marine core samples for paleoclimatic/ paleoceanographic studies. Exercises in oceanography. Interpretation of various types of paleoceanographic and paleoclimatic data.

Essential/recommended readings

Bradley, R.S., Paleoclimatology: Reconstructing Climates of the Quaternary, Academic. Press.
Brasier, M.D. 1980 Microfossils, George Allen and Unwin.

Suggestive readings

Frank J Millero, Chemical Oceanography, CRC Press, Taylor and Francis Group, 2013
Alan Trujillo (Author), Harold Thurman (Author), Essentials of Oceanography 13th Edition, 2023, Pearson Education.
Bradley, R.S., Paleoclimatology: Reconstructing Climates of the Quaternary, Academic. Press.
Brasier, M.D. 1980 Microfossils, George Allen and Unwin.
Cronin, T.M., 1999. Principles of Paleoclimatology, Columbia University Press.
Fischer, G. and Wefer, G 1999 Use of Proxies in Paleoceanography: Examples from the South Atlantic, Springer.
Haq and Boersma, 1978. Introduction to Marine Micropaleontology, Elsevier.
Kennett, J.P.1982 Marine Geology, Prentice-Hall Inc.
North, G.R. and Crowley, T.J., 1995. Palaeoclimatology, Oxford University Press
Schopf, T.J.M., 1980. Paleoceanography, Harvard University Press.
Tolmazin, D., 1985. Elements of Dynamic Oceanography, Allen and Unwin.

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVES

Discipline Specific Elective (DSE-4): Exploration Geology or Geophysics or Application of Hydrogeology in Industries and Mining (L3, P1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-4 Exploration Geology (L3, P1) or Research Methods in Geoscience (L3, P1) or Application of Hydrogeology in Industries and Mining (L3, P1)	4	3	0	1	12 th pass with science	Studied Earth System Science and Structural Geology, Hydrogeology or Equivalent

DSE-4: Exploration Geology (4 credits)
Theory (45 hours)
Practical (30 hours)

Learning Objectives

The course on exploration geology is intended to provide introductory knowledge of mineral exploration at different stages through geological, geochemical, geophysical, and remote sensing methods. Students will also be provided basic understanding about the estimation of reserves.

Learning outcomes

After going through this course, students will have a clear idea and knowledge about the exploration methods and tools, and their application in mineral resource exploration and exploitation.

SYLLABUS OF DSE-4 (Exploration Geology)

Theory (45 Hours)

UNIT – I (9 Hours)

Detailed content

Introduction to exploration geology: Definitions and different terminologies of exploration components. Basic exploration and exploitation steps or stages. Classification of mineral deposits with respect to exploration strategies. Mineral resources and their uses

UNIT – II (9Hours)

Principles of mineral exploration: Importance of mineralogy, grain size-shape and texture in exploration. Mineral identification and analytical techniques. Sampling techniques, drilling and logging. Estimation of grade in samples.

UNIT – III (9 Hours)

Detailed content

Prospecting and exploration: Surficial survey methods and applications. Geochemical survey methods and applications. Geophysical survey methods and applications. Remote sensing methods and applications

Unit – IV (9 Hours)

Detailed content

Importance of drilling and logging in exploration: Core and non-core drilling. Basic parts of drilling machine. Types of drilling techniques. Planning and location of bore holes on ground.

Unit – V (9 Hours)

Detailed content

Principles of reserve estimation: Reserves estimation methods and models. Critical geological data to be considered. Factors affecting reliability of reserve estimation and types of errors. Evaluation of sampling data: mean, median, mode, standard deviation and variance.

Practical Component- (30 Hours)

Exercises based on Evaluation of data Average grade and reserve estimation techniques. Geological cross-section and borehole problems.

Essential/Recommended readings

Moon, C.J., Whateley, M.K.G. & Evans, A.M. 2006. Introduction to Mineral Exploration, Blackwell Publishing.

Halдар, S.K., 2013. Mineral Exploration – Principles and Applications. Elsevier Publication.

Recommended readings

Moon, C.J., Whateley, M.K.G. & Evans, A.M. 2006. Introduction to Mineral Exploration, Blackwell Publishing.

Halдар, S.K., 2013. Mineral Exploration – Principles and Applications. Elsevier Publication.

Arogyaswami, R.P.N.(1996. Courses in Mining Geology. 4th Ed. Oxford-IBH.

Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.

or

DSE-4: Research Methods in Geoscience (L3, P1)

Credits: 4

Theory: 45 hours

Practical: 30 hours

Learning Objectives

Main objective of this course to provide an introduction to research methods relevant to geoscience through lectures and practical training about literature review, proper referencing and citation, professional ethics, geoscience hypotheses, analytical techniques, data analysis, preparation of scientific reports and proposals.

Learning outcomes

After successful completion of this course, students will have a basic understanding and be able to develop a research plan related to critical issues in geoscience. The students will also be able to develop skills to synthesise scientific ideas and appreciate the scope of research work in geoscience.

SYLLABUS OF DSE-4

Research Methods in Geoscience (4 credits)

Theory (45 hours)

UNIT – I (9 Hours)

Detailed Content

Fundamentals of research in geoscience: Concept and definitions of research issues in geoscience, types of research in geosciences, testing of hypothesis in geosciences, literature survey of scientific articles relevant to geoscience, critical gaps and key questions to resolve through scientific research in geoscience.

UNIT –II (9 Hours)

Detailed Content

Planning and development of research work: Defining major objective and sub-objectives of geological research in a particular field. Assessment of required methodologies and experimental setups. Types of field and laboratory data, time period and key milestones of the progress, synthesis of acquired data and writing of thesis.

UNIT –III (9 Hours)

Detailed Content

Analytical techniques: Geological fieldwork and collections of representative samples, sample preparation, petrographic techniques, mineralogical and geochemical analytical techniques.

UNIT –IV (9 Hours)

Detailed Content

Data handling and statistical treatments: Basic statistical methods, correlation and regression, principal component analysis, factor analysis, cluster analysis, making of different geological maps and figures using software's.

UNIT –V (9 Hours)

Detailed Content

Writing of thesis and scientific reports: Review of concerned geoscience research articles. Introduction, significance and utility of the concerned geoscience research. Easy to follow stepwise chapters on different aspects of the research work. Synthesis and interpretations, conclusions, referencing, bibliographies, ethics and plagiarism.

Practical: 30 hours

Students will be exposed to basic instrumentation facilities and their working, such as thin section preparation, petrographic analysis, mineralogical and geochemical analytical techniques and writing of project reports.

Essential readings

Lisle, R.J., Brabham, P., Branes, J. 2011. Basic Geological mapping, Wiley

Wilson M. J. 1987. A handbook of determinative methods in clay mineralogy. Blackie

Recommended readings

Lindholm, R.C. 1963. A practical approach to Sedimentology, Allen & Unwin
Faure, G. and Mensing, T.M. 2009. Isotopes principles and Applications. Willey.

Jackson M. (1975) Soil Chemical Analysis–Advanced Course: 10th printing, published by author, Dept. Soil Science, University of Wisconsin, Madison, Wisconsin.

Or

Application of Hydrogeology in Industries and Mining (L3, P1)

Credits: 4

Theory: 45 hours

Practical: 30 hours

Learning Objectives

The course introduces the students to the legal and constitutional framework of ground water governance in India. It aims to provide knowledge about the scientific processes and protocols involved in impact assessment and comprehensive hydrogeological studies for developmental projects involving groundwater extraction.

Learning outcomes

After completing the course, students will become familiar with the salient aspects of India's ground water governance framework. They will develop an understanding of the groundwater resources estimation methods, and acquire basic skill to undertake impact assessment, comprehensive hydrogeological and water audit studies for developmental projects involving groundwater extraction. Learners will be trained to write professional grade Impact Assessment Report, Comprehensive Hydrogeological Report and Water Audit Report. They will be skilled with capability of formulating and processing No Objection Certificate (NOC) application for ground water extraction.

SYLLABUS OF DSE-4

Application of Hydrogeology in Industries and Mining (4 credits)

Theory (45 hours)

Unit 1: (9 hours)

Detailed content

Ground water governance: Ground water ownership: The Indian Easement Act 1882. Constitutional provisions regarding ground water. National Water Policy. Environment Protection Act 1986 – Central Ground Water Authority (CGWA) and State Ground Water Regulatory Bodies. National Green Tribunal.

Unit 2: (9 hours)

Detailed content

Guidelines to regulate and control ground water extraction in India: Preamble and background: exemptions from seeking No Objection Certificate, Drinking & Domestic use for Residential apartments/ Group Housing Societies/ Government water supply agencies in urban areas, Agriculture Sector, Commercial Use, Industrial Use, Mining Projects, Infrastructure projects, Ground water abstraction/ restoration charges, Bulk Water Supply, Abstraction of Saline ground water, Protection of Wetland Areas, General compliance conditions in No Objection Certificate, Monitoring of compliance of No Objection Certificate Conditions, Renewal and extension of No Objection Certificate, Delegation of powers against illegal ground water withdrawal, Ground Water Level Monitoring, Environmental Compensation, Provision of penalty and other important conditions. No Objection Certificate Application Portal (NOCAP). Water Audit Report. Accreditation of Ground Water Professionals.

Unit 3: (9 hours)

Detailed content

Ground Water Resources Estimation: Dynamic ground water resources of unconfined aquifers for command and non-command areas: assessment unit, estimation of monsoon and non-monsoon recharge from all sources and provision for natural discharges, estimation of monsoon and non-monsoon extraction by different sectors, categorization of assessment blocks and validation. Poor ground water quality area. Waterlogged and shallow water table areas. In-storage ground water resources of unconfined aquifer. INGRES portal.

Unit 4: (9 hours)

Detailed content

Impact Assessment Report (IAR): Buffer zone demarcation, Land Use Land Classification (LULC), Digital Elevation Model (DEM), geomorphology, details of water bodies, geological set up. Hydrogeological set up: aquifer characteristics, depth to water level, water table contours and ground water flow, surface ground water interaction, hydrogeological map, seasonal and long-term water level fluctuation, ground water quality, water quality of nearby water bodies. Assessment of impact of proposed ground water extraction using analytical modelling/numerical solutions, etc. Socio-economic analysis and mitigation measures. Case studies.

Unit 5:

Detailed content

Comprehensive Hydrogeological Report (CHR): Buffer zone demarcation, Land Use Land Classification (LULC), Digital Elevation Model (DEM), geomorphology, details of water bodies, geological set up. Hydrogeological set up: geophysical studies and aquifer characteristics, depth to water level, water table contours and ground water flow, surface - ground water interaction, hydrogeological map, seasonal and long-term water level fluctuation, ground water quality, water quality of nearby water bodies. Mine plan and seepage estimation. Assessment of impact of proposed ground water extraction using analytical modelling/numerical solutions, etc. Socio-economic analysis and mitigation measures. Case studies.

Practicals (30 hours)

Students will be trained to carry out Ground Water Resource estimation, hands on exercises on IAR and CHR, hands on exercises on Water Audit, and exercises based on analytical modelling/numerical solutions for impact assessment, mine seepage estimation analysis.

Essential readings

Todd, D.K., 2004. Ground Water Hydrology, John Wiley & Sons, New York.
Fetter, C.W., 1984. Applied Hydrogeology, McGraw-Hill Book Co., New York
Ministry of Jal Shakti (Department of Water Resources, River Development and Ganga Rejuvenation) (Central Ground Water Authority). Guidelines to regulate and control ground water extraction in India. Notification No. 2941. The Gazette of India: Extraordinary [Part II—Sec. 3(ii)]. 24th September, 2020. Weblink: <https://cgwb.gov.in/CGWA/CGWA%20New%20Guidelines%202020.pdf>

Recommended Readings

Raghunath, H.M., 1987. Ground Water, Wiley Eastern Ltd., Calcutta.
Ministry of Water Resources, River Development & Ganga Rejuvenation Government of India. 2017. Report of The Ground Water Resource Estimation Committee (GEC-2015) Methodology. Weblink: http://cgwb.gov.in/Documents/GEC2015_Report_Final%2030.10.2017.pdf
Central Ground Water Authority, Ministry of Jal Shakti. 2022. Standard Operating Procedures: Impact Assessment Report and Comprehensive Hydrogeological Report. Weblink: <https://cgwa-noc.gov.in/landingpage/UserAssistance/ImpactAssessmentRepMin3.pdf>
Central Ground Water Authority, Ministry of Jal Shakti. 2023. Notification of Guidelines dated 24th September 2020 & Amendments dated 29th March 2023: Standard Operating Procedure for Implementation of Guidelines. Weblink: <https://cgwa-noc.gov.in/LandingPage/UserAssistance/STANDARDOPERATINGPROCEDUREV-9.1.pdf>
are updated at regular intervals and the updated SOP from CGWA site will be added (update SOP material)

COMMON POOL OF GENERIC ELECTIVES

One GE from GE pool (GE-6): Evolution of life through time (L3, T1)

Credit distribution, Eligibility and Pre-requisites of the Course GE-5

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
GE-6 Evolution of life through time (L3, T1)	4	3	1	0	12th Pass	Nil

Learning Objectives

The main objective of the course is to make the student aware about the evolution of life through geological time from simple prokaryotic to complex multicellular life forms, and the role of geological processes and climatic events in shaping the evolution of life on the Earth.

Learning outcomes

On completion of the course, the student will be able to learn how fossilization processes operate in nature and what early planetary conditions led to the origin and evolution of early life. The student will also be able to understand mass extinction events in the Phanerozoic Era and their causes, and how various geological and climatic events influenced the evolution of life and how life itself has influenced the geological processes.

SYLLABUS OF GE-6

Theory (45 hours)

UNIT – I (9 Hours)

Detailed contents

Life through ages: Fossilization processes and modes of fossil preservation, exceptional preservation; Geological Time Scale with emphasis on major bio-events.

UNIT – II (9 hours)

Detailed contents

Geobiology: Biosphere as a system, processes and products; Biogeochemical cycles; Abundance and diversity of microbes, extremophiles; Microbes-mineral interactions, microbial mats.

Origin of life; possible life sustaining sites in the solar system.

UNIT – III (9 Hours)

Detailed contents

Archean life: Earth's oldest life, the oxygen revolution and radiation of life.

Proterozoic life: The Garden of Ediacara and the evolution of metazoan life.

UNIT – IV (9 Hours)

Detailed contents

Palaeozoic Life: The Cambrian Explosion of Life; Biomineralisation and the fossil record.

Palaeozoic Marine Life; Origin and progression of vertebrates; Early adaptations of plants to terrestrial life.

Mesozoic Life: Life after the largest (P/T) mass extinction, life in the Jurassic seas, dinosaurs, mammals; Rise and fall of dinosaurs; Origin of birds; and spread of flowering plants.

UNIT – V (9 Hours)

Detailed contents

Cenozoic Life: Radiation of placental mammals following K/Pg mass extinction; Evolution of modern grasslands and co-evolution of hoofed grazers; Palaeocene-Eocene Thermal Maximum (PETM) deep time analogue for modern greenhouse state; Back to water – Evolution of Whales; The age of humans; Hominid dispersals and climate setting

Tutorial (30 hours)

Students in different batches or groups will be given exercises to prepare short reports about the life evolution and extinction through different geological times on Earth.

Essential/recommended readings

Stanley, S.M. & Luczaj, J.A. (2014). Earth System History (4th Edition), W.H.Freeman (Macmillan)
Cowen, R. (2000). History of Life. Wiley-Blackwell.
Benton, M.J. & Harper, D.A.T. (2016). Introduction to Paleobiology and the fossil record. Wiley

Suggestive readings

Stanley, S.M. & Luczaj, J.A. (2014). Earth System History (4th Edition), W.H.Freeman (Macmillan)
Cowen, R. (2000). History of Life. Wiley-Blackwell.
Benton, M.J. & Harper, D.A.T. (2016). Introduction to Paleobiology and the fossil record. Wiley
Canfield, D.E. & Konhauser, K.O. (2012). Fundamentals of Geobiology, Blackwell.
Suggested Reading:
Cowen, R. (2000). History of Life. Wiley-Blackwell.
Lumine, J.I. (1999). Earth-Evolution of a Habitable World, Cambridge University Press.
Lieberman, B.S. & Kaesler, R. (2010). Prehitoric Life-Evolution and the Fossil Record, Wiley-Blackwell.
Lieberman, B.S. & Kaesler, R. (2010). Prehitoric Life-Evolution and the Fossil Record. Wiley-Blackwell.
Cockell, C., Corfield, R., Edwards, N. & Harris, N. (2007). An Introduction to the Earth-Life System Cambridge University Press.

Department of Zoology

SEMESTER-IV BSc (Hons.) Zoology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

DISCIPLINE SPECIFIC CORE COURSE -10 – : Comparative Anatomy of Vertebrates Zoo-DSC-10

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Comparative Anatomy of Vertebrates Zoo-DSC-10	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	Basic knowledge of Vertebrates

Learning Objectives

The learning objectives of this course are as follows:

- to impart in-depth knowledge about the structural patterns and a comparative account of the different organ systems of vertebrates.
- to understand the account of the functional and comparative morphology provides a deep understanding of animal diversity and the adaptive changes the vertebrates have gone through during evolution from common ancestors
- to help students identify the body plan types of complex chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.
- to apprise the students about the correlation of comparative development to evolutionary biology and phylogeny, and how it helps in classifying animals.
- to enable students to establish the evolutionary links based on fossil records.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the evolutionary significance of comparative anatomy.
- understand the importance of morphology and anatomy of organisms in relation to evolution.
- appreciate the comparative anatomy among vertebrates that provides evolutionary evidences.
- enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

SYLLABUS OF DSC-10

UNIT 1: Integumentary System Structure and derivatives of integument.	4 hrs
UNIT 2: Digestive System Alimentary canal and associated glands; Dentition.	4 hrs
UNIT 3: Circulatory System General plan of circulation; Evolution of heart and aortic arches.	4 hrs
UNIT 4: Respiratory System Skin, gills, lungs, accessory respiratory organs in fishes, air sacs.	4 hrs
UNIT 5: Skeletal System Outline of axial and appendicular skeleton; Concept of neurocranium, dermatocranium and splanchnocranium; Structure of a typical vertebra and its classification based on centrum; Jaw suspensorium; General plan of girdles and limbs.	5 hrs
UNIT 6: Nervous System Comparative account of brain; Cranial nerves in mammals.	3 hrs
UNIT 7: Sense Organs Classification of receptors; Structure and function of mammalian eye and ear.	3 hrs
UNIT 8: Urinogenital System Succession of kidney; Evolution of urinogenital ducts; Types of uteri in mammals.	3 hrs
Practical (Laboratory periods: 15 classes of 4 hours each)	(60 hrs)
1. Study of different types of feathers of birds. 2. Study of the disarticulated skeleton of Frog, Varanus, Fowl, Rabbit (Vertebral Column, Sternum, Girdles, Ribs, Limb bones). 3. Study of the vertebrate Skull (i) one herbivorous and one carnivorous animal skull; (ii) one monocondylic and one dicondylic skull. 4. Study of carapace and plastron of turtle/tortoise. 5. Study of the digestive, circulatory and urinogenital system of frog/rat through videos on dissection or through virtual dissections. 6. Project related to topics covered in theory. 7. Field trips/Documentary film show on vertebrates/Visit to Zoological Park, Biodiversity Park or Sanctuary.	

8. Student Presentation: Power point presentation on any two animals from two different classes.

Essential/recommended readings

1. Kardong, K.V. (2005) Vertebrate's Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.

Suggestive readings

1. Leiem C.F., Bermis W.E, Walker, W.F, Grande, L. (2001) Functional anatomy of the vertebrates, An evolutionary perspective. III Edition, Brookes/Cole, Cengage Learning.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -11 – : Developmental Biology Zoo-DSC-11

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Developmental Biology Zoo-DSC-11	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	Basic knowledge of Chordates

Learning Objectives

The learning objectives of this course are as follows:

- to provide an in-depth knowledge on the embryonic and post embryonic developmental processes.
- to apprise the students of the fascinating aspect of the development of a single fertilized egg to mature into a fully developed complex organism.
- to explain the basic principles and concepts the developmental processes from a single cell system to a multi-cellular system.
- to understand morphogenesis in Sea urchin, Drosophila, Frog and Chick.
- to provide the undergraduate students an in-depth knowledge on the embryonic

and post embryonic developmental processes.

- by understanding the developmental processes, the students can relate to errors occurring during development leading to congenital disorders and human diseases.
- to familiarize the students with the technique of IVF and pre-diagnostic methods to identify any abnormality arising during development.
- To make the students aware of the areas of great interest including stem cell therapy, tissue engineering and regenerative medicine.

Learning Outcomes

By studying this course, students will be able to

- appreciate the events that lead to the formation of a multicellular organism from a single fertilized egg.
- better understand the general patterns and sequential developmental stages during embryogenesis.
- gain knowledge of the general mechanisms involved in morphogenesis.
- comprehend the processes of ageing to improve the overall health and quality of life in aged people.
- acquire basic knowledge and importance of latest techniques like stem cell therapy, *in vitro* fertilization and amniocentesis etc.
- develop the skill to raise and maintain culture of model system- *Drosophila* in the laboratory.

Syllabus of DSC-11

UNIT- 1: Introduction

2 hrs

Historical perspectives and basic concepts: Phases of development, Pattern formation, Differentiation and growth, Cytoplasmic determinants.

UNIT- 2: Early Embryonic Development

12 hrs

Gametogenesis: oogenesis, spermatogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal), Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps; Gastrulation in frog and chick, Embryonic induction and organizers.

UNIT- 3: Late Embryonic Development

6 hrs

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure, types, and functions of placenta.

UNIT- 4: Post Embryonic Development

6 hrs

Metamorphosis and its hormonal regulation in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: concepts and theories.

UNIT- 5: Implications of Developmental Biology

4 hrs

Teratogenesis: Teratogenic agents and their effects on embryonic development; *in-vitro* fertilization, Embryonic stem cell (ESC), Amniocentesis.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula (Neural plate, Neural fold and Neural tube stages), tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7- 24 hours, Stage 8-28 hours, Stage 10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation
3. *in vivo* study of chick embryo development by windowing and candling methods. (Demonstration only)
4. Study of indirect development and metamorphosis by rearing any one insect.
5. Study of different sections of placenta (photomicrographs/ slides).
6. Project report on *Drosophila* or any insect culture/Visit to Poultry Farm/IVF Centre
7. Student Presentation: Power point presentation on any topic related to developmental biology.

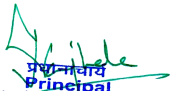
Essential/recommended readings

1. Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.
2. Gilbert, S. F. (2010) Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
3. Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.
4. Balinsky B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.

Suggestive readings

1. Baweja, V. and Misra, M. (2021) E-book on Practical Manual of developmental Biology.
2. Arora, R. and Grover, A. (2018) Developmental Biology: Principles and Concepts. I Edition, R. Chand & Company.
3. Wolpert, L. (2002) Principles of Development. II Edition, Oxford University Press.
4. Kalthoff, K. (2001) Analysis of Biological Development. II Edition, McGraw Hill Publishers.

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DISCIPLINE SPECIFIC CORE COURSE– 12:**Animal Behaviour Zoo-DSC-12****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Animal Behaviour Zoo-DSC- 12	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To provide an overview of animal behaviour in a scientific study of the wild and the wonderful ways in which animals interact with each other, with other living beings, and with the environment.
- to understand and appreciate different types of animal behaviour, their adaptive and evolutionary significance.
- to equip the students with an ability to pursue career in behavioural ecology other related areas.
- to apprise the students of the versatility of Animal behaviour and its crosstalk among conservation biology, molecular biology, behavioural ecology and integrated pest management.

Learning Outcomes

By studying this course, students will be able to:

- comprehend various types of animal behaviour and their importance.
- observe, analyse, interpret and document the different types of behaviour.
- enhance their skills by taking short projects pertaining to Animal behaviour.
- appreciate and develop passion to biodiversity; and respect the nature and environment.
- better understand and relate the fundamentals and advanced concepts so as to develop a strong foundation that will enable them to acquire skills and knowledge.

SYLLABUS OF DSC-12**UNIT- I Introduction to Animal Behaviour****4 hrs**

Origin and history of ethology; Pioneers of modern ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behavior.

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UNIT- 2 Mechanisms of Behaviour**5 hrs**

Innate behaviour, Instinct, Stimulus filtering, Sign stimuli, Code breakers.

UNIT- 3: Patterns of Behaviour**5 hrs**

Orientation: Primary and secondary orientation; Kinesis - orthokinesis, klinokinesis;

Taxis: tropotaxis and klinotaxis, menotaxis (light compass orientation).

Learning: Associative learning, Classical and operant conditioning, Habituation, Imprinting;

Reasoning: Intelligence and artificial intelligence.

UNIT- 4: Communication**3 hrs**

Importance of communication; Role of Tactile, Chemical, Auditory, Visual stimuli in communication.

UNIT- 5: Social Behaviour**4 hrs**

Concept of Society; Insects' society; Honey bee: Society organization, polyphenism and polyethism; Foraging in honey bee, round dance, waggle dance; Experiments to prove distance and direction component of dance; Formation of new hive/queen.

UNIT- 6: Altruism**3 hrs**

Altruism, Inclusive fitness, Hamilton's rule

UNIT 7: Sexual Behaviour**6 hrs**

Asymmetry of sex; Sexual dimorphism, mate choice; Intra-sexual selection (male rivalry); Inter- sexual selection (female choice); Courtship behaviour, Courtship behavior in 3-spine stickleback; Infanticide; Parental care, sexual conflict in parental care.

Practical**(60 hrs)****(Laboratory periods: 15 classes of 4 hours each)**

1. Tools, techniques and methods used in studying animal behavior.
2. To study nests and nesting behaviour of the birds and social insects.
3. To study the behavioural responses of wood lice to dry and humid conditions.
4. To study geotaxis behaviour in earthworm.
5. To study the phototaxis behaviour in insect larvae.
6. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects and birds, and parental care from short videos/movies. At least two videos for each behaviour.
7. Construction of ethogram using suitable data to study animal behaviour.
8. Visit to Forest/Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.

Essential/recommended readings

1. John Alcock, (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
2. Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, VI th Edition, Cambridge University Press, UK.
3. McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK.

Suggestive readings

1. Rubenstein, D. (2022) Animal Behavior, XIIth Edition, Sinauer Associates, Oxford University Press, UK.
2. Gadagkar, R. (2021) Experiments in Animal Behaviour: Cutting-Edge Research at Trifling Cost, Indian Academy of Sciences. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.

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POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES

SEM IV

DISCIPLINE SPECIFIC ELECTIVES (DSE-5): Bioenergetics and Enzymology Zoo-DSE-5

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Bioenergetics and Enzymology Zoo-DSE-5	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Basic knowledge of Biochemistry	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to develop a holistic understanding of the complex enzymatic reactions occurring within body through lectures, practical and laboratory exercises, assignments, seminars and visit to research Institutes.
- to appreciate the basic laws of thermodynamics; free energy, and equilibrium to acquire the knowledge to introspect and understand the core concepts of biochemistry
- to build upon undergraduate-level knowledge of biochemical principles with specific emphasis on concepts of transfer of energy in different metabolic pathways.
- to learn about the basic tools used over and over in biological reactions.

Learning Outcomes

By studying this course, students will be able to

- differentiate between the "high energy" biomolecules with respect to their hydrolysis and group transfers.
- appreciate the energy stored in reduced organic compounds that can be used to reduce cofactors such as NAD⁺ and FAD, which serve as universal electron carriers.
- Increase the understanding of the function of electron-transport chain in mitochondria and the chemi-osmotic theory involved in ATP synthesis.
- explain the thermodynamic basic principles for energy transformation in biological membranes.

- use spectroscopic and other physical analytical methods to use membrane proteins and biological redox processes.

SYLLABUS OF DSE-5

UNIT- 1: Principles of Biophysical Chemistry

5 hrs

Concept of pH, buffers, Principles of thermodynamics: free-energy, entropy, enthalpy, chemical bonds and stabilizing interactions: van der Waals, electrostatic, hydrogen bonding and hydrophobic interactions.

UNIT- 2: Bioenergetics:

9 hrs

Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change.

High energy phosphate compounds- introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG . Transfer of energy: Electron Transport Chain, Bioenergetics of the liver.

UNIT- 3: Kinetics of enzyme action

10 hrs

Concept of ES complex, Derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of K_m and V_{max} and their physiological significances. Importance of K_{cat}/K_m . Kinetics of zero and first order reactions.

Classification of multi substrate reactions with example of each class. Ping Pong random and ordered BiBi mechanisms. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanisms.

Reversible (glutamine synthase and phosphorylase) and irreversible (proteases) inhibition. Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, Suicide inhibitor.

UNIT- 4: Mechanism of Enzyme Action

8 hrs

Cofactor dependency, pH, temperature and ionic strength dependency; Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain and distortion theory. Chemical modification of active site groups. Mechanism of action of chymotrypsin.

UNIT V: Enzyme Regulation**7 hrs**

Feedback inhibition and feed forward stimulation; Allosteric enzymes: qualitative description of “concerted” & “sequential” models for allosteric enzymes; Half site reactivity, Flip-flop mechanism, positive and negative co-operativity.

UNIT VI: Multi-enzyme system:**6 hrs**

Occurrence, isolation and their properties: Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.

Practical**(30 hrs)****(Laboratory periods: 15 classes of 2 hours each)**

1. Titration of a weak acid using a pH meter, preparation of buffers
2. Verification of Beer-Lambert's law and determination of absorption coefficients.
3. Preparation of cytochrome C from goat/chicken heart and distinguish between different cytochromes in ETC using absorbance spectra.
4. Isolation of NAD from brewer's yeast. Calculate Gibbs' Free Energy for electron flow from reduced NADH to Oxygen.
5. Assay of enzyme activity and specific activity, e.g. acid phosphatase, alkaline phosphatase, SGOT, SGPT.
6. Determination of K_m and V_{max} using Lineweaver-Burk graph. (Dry experiment).
7. Enzyme inhibition - calculation of K_i for competitive inhibition. (Dry experiment)
8. Perform complex energy calculations that can be applied to biological systems. (Dry experiment)

Essential/recommended readings

1. Lehninger by D. Nelson, and M. Cox, (2017) “The principles of Biochemistry”, 7 th edition, M.W.H. Freeman and Company, New York.
2. D. M. Greenberg, (2014) “Metabolic Pathways”, 3rd edition, Academic Press, Elsevier Science & Technology Books,
3. David G. Nicholls and Stuart J. Ferguson (2013) “Bioenergetics 4”, Academic Press.
4. L. Stryer, (2012) “Biochemistry”, 7 th edition, W.H. Freeman and Company, New York.

Suggestive readings

1. J. M. Berg, J. L. Tymoczko, L. Stryer (2007) “Biochemistry”, 6th edition, W. H. Freeman and Company, New York, NY, 2007.
2. D.J. Voet, J.G. Voet, C.W. Pratt, (2008) “Principles of Biochemistry” 3rd edition, John Wiley & Sons, Inc.

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DISCIPLINE SPECIFIC ELECTIVES (DSE-6): Cell Growth and Regulation
Zoo-DSE-6

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Cell Growth and Regulation Zoo-DSE- 6	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Basic knowledge of Cell Biology	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to enable students to learn biological phenomenon at cellular level
- to develop an understanding of cell function and its regulatory mechanisms.
- to understand cell division, cell cycle and its regulation, growth factors, survival factors; cell cycle control systems and checkpoints.
- to provide in-depth knowledge on various experimental skills and histopathological studies used in clinical and research laboratories
- to acquire knowledge in the areas of cellular malfunctioning causing serious health conditions such as autoimmune disorders, cancers etc.

Learning Outcomes

By studying this course, students will be able to:

- appreciate the diverse cellular processes, cell signaling, and cellular interactions.
- Know more about the defects in cellular functioning and molecular mechanisms that can lead to diseases and disturb the homeostasis of the body.
- to elucidate the roles of cell signalling in gene regulation
- appreciate differences in normal and cancer cell, apoptosis vs. necrosis; cell death and cell renewal
- observe stem cells and their applications in therapeutic cloning and regenerative medicine.
- Know the fundamentals of targeted cancer therapies and molecular approaches to cancer treatment.

SYLLABUS OF DSE- 2

UNIT 1: Cell division, Cell Cycle, and its Regulation

10 hrs

A brief study of stages and events during mitosis and meiosis; overview of cell cycle; mitogens, growth factors, and survival factors; cell cycle control system: components and mechanisms; cell cycle checkpoints.

UNIT- 2: Cell Signalling

7 hrs

Types of cell-cell signalling, signalling molecules, and cell receptors; components of a generalized signalling pathway; examples of two pathways: GPCR/ cAMP/ PKA/ CREB/ target gene and a nuclear receptor pathway (to elucidate roles in gene regulation).

UNIT 3: Gene Regulation

9 hrs

Concepts of positive and negative gene regulation; principles of eukaryotic transcriptional regulation of genes; concepts of activators, repressors, silencers, and enhancers.

UNIT- 4: Cell Death and Cell Renewal

9 hrs

Apoptosis vs. necrosis; intrinsic and extrinsic pathways of programmed cell death; stem cells and maintenance of adult tissues; cells in culture and cell lines; embryonic and induced pluripotent stem cells and their applications in therapeutic cloning and regenerative medicine.

UNIT 5: Cancer Biology

10 hrs

Hallmarks of a cancer cell; types and causes of cancer; oncogenes and tumour suppressor genes; tumour viruses; correlation of cell signaling, gene regulation, cell cycle control, and cell death in cancer development (any one example); targeted cancer therapies/molecular approaches to cancer treatment.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Principles of Microscopy.
2. Preparation of a temporary slide of onion root tip to study various stages of mitosis.
3. Study of various stages of meiosis through permanent slides.
4. Cell culture techniques: preparation of media, seeding, thawing and maintenance of cell culture, trypsinization and cryopreservation
5. Measurement of cell growth: Direct count by Trypan blue and Indirect count by Spectrophotometer.
6. Calculation of Doubling Time based on given data.
7. Assessment of metabolic activity by MTT.
8. Study of monolayer (in Roux Bottle, Roller bottle, Plastic film, Optical culture system, Bread Bed reactors, Heterogenous reactors). Suspensions (stirred bioreactors, continuous flow cultures, air lift fermenter) and immobilized cultures.

9. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc.

Essential/recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
2. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Suggested readings

1. Alberts et. al., (2008) Molecular Biology of the Cell, Garland Science, Taylor & Francis Group, New York, USA.
2. Lodish et. al., (2007) Molecular Cell Biology, W.H. Freeman and Company, New York, USA

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DISCIPLINE SPECIFIC ELECTIVES (DSE-7):
Fish and Fisheries Zoo-DSE-7

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Fish and Fisheries Zoo-DSE- 7	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Nil	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- To offer an insight about the climatic conditions that favours fish growth and reproduction.
- to understand the importance of fish as a rich source of animal protein.
- To learn the basic concepts and knowledge of fish biology and its applications.
- to equip the student with a balanced and complete scientific understanding of fisheries.
- to enable students to learn more technical skills to generate entrepreneurial skills and suitable employment opportunities.
- to acquire knowledge of the pathogenic and pathological basis of fish diseases including infectious diseases caused by viruses, prokaryotes, protozoans, helminthes, vector borne and zoonotic diseases.
- To learn about nutritional deficiencies and lifestyle diseases, endocrine diseases and cancer.

Learning Outcomes

By studying this course, students will be able to:

- acquire basic knowledge of physiology and reproduction in fishes.
- analyse different kinds of water and identify/differentiate among various kinds of fishes.
- equip the students with the knowledge on the procedures for artificial and induced breeding which can be learnt by visiting any fish farm or demonstrated in research labs in college/Departments.
- have more knowledge of the in-land and marine Fisheries in India and to explore ways in which it can contribute to the Indian economy.
- know more about the different methods of fishing and fish preservation

which can be employed for export and storage of commercial fishes.

- develop skills for entrepreneurship or self-employment in fisheries-related business.

SYLLABUS OF DSE- 7

UNIT– 1 Introduction and Classification

6 hrs

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction. Brief introduction to transgenic fishes.

UNIT– 2 Morphology, Physiology and Behavior

14 hrs

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs, Schooling; Parental care; Migration.

UNIT– 3 Fisheries

8 hrs

Inland Fisheries; Estuarine Fisheries, Marine Fisheries; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations.

UNIT – 4 Aquaculture

17 hrs

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation of compound diets for fish; Role of water quality in aquaculture; Post harvest handling techniques and Fishery by-products.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Study of specimens- *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas* (at least one fish from each class).
2. Study of different types of scales by preparing a temporary/permanent mount.
3. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*.
4. Demonstration of induced breeding in Fishes and hatchery management (video/visit to fisheries institute/fish farm).
- Demonstration of the setting up of a fish aquarium, and its management/maintenance.
5. Study of parental care in fishes through visual media and resources.
6. Study of different methods of fish tagging.
7. Determination of fish density in a pond by Peterson's mark recapture method.
8. Project Report on a visit to any fish farm/pisciculture unit.

Essential/recommended readings

1. Pandey, K. and Shukla, J.P. (2013) Fish and Fisheries. Rastogi publication, India
2. Chakrabarti, R. and Sharma, J. G. (2008). Aquahouse: New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
3. Norman, J.R. A History of Fishes. Hill and Wang Publishers. Khanna, S.S. and Singh, H.R. (2014) A text book of Fish Biology and Fisheries. Narendra, Publishing House.
4. Bone, Q. and Moore, R. (2008) Biology of Fishes. Talyor and Francis Group, CRC Press, U.K.

Essential/recommended readings

1. Srivastava, C.B.L. (2008) Fish Biology. Narendra Publishing House.
2. Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan Publication Cooperation. India.

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DISCIPLINE SPECIFIC ELECTIVES (DSE-8):
Parasitology Zoo-DSE-8

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Parasitology Zoo-DSE- 8	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Basic understanding of parasitic animals	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- To enable the students to see, appreciate and understand the diversity of parasites
- to learn about Parasitology that will enable students to diagnose parasites correctly, understand their life cycle and control them effectively and use some of them as bio control agents
- to acquire understanding of study of life cycles of parasites, that can help in defying the stigmas and religious taboos for many societies making free many of the people from superstition and ill health.
- to make the students aware about the possible scope of the subject which includes research and applied aspects including entrepreneurial skill

Learning Outcomes

By studying this course, students will be able to:

- better understand the variation amongst parasites, parasitic invasion in animals; applicable to medical and agriculture aspects
- Identify the stages of the life cycles of parasites and their respective infective stages. develop ecological model, on the base knowledge of population dynamics of parasites.
- comprehend the different methods adopted by parasites to combat with the host immune system.
- develop skills and realize significance of diagnosis of parasitic attack and treatment of patient or host.

- analyse and interpret the case studies to highlight innovative researches, serendipities towards the advancement and enrichment of knowledge in the field of Parasitology.

SYLLABUS OF DSE- 8

UNIT- 1: Introduction to Parasitology

3 hrs

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors; Host parasite relationship

UNIT- 2: Parasitic Protists

10 hrs

Study of Morphology, Life Cycle, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Trypanosoma gambiense* and *Plasmodium vivax*.

UNIT- 3: Parasitic Platyhelminthes

10 hrs

Study of Morphology, Life Cycle, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski*, *Schistosoma haematobium* and *Taenia solium*

UNIT- 4: Parasitic Nematodes

10 hrs

Study of Morphology, Life Cycle, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*.

UNIT- 5: Parasitic Arthropoda

8 hrs

Biology, importance and control of ticks, mites, *Pediculus humanus* (Head and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*

UNIT- 6: Parasitic Vertebrates

4 hrs

A brief account of parasitic vertebrates; Cookicutter Shark, Hood Mockingbird and Vampire bat.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Study of life stages of *Entamoeba histolytica*, *Trypanosoma gambiense*, and *Plasmodium vivax* through permanent slides/micro photographs.
2. Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium* and *Taenia solium* through permanent slides/microphotographs.
3. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale* and *Wuchereria bancrofti* through permanent slides/microphotographs.
4. Study of *Pediculus humanus* and *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs.

5. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by-product of the industry]
6. Submission of a brief report on parasites (anyone phylum).
7. Visit to rural area/hospital near rural area/NCDC/NIMR/NICD to study the natural history and diagnostics of parasites.

Essential/recommended readings:

1. Parija, S. C. (2013) Textbook of Medical Parasitology, Protozoology & Helminthology (Text and colour Atlas), IV Edition, All India Publishers & Distributors, New Delhi.
2. Ichhpujani, R.L. and Bhatia, R. (2009) Medical Parasitology. III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group.

Suggested readings:

1. Chatterjee, K. D. (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.
2. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
3. Noble, E.R. and Noble, G.A. (1989) Parasitology: The Biology of Animal Parasites. VI Edition, Lea and Febiger

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-8): Exploring Animal World Zoo-GE-8

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Exploring the Animal world Zoo-GE-8	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to overview the concepts of invertebrate and vertebrate animals, including sponges, cnidarians, comb jellies, flatworms, nematodes, annelids, molluscs, arthropods, echinoderms, invertebrate chordates, fishes, amphibians, reptiles, birds, and mammals.
- to enable students to understand the diversity within different groups, and interrelationship among different species and genera within each group of animals.
- to learn the hierarchy, body plan and their role in ecological development of animals.

Learning Outcomes

By studying this course, students will be able to

- Learn about the importance of systematics, taxonomy, and structural organization of non-chordates and chordata.
- Appreciate the diversity of animals living in varied habits and habitats.
- Understand evolutionary history and relationships of different animals through functional and structural affinities.
- better understand coelom formation, different levels of organization, role of macronutrients and micronutrients, their nutritional requirements for different age groups during various health conditions.

SYLLABUS OF GE-8

UNIT- 1: An Introduction to the Animal Kingdom **2 hrs**
Non-chordates vs. Chordates; Outline of Coelom, Body symmetry, Levels of organization

UNIT-2: Kingdom Protista **2 hrs**
General characters of Protozoa; Locomotory organelles

UNIT- 3: Porifera **2 hrs**
General characters of Phylum Porifera, Canal system in Porifera

UNIT- 4: Radiata **2 hrs**
General characters of Phylum Cnidaria & Ctenophora; Polymorphism

UNIT- 5: Helminthes **3 hrs**
General characters of helminths (Platyhelminthes and Nematelminths); Parasitic Adaptations

UNIT- 6: Coelomates (Non-chordates) **6 hrs**
General characters of Phylum Annelida; Metamerism
General characters of Phylum Arthropoda; Vision in insects
General characters of Phylum Mollusca; Pearl Formation
General characters of Phylum Echinodermata, water vascular system in starfish

UNIT- 7: Lower chordates (Protochordata) **1 hr**
Salient features of Protochordates (Hemichordates, Urochordates and Cephalochordates)

Unit 8: Higher chordates **12 hr**
General characters of Vertebrates:

- Cyclostomes; Cartilaginous and Bony fishes; Catadromous and Anadromous migration.
- Amphibians; Adaptations for Terrestrial Life
- Reptiles; Poisonous and Non-poisonous Snakes
- Aves; Flight Adaptations in birds
- Mammals - Prototheria, Metatheria and Eutheria.

Practical **(60 hrs)**
(Laboratory periods: 15 classes of 4 hours each)

1. Study of specimens- Non-chordates:

Euglena, Noctiluca, Paramecium; Sycon; Physalia, Tubipora, Meandrina; Taenia, Ascaris; Nereis, Heteronereis, Aphrodite, Hirudinaria, Peripatus; Limulus, Cancer, Daphnia, Julus, Scolopendra, Apis, Termite; Chiton, Dentalium, Octopus; Asterias and Antedon

2. Study of specimens- Chordates:

Balanoglossus, Herdmania, Amphioxus; Petromyzon; Sphyrna, Pristis, Hippocampus, Exocoetus, Diodon/ Tetrodon; Ichthyophis/ Uraeotyphlus, Bufo, Hyla, Salamandra; Rhacophorus, Draco, Uromastix, Naja, Viper;

Any three common birds (Crow, duck, Owl); Funambulus, Loris and Bat

3. Study through Permanent Slides:

- i) Cross Section of *Sycon*, and *Ascaris* (male and female).
- ii) T. S. of Earthworm passing through Pharynx, Gizzard, and Typhlosole region of intestine.
- iii) Septal and Pharyngeal Nephridia of Earthworm.
- iv) Placoid and Cycloid Scales in Fishes.

4. Study of Organ Systems (through videos/animations/photographs/dissections*:

- i) Digestive System of Cockroach;
- ii) Urinogenital System of Rat

* subject to UGC guidelines

Essential/recommended readings

1. Young, J.Z. (2004) The Life of Vertebrates. III Edition, Oxford University Press.
2. Ruppert, Fox and Barnes (2003) Invertebrate Zoology. A Functional Evolutionary Approach, VII Edition, Thomson Books/Cole.
3. Parker T.J. and Haswell W.A. (1972). Textbook of Zoology Vertebrates. VII Edition, Volume II. Blackwell, Hoboken

**Note: Refer Ruppert, Fox and Barnes (VII Ed.) for the classification of invertebrates;*

Suggestive reading

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd.
2. Campbell and Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Mann Raven, P.H. and Johnson, G.B. (2004). Biology, VI Edition, Tata McGraw Hill Publications. New Delhi.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-9): Microbiota: Importance in Health and Disease

Zoo-GE-9

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Microbiota: Importance in Health and Disease Zoo-GE-9	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts of microbiota that coexist with the human being both in health and in different pathologies.
- To enable students to understand how microbiota undergoes changes as a consequence of the influence of multiple factors, diet, lifestyle, pharmacological treatments generating alterations in this bacterial ecosystem.
- To compare the role of our microbiota in behavior, mood, and development.
- to make the students aware of the microbial communities that reside within or upon us, and how they impact our health.
- To acquire knowledge about the interactions between the different types of microbiota and their host in different pathophysiological situations.

Learning Outcomes

By studying this course, students will be able to

- Identify the components of the human microbiota and their major characteristics.
- Learn the key approaches and techniques used to identify and quantify the bacterial, fungal, archaeal, protozoan, and viral components of the microbiota.
- Identify the common members of the microbiota and their influence on various body systems including the skin, upper and lower respiratory system, oral and the lower digestive system, urinary and reproductive systems, the immune system, and the nervous system in healthy and diseased states.
- Compare the role of our microbiota in behavior, mood, and development.
- Appreciate the emerging treatment approaches for microbiota-associated illnesses.

SYLLABUS OF GE-9

UNIT- 1: Microbes

4 hrs

Introduction to microbes, general approaches and techniques used for studying microbiota, the nature of microbiological problems, Prokaryotic and eukaryotic organisms.

UNIT- 2: Introduction to the Human Microbiome

16 hrs

Importance of human body environment for growth of a variety of microorganisms, concept of contamination, infection and disease, septicaemia, Acute and subacute bacterial endocarditis.

a) Microbial Diseases of the Respiratory System: Tuberculosis; Common cold,

b) Microbial Diseases of the Eyes: Conjunctivitis, Trachoma; Viral Diseases of the Eye.

c) Microbial Diseases of skin: Bacterial diseases of the skin: Acne, folliculitis, boils, cellulitis, Infections of burns and surgical wounds, gangrene, Leprosy. Viral Diseases of the Skin: Chicken pox;

Fungal Diseases of the Skin: Candidiasis.

d) Microbial Diseases of the Nervous System: Bacterial diseases: Tetanus, Viral diseases: Polio/Rabies; Protozoan diseases: Trypanosomiasis

e) Microbial Diseases of the Oral Cavity and Digestive System: Bacterial diseases: Dental caries; Cholera, Gastroenteritis; Fungal diseases: Aflatoxin poisoning, Ergot poisoning; Viral diseases: Mumps; Protozoan diseases: Amoebic dysentery, Giardiasis

f) Microbial Diseases of the Urinary/Reproductive Systems: Bacterial diseases: Syphilis; Viral diseases: genital warts; Protozoan diseases: Trichomoniasis; Fungal diseases: Vaginitis

UNIT- 3: Microbiota and the Immune System Development

5 hrs

Normal flora, transient flora opportunistic microbes, Pathogenicity, virulence, and factors that increase virulence (enzymes, toxins), Factors that affect the spread of disease, Nonspecific immune responses, Specific immune responses: humoral and cell mediated immunity

UNIT- 4: Human Microbiota in Health and Disease

5 hrs

Basic concept of Gut microbiota in the mother-child environment, Gut microbiota and cancer; Microbiota and viral diseases- An opportunity for COVID-19. Relationship between diet and the intestinal microbiota, Probiotics, prebiotics and other "biotics".

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Bacterial shapes and arrangements Cell wall, Cell membrane, Glycocalyx, Endospores, Flagella, Cytoplasmic inclusions, Cytoplasmic structures/organelles, Bacterial growth curve, Physical factors affecting microbial growth.
2. To understand Good Lab practise: The effectiveness of hand washing and sterilization.
3. To understand microbial morphology by Gram Staining.
4. To appreciate bacterial anatomy by Acid-fast Staining.
5. Environmental Factors affecting growth of microorganisms: Temperature, pH and Osmotic Pressure.
6. Bacterial growth curve and evaluation of factors affecting microbial growth.
7. Isolation of normal microbiota from the human Body (Nose, Throat, or Skin).
8. Effects of chemical agents on bacteria growth (Kirby-Bauer method).

Essential/recommended readings

1. Leboffe, M. J and Pierce; B. E. (2014) A Photographic Atlas for the Microbiology Laboratory, 5th Edition, Morton Publishing Company.
2. Michael Wilson (2005) "Microbial Inhabitants of Humans-Their Ecology and Role in Health and Disease"; Oxford University Press, UK.

Suggestive readings

1. Nina Parker, Mark Schneegurt, Anh-Hue-Thi Tu and Brian M. Forster; (2016) "Microbiology"; 1st Edition, OpenStax Resource.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-10): Insect Vector and Disease
Zoo-GE-10

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Insect Vector and Disease Zoo-GE-10	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to familiarize the students with a variety of diseases caused by insects.
- to learn the complex interactions between the transmission by Insect-borne pathogens affecting human health.
- to acquire knowledge of how the insects can only be controlled and prevented by studying their biology, modalities of pathogen transmission
- to enable students to evaluate the associated risk factors and devising new efficient techniques to control these insects.
- to help understand the environmental pressures caused by stagnant water.
- to motivate students to pursue a career in Health Management.

Learning Outcomes

By studying this course, students will be able to

- identify different insects and classify them based on their morphology and behaviour.
- describe the host-pathogen relationships and the role of the host reservoir on transmission of parasite.
- explain various modes of transmission of parasite by insect vectors.
- recognize various possible modern tools and methodologies for laboratory diagnosis, surveillance and treatment of diseases.
- develop a critical understanding of insect transmitted diseases such as Zoonotic, Vertical and Horizontal transmission, host specificity etc.
- spread awareness on public health programs about insect borne diseases and their control.

- To use advanced management strategies in disease control with respect to parasite evolution

SYLLABUS OF GE-10

UNIT- 1: Introduction to Insects

8 hrs

General Features of Insects, Classification of insects up to Orders- General features of orders, Morphological features: Head, legs and types of antennae. Types of Insects mouth parts w.r.t. feeding habits: siphoning type (butterfly), sponging type (housefly), biting and chewing type (cockroach), piercing and sucking type (mosquito), chewing and lapping type (honey bee).

UNIT- 2: Concept of Vectors

5 hrs

Brief introduction to carriers and vectors (mechanical and biological vector); Insect reservoirs; Host-vector relationship; Vectorial capacity; Host Specificity; Modes of disease transmission - vertical and horizontal transmission. Insects as vectors: General adaptations in insects to act as vectors.

UNIT- 3: Dipterans as disease Vectors-I

7 hrs

Dipterans as important insect vectors–Mosquitoes. Study of mosquito borne diseases–Malaria, Dengue, Chikungunya, Filariasis, Viral encephalitis. Control and prevention/cure of diseases caused by mosquitoes. Study of sand fly-borne diseases-Visceral Leishmaniasis, Cutaneous Leishmaniasis; Control of Sand fly; Study of house fly as important mechanical vector, Control of house fly.

UNIT- 4: Siphonapterans as disease vectors

5 hrs

Fleas as insect vectors; Study of flea borne diseases – Plague, typhus fever; Control and prevention/cure of diseases caused by fleas.

UNIT- 5: Siphunculata as disease vectors

5 hrs

Human louse (head, body and pubic louse) as disease vectors; study of louse borne diseases – Typhus fever, relapsing fever, vagabond's disease, phthiriasis; Control of human louse and prevention/cure of diseases caused by them.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Study of different kinds of mouth parts and legs of insects through slides/specimens
2. Study of insect vectors through permanent slides or photographs: Mosquitoes (*Aedes*, *Culex*, *Anopheles*), lice [head, body (*Pediculus*), pubic (*Phthirus*)], Flea (*Xenopsylla cheopis*), sand fly (*Phlebotomus*), house fly (*Musca domestica*)

3. Study of different diseases transmitted by above insect vectors using photographs.
4. Project report on any one disease transmitted by insect vector.
5. Optional field trip/Lab. visit to institutes such as NIMR, NCDC.

Essential/recommended readings

1. Mullen and Darden (2009) Medical and Veterinary Entomology, 3rd Edition, Academic Press.
2. Service, M.W. (1980) A Guide to Medical Entomology, Macmillan Press.

Suggestive readings

1. Burgess, N.R.H and Cowan, G.O. (1993) A colour atlas of medical entomology. Springer Science and Business Media, B. V. House.

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DEPARTMENT OF ZOOLOGY

SEMESTER - V

Category I

(B.Sc. Honours in Zoology in three years)

DISCIPLINE SPECIFIC CORE COURSE -13 –:

Principles of Immunology

Zoo-DSC-13

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Immunology Zoo-DSC-13	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to impart an in-depth knowledge on how our immune system fights with infection and foreign substances that can harm our body
- to understand and design new therapeutics against a wide range of diseases and infections.
- to assist in comprehending the quick response to pandemics in the form of vaccines
- to apprise the students on the development of therapies targeting different components of the immune system that can alter the progression of human inflammatory diseases and cancers.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the concepts of innate and acquired immunity.
- acquire knowledge of the immunogenicity of biomolecules
- comprehend and analyze the different cellular and humoral components of the immune system
- appreciate the contribution of various components of immune system in health and disease including basis of vaccination, autoimmunity, immunodeficiency and hypersensitivity

SYLLABUS OF DSC-13

UNIT 1: Overview of the Immune System **6 hrs**

Early theories (Selective and Instructional) and Clonal Selection theory; Innate immunity: components and defensive barriers of innate immunity. Adaptive immune system: Components and attributes of acquired immunity, humoral and cell mediated immunity, active and passive immunity, primary and secondary immune response,

UNIT 2: Antigens and Immunoglobulins **10 hrs**

Antigens and immunogens; antigenicity and immunogenicity; factors affecting immunogenicity; antigenic determinants and its properties (B- and T-cell epitopes); Haptens and Adjuvants.

Structure and functions of different classes of antibodies; antigenic determinants on immunoglobulin; Production and applications of monoclonal antibodies.

UNIT 3: MHC and Antigen Presentation **4 hrs**

Structure and functions of MHC (MHC-I & MHC-II); endogenous and exogenous pathways of antigen processing and presentation.

UNIT 4: Complement System and Cytokines **3 hrs**

Pathways of complement activation and biological consequences of complement activation; properties and functions of cytokines

UNIT 5: Immune System in Health and Diseases **7 hrs**

Vaccines and their types; Gell and Coombs classification of hypersensitivity; autoimmunity and immunodeficiency with suitable examples.

Practical **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of lymphoid cells and organs in rat/mouse*.
2. Histological study of spleen, thymus and lymph nodes through slides/photomicrographs.
3. To study various types of white blood cells using Leishman's/Giemsa/Crystal violet stained blood smear.
4. To understand the antigen and antibody interactions by
 - i) Ouchterlony's double immunodiffusion method.
 - ii) ABO Blood group antigen determination by heamagglutination test.
 - iii) Demonstration of ELISA.
 - iv) Demonstration of Immunoelectrophoresis.
 - v) FACS
 - vi) RIA
 - vii) Elispot

5. Cell counting and viability test (trypan blue dye exclusion test) from splenocytes* from rat/mouse/any other species.
6. Project on any topic/ Project report on visit to any research institute/laboratory to study the immunological techniques.

*depending on availability of animals or sample.

Essential/recommended readings

Punt, J., Stranford, S., Jones, P., Owen, J.A. (2018) Kuby Immunology, VIII Edition, WH Freeman and Company

Abul Abbas, Andrew Lichtman, Shiv Pillai (2017) Cellular and Molecular Immunology; Elsevier

Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006) Immunology, VI; Edition, W.H. Freeman and Company

David, M., Jonathan, B., David, R. B. and Ivan, R. (2006) Immunology, VII Edition, Mosby, Elsevier Publication.

Suggestive readings

1. Singh, I. K. and Sharma, P. [Eds.] (2022) An Interplay of Cellular and Molecular Components of Immunology. Taylor & Francis group, CRC Press.
2. Kaur, H., Toteja, R., and Makhija, S. (2021) Textbook of Immunology, I.K International Publishing House and Wiley India Ltd
3. Singh, I. K. and Sharma, P. [Eds.] (2022) Essentials of Immunology, Laboratory Manual; Prestige Publishers.
4. Kenneth Murphy, Casey Weaver (2016) Janeway's Immunobiology; 9th Edition, Garland Science

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -14 –:
Cell and Molecular Biology
Zoo-DSC-14

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Cell and Molecular Biology Zoo-DSC-14	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	Basic knowledge of cell biology

Learning Objectives

The learning objectives of this course are as follows:

- to provide an understanding of structure-function relationships of nucleic acids and protein and the regulatory processes.
- to demonstrate practical knowledge of raising, handling, maintenance and special features such as antibiotic resistance of a simple prokaryotic model organism, *Escherichia coli*.
- to empower the students with a broad range of research and development related to cell signalling, cell culture and cell lines.
- to elucidate the molecular machinery and mechanism of information transfer processes- transcription and translation-in prokaryotes and eukaryotes;

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the diverse cellular processes and cellular interactions.
- have an in-depth knowledge of the defects in cellular functioning and the molecular mechanisms that can lead to various diseases.
- appreciate the importance of homeostasis of the body and the adversities of disturbing it.
- acquire the basic information of cell signalling pathways and to elucidate its roles in gene expression and its regulation in eukaryotes.
- interpret the differences between cellular deaths; stem cells and their applications in therapeutic cloning and regenerative medicine.
- explain post-transcriptional modification mechanisms for the processing of eukaryotic mRNA.
- impart experimental skills used in clinical and research laboratories giving the students an extra edge for taking up higher studies.

Syllabus of DSC-14

UNIT- 1: Cell Signalling

3 hrs

Introduction to cell signalling pathways GPCR, cAMP, PKA, CREB, target gene and a nuclear receptor pathway.

UNIT-2: Cell Death and Cell Renewal

4 hrs

Apoptosis vs. necrosis; intrinsic and extrinsic pathways of programmed cell death; stem cells and maintenance of adult tissues; embryonic and induced pluripotent stem cells.

UNIT-3: DNA and its Replication

7 hrs

DNA replication in prokaryotes and eukaryotes-replication machinery and mechanisms, semi-conservative, bidirectional and semi-discontinuous replication, Replication of circular and linear double stranded DNA, Replication of telomeres.

UNIT 4: Transcription

5 hrs

Machinery and mechanism of transcription in prokaryotes and eukaryotes-RNA polymerases, Transcription unit, Transcription factors, Synthesis of rRNA.

UNIT 5: Translation

5 hrs

Genetic code, Process of protein synthesis in prokaryotes: fidelity of protein synthesis, aminoacyl-tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Difference between prokaryotic and eukaryotic translation.

UNIT 6: Post Transcriptional Modifications

2 hrs

Split genes: concept of introns and exons, splicing mechanism, alternative splicing, and RNA editing.

UNIT 7: Gene Regulation

4 hrs

Transcription regulation in prokaryotes: Lac operon; Overview of transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Requirement of a Tissue culture laboratory, its equipment and its layout. Concept of cell culture and cell lines; Media preparation for mammalian tissue culture.
2. Preparation of permanent slides of mitosis/meiosis*.
3. Study of Polytene chromosomes from *Chironomous/Drosophila* larva.
4. Inoculation and culture of *E. coli* in liquid culture medium (LB).
5. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
6. Estimation of the growth kinetics of *E. coli* from the data provided.
7. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter.

(Diphenylamine reagent) or spectrophotometer (A_{260} measurement).

8. Study and interpretation of electron micrographs/photographs showing: DNA replication, Transcription, and Split genes.
9. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc.

*Subject to UGC guidelines

Essential/recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. R. Ian Freshney (2021) Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell.
3. Lodish et. al., (2007), Molecular Cell Biology, W.H. Freeman and Company, New York, USA
4. Alberts et. al., (2008), Molecular Biology of the Cell Garland Science, Taylor & Francis Group, New York, USA.
5. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

Suggestive readings

1. Watson, J. D. Baker T.A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2008) Molecular Biology of the Gene. VI edition. Cold Spring Harbour Lab. Press, Pearson Pub.
2. Lewin B. (2008). Gene XI. Jones and Bartlett.
3. Gupta, R., Makhija, S. and Toteja, R. (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi-110003.
4. Sharma, V. K. (1991). Techniques in Microscopy and Cell Biology, Tata McGraw Hill Publishing Company Limited, New Delhi.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE 15—:
Fundamentals of Genetics
Zoo-DSC-15

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Fundamentals of Genetics Zoo-DSC-15	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to be able to list some of the distinguishing features of prokaryotes versus eukaryotes.
- to provide an understanding of the basic patterns of inheritance.
- to explain how genotype is related to phenotype?
- to describe how a mutation can change the phenotype.

Learning Outcomes

By studying this course, students will be able to

- Enhance knowledge of the basic principles of inheritance.
- Develop analytical skills and critical thinking through pedigree analysis.
- Understand the mechanism of gene transfer and mapping in both prokaryotes and eukaryotes.
- Learn the mechanisms of mutations and harmful and beneficial effects of mutagens, which help evolve new species over time.
- Be able to grasp basic concepts of human chromosomal disorders.

SYLLABUS OF DSC-15

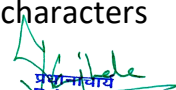
UNIT- 1: Mendelian Genetics and its Extensions

7 hrs

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, penetrance and expressivity, Epistasis, Phenocopy, Pleiotropy, Polygenic Inheritance, Sex-linked, Sex-influenced, and Sex-limited characters inheritance.

UNIT- 2: Linkage, Crossing Over and Chromosome Mapping

Linkage and crossing over, Cytological basis of crossing over, Recombination frequency


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as a measure of linkage intensity, two-factor and three-factor crosses, Linkage map, Coefficient of Coincidence and Interference, Gene mapping by Somatic cell hybridization.

UNIT- 3: Mutations

8 hrs

Types of gene mutations, Detection of mutations in *Drosophila*: CLB method, Mutagens: Physical and chemical, molecular basis of spontaneous and induced mutations, Chromosomal aberrations: Structural Variations in chromosomes, Aneuploidy & Polyploidy.

UNIT- 4: sex Determination

3 hrs

Basis of sex determination: Genetic and environmental; Sex determination in *Drosophila* and human; Mechanism of dosage compensation.

UNIT- 5: Extra-chromosomal Inheritance

3 hrs

Comparison of nuclear and extranuclear inheritance; Organelle inheritance: Antibiotic resistance in *Chlamydomonas*, Infective heredity in *Paramecium*. Maternal effects: Shell coiling in *Limnaea*, pigmentations in *Ephestia*.

UNIT- 6: Transposable Genetic Elements

3 hrs

Transposons in bacteria, Ty elements in yeast, Ac-Ds elements in maize, P elements in *Drosophila*, Transposons in humans, Significance of Transposons.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Simulation exercises using beads or seeds to study the gene interactions: 9:3:4; 12:3:1; 9:7; 9:3:3:1 (comb shapes in roosters) and verification of ratios by using Chi-square analysis.
2. Pedigree analysis of Autosomal Dominant trait, Autosomal recessive trait, X-linked Dominant traits, X-linked recessive traits, Y-linked traits and mitochondrial traits.
3. Use of probability in solving problems of genetics (Sum rule, Multiplication rule & Binomial expansion).
4. Gene mapping (order and distance) using data from interrupted mating experiments in bacteria.
5. Linkage maps based on data (two - point and three - point crossing over) from *Drosophila*.
6. Human Karyotypes, Human chromosomal disorders & single gene disorders.
7. Project on Epigenetic, Eugenics, Euthenics and Euphenics.

*Subject to UGC guidelines

Essential/recommended readings

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
3. Pierce, B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company

Suggestive readings

1. Peter, J. Russell. (2009), iGenetics: A molecular approach. 3rd Edition. Benjamin Cumming
2. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, Sean B. Carroll (2007). Introduction to Genetic Analysis. 9th Edition. W H Freeman.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER-V

POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES

DISCIPLINE SPECIFIC ELECTIVES (DSE-9): Chronobiology Zoo-DSE-9

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Chronobiology Zoo-DSE-9	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Basic knowledge of animal behavior	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to understand and appreciate the cyclic physiological phenomena.
- to acquaint the students to the concept of generation of internal time.
- to learn about the fascinating phenomena of seasonal migration and hibernation.
- to expose the students to clock dysfunctions
- to make the students aware of the various aspects of chronobiology and how it can be applied to therapeutics and medicine?
- to facilitate the students to learn about their very own rhythms of sleep and body temperature
- to familiarize the students to actograms and their interpretation and analysis.

Learning Outcomes

By studying this course, students will be able to

- better understand the concept and biological significance chronobiology.
- acquire knowledge about the various types of biological rhythms and their adaptive role.
- appreciate the importance of circadian rhythms in human mental and physical health.
- better understand physiological and molecular mechanisms controlling circadian rhythms.
- know the genetic components comprising the biological clocks.
- gain knowledge about the importance of photoperiodism and its association with circannual rhythms.
- learn about the applications of chronobiology in medicine, pharmacology and

therapeutics.

SYLLABUS OF DSE-9

UNIT- 1: Introduction to Chronobiology

8 hrs

Historical developments in chronobiology; Biological oscillation: the concept of average, amplitude, phase and period; Types of Rhythms – Ultradian rhythms, Circadian rhythms, Infradian rhythms; Lunar rhythm; Circannual rhythm; Adaptive significance of biological rhythms.

UNIT- 2: Circadian rhythms

8 hrs

Characteristics of circadian rhythms, Free-running rhythm; Temperature compensation; Masking and synchronization; Zeitgebers- Photic and non-photoc Zeitgebers; Effect of light, Intensity- Aschoff's rule.

UNIT- 3: Biological clock system

9 hrs

Input, time generation and output components; Central and peripheral clocks; Suprachiasmatic nucleus; Molecular mechanisms underlying the generation of circadian time in Drosophila and Mammals.

UNIT- 4: Circannual rhythm and Photoperiodism

9 hrs

Circannual rhythms; Photoperiodism and regulation of seasonal reproduction in vertebrates; Migration in birds; Hibernation in mammals.

UNIT- 5: Circadian clock, diseases and therapeutics

11 hrs

Circadian clock and sleep-wake cycle; Jet Lag, Shift work ; Sleep and Chronotypes; Consequence of clock dysfunction- Sleep Disorders, Depression, Anxiety, Stress, Cancer; Obesity, Immune Disorders; Chronopharmacology, Chronomedicine and Chronotherapy.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Study of basic characteristics of biological rhythms from a given dataset.
2. Study and actogram construction of locomotor activity of suitable animal models.
3. Study of body temperature rhythm using periodically assembled data.
4. Study of the alertness rhythm using periodically assembled data.
5. Study of phase shift in circadian rhythm using given data.
6. Research plan presentation/ project on circadian (daily) rhythm functions, like eating, sleep or body temperature.
7. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc.

Essential/recommended readings

1. Binkley, S. (2020). Biological clocks: Your owner's manual. CRC Press.
2. Vinod Kumar (2017): Biological Timekeeping: Clocks, Rhythms and Behaviour.
3. Wirz-Justice, A., Benedetti, F., & Terman, M. (2013). Chronotherapeutics for Affective Disorders: A Clinician's Manual for Light and Wake Therapy. Medical and Scientific Publishers

4. Koukkari, W. L., & Sothorn, R. B. (2007). Introducing biological rhythms: A primer on the temporal organization of life, with implications for health, society, reproduction, and the natural environment. Springer Science & Business Media.

Suggestive readings

1. Dunlap J. C, Loros J. J, DeCoursey P. J. (2004) Chronobiology Biological Timekeeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
2. Palmer, J. D. (2002). The living clock: The orchestrator of biological rhythms. Oxford University Press.
3. Vinod Kumar (2002) Biological Rhythms. Narosa Publishing House, Delhi/ Springer-Verlag, Germany.
4. Saunders D. S. (2002). Insect Clocks. III Edition, Barends and Noble Inc. New York, USA
5. Weiner, J. (2000). Time, love, memory: a great biologist and his quest for the origins of behavior. Vintage.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-10):
Integrative Systems Biology and Bioinformatics

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Integrative Systems Biology and Bioinformatics Zoo-DSE- 10	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Basic knowledge of computer and biology	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to give an overview of the key principles of Systems Biology and Bioinformatics.
- to introduce students to a variety of *in silico* solution for biological problems and systems data by analysing biological databases, gene sequence alignments, gene annotation, structure predictions, and drug development, among other areas.
- to encourage undergraduate students to pursue higher education in this field as Bioinformatics has been identified as a critical area of study and development

Learning Outcomes

By studying this course, students will be able to:

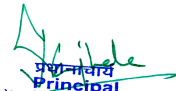
- know more about the basic of systems biology and bioinformatics
- better understand about the availability of experimental data through biological databases, usage of small molecules, nucleic acids, protein sequences, in a variety of biological sciences domains
- gain more knowledge about the gene sequence annotation, protein structure prediction and gene enrichment prediction
- acquire skills to perform and understand pair-wise and multiple sequence alignment
- better understand a variety of computational tools and approaches, as well as their use in *in silico* drug discovery, structural bioinformatics, and functional genomics etc.

SYLLABUS OF DSE- 10

UNIT- 1: Introduction to Systems Biology and Bioinformatics

5 hrs

Introduction to Systems Biology, Bioinformatics, Genomics, Proteomics, Transcriptomics, Metabolomics, Scope and their applications.


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UNIT- 2: Systems Biology**10 hrs**

Computational models, modelling and their basic notions, networks (feed forward gene circuit, transcription regulatory networks and protein-protein interaction networks)

UNIT- 3: Biological Databases**8 hrs**

Introduction to biological databases; Primary, Secondary and Composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, Reactome, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

UNIT- 4: Sequence Alignment and Phylogeny**10 hrs**

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); HMM model, Local and global alignment, pair wise and multiple sequence alignments, Molecular Phylogeny.

UNIT- 5: Structural Biology and Drug Discovery**12 hrs**

Protein secondary structure prediction (Chou-Fasman & GOR methods), Protein tertiary structure prediction and its validation (Homology modelling, Threading and *Ab-initio* methods); Lipinski rule, Molecular docking (rigid and flexible docking), ADMET properties, Molecular Dynamics, Drug-DNA interactions.

Practical**(30 hrs)****(Laboratory periods: 15 classes of 2 hours each)**

1. Retrieval of DNA, RNA, protein sequences and structures from the biological databases and to create various datasets.
2. Perform pairwise and multiple sequence alignments from the generated datasets in Experiment 1, using online/offline tool.
3. Retrieval and analysis of any one disease network from KEGG pathway database.
4. Gene functional enrichment analysis using DAVID tool.
5. Protein structure prediction through homology modelling using Swiss Modeller.
6. Molecular docking (Protein-ligand) using AutodockVina/ SwissDock/ PatchDock/ZDock (anyone).
7. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc.

Essential/recommended readings

1. Pevsner, J. (2015) Bioinformatics and Functional Genomics, 3rd edition, Wiley and Blackwell.
2. Xiong, J. (2012) Essential Bioinformatics, Cambridge University Press.
3. Claverie, JM and Notredame, C. (2006) Bioinformatics for Dummies 2nd edition, Wiley Publishing Inc.
4. Klipp, E., Liebermeister, W., Wierling, C. and Kowald, (2016) A. System Biology, 2nd edition, Wiley-VCH.

Suggestive readings

1. Alon, U. (2019) An Introduction to Systems Biology 2nd edition, CRC, Taylor & Francis.
2. Jenny Gu, J. and Bourne, P.E.(2011) Structural Bioinformatics 2nd edition, Wiley Blackwell.
3. Harren Jhoti, H. & Leach, A. (2007) Structure-based Drug Discovery, Springer.
4. Kitano, H. (2001) Foundations of Systems Biology, MIT press Cambridge.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-11): Basics of Neuroscience

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Dept offering the course
		Lecture	Tutorial	Practical			
Basics of Neuroscience Zoo-DSE- 11	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	Concept of functioning of nervous system	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to understand the structure and function of the nervous system at the molecular, cellular, and systems levels.
- to provide an in-depth understanding of neuronal excitability, signal generation and propagation, synaptic transmission, post-synaptic mechanisms of signal integration, and neural plasticity.
- to gain an insight into how membrane excitability elicits functional effects in individual neurons and neuronal networks and how different parts of the brain control various behavioural patterns by releasing neurohormones/neuropeptides.
- to have a thorough knowledge of neuroimaging techniques and a comprehensive understanding of the kinds of information each technique provides about the brain.
- to gain knowledge about the neural mechanism and pathogenesis of common neurodegenerative disorders such as Alzheimer's, Parkinson's disease etc.

Learning Outcomes

By studying this course, students will be able to:

- understand the fundamentals of neuroscience, key concepts, and the relationship between the nervous system and behaviour/cognition.
- comprehend the neural basis of sleep, emotions, learning and memory and related aspects of cognition.
- have a detailed understanding of how different neuroimaging techniques are used to assess brain function and explore questions in clinical and behavioural neuroscience.
- explore potential developments to current research, design, execute and communicate a substantive research project in the field of neuroscience or its application.

SYLLABUS OF DSE- 11

UNIT- 1 Introduction to Nervous System **6 hrs**

Origins of Neuroscience; Neuron doctrine; Classification of the nervous system.

UNIT- 2 Structure of the Brain **5 hrs**

Gross anatomy of the human brain, Meninges, ventricular System, Blood-brain Barrier, Cranial nerves.

UNIT-3 Cellular and Molecular Neurobiology **10 hrs**

Classification of neurons; Structure of prototypical neuron; Electrophysiology of membrane potentials-resting and action potentials, generation, and propagation; Ion Channels and Membrane Ion Currents; Types of Synapses, synaptic transmission and integration; Post synaptic potentials - EPSPs and IPSPs; tripartite synapse.

UNIT- 4 Neurotransmitters **4 hrs**

Types of neurotransmitters; transmitter-gated channels; neurotransmitter receptors Ionotropic and metabotropic receptors; G-protein coupled receptors and effectors.

UNIT- 5 Cognitive and Behavioural Neuroscience **10 hrs**

Neurobiology of visual perception; Molecular basis of learning and memory: Classification of memory, amnesia, case of H.M. (Henry Malaison); Synaptic plasticity, Long-term potentiation (LTP), Long-term depression (LTD); Memory consolidation.

UNIT-6 Neurophysiology of Sleep **4 hrs**

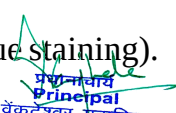
Neurophysiology of sleep and wakefulness, electroencephalogram rhythms (EEG).

UNIT- 7 Neuroimaging and Neuropathology **6 hrs**

Computed Tomography Scan (CT), Magnetic Resonance Imaging (MRI), functional Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET); Neurological disorders (in brief)- Epilepsy, Schizophrenia; Aetiology and Molecular pathogenesis - Parkinson's, Alzheimer's.

Practical **(30 hrs)** **(Laboratory periods: 15 classes of 2 hours each)**

1. Study of brain coordinates using stereotaxis instrument (video demonstration).
2. Study of *Drosophila* nervous system using GFP reporter system.
3. Study of anatomy of mammalian brain (from slaughter house or) using brain models (Medical anatomical teaching models, graphics, videos etc., can be used).
4. Histological study of neurons and myelin sheath (Nissl and Luxol Fast Blue staining).
5. Study of novelty, anxiety, and spatial learning in mice.
6. Histological study of the cerebellum and spinal cord by H&E stain and cerebellar cortex by Nissl stain.


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7. Study of neurodegenerative diseases (Parkinson's and Alzheimer's) with the help of brain scan images or brain tissue images.

Essential/recommended readings

1. Purves, D. et al., (2017) Neuroscience, VI Edition. Oxford University Press.
2. Bear, M. F., Connors, B. W. and Paradiso, M. A. (2016). Neuroscience: Exploring the Brain. IV Edition. Philadelphia: Wolters Kluwer.
3. Squire, L., Berg, D., Bloom, F. E., du-Lac, S., Ghosh, A., Spitzer, N. C. (2012) Fundamental Neuroscience, IV Edition, Academic Press Publications.
4. Kandel, E.R., Schwartz, J.H. and Jessell, T.M. (2000) Principles of Neural Science. IV Edition, McGraw-Hill Companies.

Suggestive readings

1. Carter, R. (2014). The Human Brain Book. D. K. Publishers.
2. Stephan M. Stahl (2000) Essential Psychopharmacology- Neuroscientific Basis and Practical Applications. II Edition. Cambridge University Press.
3. Ramachandran, V. S. and Blakeslee, S. (1998). Phantoms in the Brain: Probing the Mysteries of the Human Mind. William Morrow, New York.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Biology of Insecta Zoo-DSE-12	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

The learning objectives of this course are as follows:

- to acquaint the students about biology of class Insecta.
- to acquire knowledge of the morphology and physiology of Insects.
- to enable the students to see, appreciate and understand the diversity of insects.

By studying this course, students will be able to:

- better appreciate the diversity of insects.
- better understand the physiology of Insects which has made them the most successful animals in terms of numbers and variety of species.
- get acquainted with the highly organized social life of insects.
- to make the students aware about the possible scope of the subject which includes research and applied aspects including entrepreneurial skill.

UNIT-1 Introduction

4 hrs

General features of Insects and their diversity; Classification of insects up to orders.

12 hrs

Head: Eyes, Types of antennae, Mouth parts w.r.t. feeding habits; Thorax: wings- Typical structure of insect wing and its modifications, Types of Legs; Abdomen: Typical structure.

18 hrs

General aspects of the Integumentary (structure of integument and process of moulting), digestive, excretory, circulatory, respiratory, reproductive, and nervous system (using cockroach as the type representative); Metamorphosis: Types & hormonal control.

UNIT- 4: Insect behaviour**6 hrs**

Insect-Plant Interactions: Host-plant selection by phytophagous insects.

UNIT- 5: Insects as plant pests**5 hrs**

Bionomics and control of any two phytophagous insect pests of fruits, vegetables, cash crops and stored grains.

Practical**(30 hrs)**

(Laboratory periods: 15 classes of 2 hours each)

1. Methodology of collection, preservation and taxonomic identification of insects (classification up to order with the help of taxonomic keys).
2. Study of different kinds of antennae, legs and mouth parts of insects with the help of slides/specimens/ photographs
3. Study of morphological features of insects using pictures/slides/museum specimen (cockroach): head, sclerites, antennae, mouthparts, wing venation, and legs.
4. Preparation of temporary/permanent mount of any stored grain pest and its life stages.
5. Study of biology of any insect pest of agricultural crops (Fruit/vegetable).
6. Field study of insects and submission of a project report showcasing insect diversity.

Essential/recommended readings

1. Chapman, R. F. (1998) The Insects: Structure and Function. Cambridge University Press, UK.
2. Richards, O. W., Davies, R. G. (1977) Imms' General Text Book of Entomology. Vol I & Vol II; Chapman & Hall, UK.

Suggestive readings

1. Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA.
2. Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-13):
Reproductive Biology and Assisted Reproductive Technologies (ART)
Zoo-DSE-13

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Reproductive Biology and Assisted Reproductive Technology (ART) Zoo-DSE-13	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint the students about the various aspects of reproduction in humans.
- to acquire in-depth knowledge of male and female reproductive systems as well as factors that are important in maintaining reproductive health.
- to enable the students to see, appreciate and understand the new technologies in assisted reproduction as well as contraceptive methods.
- to familiarize the students about the social and public health issues related to family planning.
- to make the students aware of the possible scope of the subject which includes research and applied aspects including entrepreneurial skills.

Learning Outcomes

By studying this course, students will be able to:

- get an in-depth understanding of morphology, anatomy, and histology of male and female reproductive organs.
- know different processes in reproduction starting from germ cell formation to fertilization and consequent pregnancy, parturition, and lactation.
- compare estrous and menstrual cycles and their hormonal regulation.
- comprehend the interplay of various hormones in the functioning and regulation of the male and female reproductive systems.
- know about the diagnosis and management of infertility, including the latest methods, technologies, and infrastructure in assisted reproduction.
- better understand the modern methods of contraception and their use in family planning strategies.
- translate their understanding into the development of products like non-hormonal contraceptives; contribute to drug discovery programs as well as

maternal health programmes and work with family planning teams to understand the needs and preferences of individuals belonging to lower socioeconomic groups.

SYLLABUS OF DSE-13

UNIT-1: Reproductive Endocrinology

8 hrs

Hypothalamo–hypophyseal–gonadal axis; Regulation of gonadotropins and gonadal steroids secretion in male and female; Steroidogenesis; Mechanism of action of hormones related to reproduction.

UNIT- 2: Male Reproductive System

9 hrs

Anatomy of the male reproductive system: Testis, epididymis, vas deferens, prostate gland, seminal vesicle; Spermatogenesis and its regulation; Sperm transport and maturation in the male genital tract.

UNIT- 3: Female Reproductive System

12 hrs

Anatomy of the female reproductive system: Ovary, fallopian tubes/oviducts, uterus, cervix, and vagina; Folliculogenesis; Oocyte maturation and ovulation; Menstrual cycle and its hormonal regulation. Lactation and its regulation.

UNIT- 4: Fertilization

8 hrs

Fertilization; Implantation; Feto-placental unit; Hormonal regulation of gestation; Parturition and its hormonal regulation;

UNIT- 5 Reproduction

8 hrs

Modern contraceptive methods; Infertility in males and females- causes and diagnosis Assisted Reproductive Technologies (ART): sperm banks, IVF, frozen embryos, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST. Ethical issues in ART.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Examination of histological sections from photomicrographs/permanent slides of rat/human: testis, epididymis, and accessory glands of male reproductive systems.
2. Sections of the ovary, fallopian tube, uterus (proliferative and secretory stages), cervix, and vagina.
3. Study the estrous cycle by examination of the vaginal smear of rats (from live animals)
4. Study of ovariectomy and castration.
5. Study of sperm count and sperm motility in rats.
6. Study of modern contraceptive devices.
7. Submission of project report on the reproductive health of a small human community involving survey, data collection, statistical analysis

OR

Report on the visit to animal culture facility including details about setting up and maintenance of the animal house, breeding techniques, care of normal and experimental animals.

*All exercises requiring live animals should be performed with the help of photomicrographs/pictures/videos.

Essential/recommended readings

1. Johnson, M.H. and Everitt, B.J. (2018) Essential reproduction. IV Edition, London, Blackwell Science.
2. Jones, R.E. and Lopez, K.H. (2014) Human Reproductive Biology. IV Edition, Elsevier.
3. Franklyn F. Bolander (2012) Molecular Endocrinology. III Edition, USA, Academic Press.
4. De-Groot, L.J. and Jameson, J.L. (eds) (2001) Endocrinology. W.B. Saunders and Company.

Suggestive readings

1. Knobil, E. and Neil, JD (eds) (2014) The Physiology of Reproduction. IV Edition, Elsevier.
2. Robert Martin (2013) How We Do It: The Evolution and Future of Human Reproduction. Basic Books.
3. Austin, C.R. and Short R.V. (Eds) (2012) Reproduction in Mammals. Cambridge University Press.

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COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-11): Animal Cell Biotechnology Zoo-GE-11

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Animal Cell Biotechnology Zoo-GE-11	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

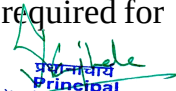
The learning objectives of this course are as follows:

- to give the students a fundamental understanding of the field of biotechnology.
- to provide a tool kit in the form of a number of techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine.
- to make the students aware of the scope of biotechnology which encompasses almost every field of science like engineering, research, commercialization and academics.
- to empower the students to face research and industrial outlets by nurturing independent thinking, initiating scientific enquiry and developing their entrepreneurship skills.
- to equip the students with basic understanding of the tools and techniques of biotechnology which are a must for anyone interested in pursuing a career in biotechnology.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the basic principles and applications of biotechnology.
- appreciate the basic techniques used in genetic manipulation helping them continue with higher studies in this field.
- acquire knowledge of the basic principles, preparations and handling required for animal cell culture.
- have an in-depth understanding of the principles underlying the design of fermenter and fermentation process and its immense use in the industry.


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- enable students to design small experiments for successful implementation of the ideas and develop solutions to solve problems related to biotechnology keeping in mind safety factor for environment and society.
- apply knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career.
- enhance their understanding of the various aspects and applications of biotechnology as well as the importance of bio-safety and ethical issues related to it.

SYLLABUS OF GE-11

UNIT- 1: Introduction

2 hrs

Concept and Scope of Biotechnology.

UNIT- 2: Techniques in Gene Manipulation

9 hrs

Outline process of genetic engineering and recombinant DNA technology, Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids (lambda & M13). Shuttle and Expression Vectors. Genomic and cDNA libraries. Transformation techniques: Electroporation and Calcium Chloride method.

UNIT- 3: Fermentation

9 hrs

Different types of Fermentation: Submerged & Solid state; batch, Fed batch and Continuous; Stirred tank, Air Lift, Downstream Processing: Filtration, centrifugation, extraction, chromatography (Only Principles: Adsorption, Ion exchange, gel filtration, hydrophobic, affinity and size exclusion and lyophilization.

UNIT- 4: Transgenic Animal Technology

5 hrs

Production of transgenic animals: Retroviral method, DNA microinjection method, Nuclear Transplantation: Dolly and Polly.

UNIT- 5: rDNA Application in Health

5 hrs

Recombinant vaccines, gene therapy (*in-vivo and ex-vivo*). Production of recombinant Proteins: Monoclonal Antibodies, Insulin and growth hormones, Bio safety: Physical and Biological containment.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Packing and sterilization of glass and plastic wares for microbial culture.
2. Preparation and sterilization of culture media.
3. Preparation of genomic DNA from *E. coli*.
4. Calculation of transformation efficiency from the data provided.
5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.

6. Techniques:

- a. Western Blot
- b. Southern Hybridization
- c. DNA Finger printing
- d. Polymerase chain reaction,
- e. DNA Microarrays
- f. Polyacrylamide gel Electrophoresis
- g. DNA sequencing: Sanger method

Essential/recommended readings

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
2. Brown, T.A. (1998). Gene Cloning and DNA Analysis: An Introduction. II Edition, Academic Press, California, USA.
3. R. Ian Freshney (2021) Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell.

Suggestive readings

1. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
2. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes-A Short Course. III Edition, Freeman and Co., N.Y., USA.
3. Mathur, J.P. and Barnes, D. (1998) Methods in Cell Biology: Animal Cell Culture Methods. Academic Press.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-12): Introduction to Public Health and Epidemiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Introduction to Public Health and Epidemiology Zoo-GE-12	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts and importance of epidemiology and its contribution in the public health research.
- to acquire knowledge about the descriptive, analytic, and experimental aspects that can be applied for assessing the epidemiological studies of health status in the Indian population-based registers.
- to understand the relevance of statistics for the analysis of health-related data and its implications in the health sector
- To enable students to interpret results of data analysis for public health research, policy or practice.

Learning Outcomes

By studying this course, students will be able to

- better understand the fundamental components of epidemiology and data analysis.
- gain an understanding of the unique resources that Indian health registers represent for epidemiological research.
- comprehend various types of epidemiological studies, and understand their 'hierarchy' with respect to research.
- evaluate and interpret basic measures of occurrence and association and interpret the results
- appreciate and analytically assess the collection, analysis of data, and evaluate the relevant hypotheses.
- evaluate the strengths and limitations of epidemiologic reports
- apply epidemiological thinking to critically read and appraise articles in medical literature.

SYLLABUS OF GE-12

UNIT- 1: Epidemiology of Infectious Diseases

12 hrs

Modes of infections with suitable examples. Overview of cause, extent, prevention, treatment and control of the diseases: Respiratory infections, Intestinal infections, Arthropod-borne infections, Zoonosis and Surface infections.

UNIT- 2: Understanding Epidemiological Data

8 hrs

Understanding incidence, mortality (rates, ratios and proportions); Components of epidemiology: disease frequency, distribution and determinants of diseases. Epidemiological approach and measurements- vital statistics, health indicator parameters (morbidity, mortality and fertility rates); Analysis of data from National Cancer Registry Program (NCRP) and Covid-19 data.

UNIT- 3: Epidemiologic Methods and Survey

6 hrs

Outlining the parameters for ethical issues in a study. Determining the target and control populations; Designing of questionnaires; Data collection: Strength of observation (descriptive and analytical) and experimental studies. Epidemiology study designs- case control and cohort studies (prospective and retrospective), procedures of sampling and matching, sources of bias.

UNIT- 4: Collection, Tabulation and Representation of Data

4 hrs

Analysis of data from NCRP data and survey conducted by the students. Basic principles of “R” software for tabulation and graphical representations (bar diagrams, histograms, pie charts, box plot, etc.), measures of central tendency (mean, mode, median and partition values), dispersion (range, standard deviation, coefficient of variance and covariance) and skewness.

Practical

60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. Designing a questionnaire for survey of prevalence diabetes/ hypertension/ allergy/ respiratory disorders/covid 19.
2. To conduct a population survey for the year for the any one of the disease- diabetes/ hypertension/ allergy/ respiratory disorders/covid 19.
3. Design an epidemiology study: case control and cohort study (prospective and retrospective), including techniques of sampling and matching, sources of bias.
4. Perform correlation and regression studies on the data collected.
5. Analyze the probabilistic distribution studies.
6. Comparison of groups and ascertaining statistical significance of differences.
8. Research and presentation on current trends in infectious diseases.

Essential/recommended readings

1. Glantz, S. (2011) Primer of Biostatistics, 7th edition, McGraw-Hill Medical. ISBN-13: 978-0071781503.
2. Park, K.(2011) Park's Textbook of Preventive and Social Medicine, 21st edition, M/s Banarsi Das Bhanot Publishers.
3. Bonita, R., Beaglehole, R., TordKjellstrøm, (2006) Basic epidemiology, 2nd edition (2006), Contributor; World Health Organization, illustrated, Publisher: World Health Organization.
4. Pagano, M. and Gauvreau, K. (2000) Principles of Biostatistics, 2nd edition, Thompson learning.

Suggestive readings

1. Wayne W Daniel and Chad L. Cross (2013), Biostatistics: A Foundation for Analysis in the Health Sciences, 10th edition, Wiley. ISBN-13: 978-1118302798.
2. Jerrold H. Zar (2009) Biostatistical Analysis, 5th edition, Pearson. ISBN-13: 978-0131008465.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-13): Concept of Animal Behaviour
Zoo-GE-13

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Concept of Animal Behaviour Zoo-GE-13	04	02	Nil	02	Passed Class XII with Biology/Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to familiarize the students with the scientific study of the behaviour of animals.
- to enable students to link behaviour patterns to the brain, genes, and hormones, as well as to the surrounding ecological and social environments.
- to acquire knowledge of aggression, the chase of the hunter and the flight of the hunted, the spinning of webs, the digging of burrows, and the building of nests or remaining motionless and concealed.
- to provide a good understanding of various concepts in animal behaviour.
- to motivate students to pursue a career in animal behaviour.

Learning Outcomes

By studying this course, students will be able to

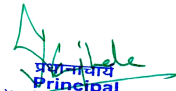
- better understand the various types of animal behaviour and their importance.
- enhance their observation skills, analytical skills, scientific interpretation and documentation skills.
- enable students to evaluate the characteristic features of animal life including static postures, active movements, noises, smells, changes in colour and shape.
- realise, appreciate and develop passion to biodiversity and respect the nature and its surroundings.

SYLLABUS OF GE-13

UNIT- 1: Introduction to Animal Behaviour

4 hrs

Origin and history of ethology, Pioneers of modern ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Four Questions for Ethology.


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UNIT- 2: Patterns of Behaviour**7 hrs**

Innate behaviour, Instinct, Sign stimuli, Code breakers, Learning: associative learning and non-associative learning, Classical and operant conditioning, Habituation, Imprinting.

UNIT- 3: Communication**3 hrs**

Importance of communication; Role of Chemical, Tactile, Auditory, Visual stimuli in communication.

UNIT- 4: Social Behaviour**7 hrs**

Concept of Society, Social insects (Honeybee as example), Bee communication, Altruism & Reciprocal altruism, Inclusive fitness, Hamilton's rule.

UNIT- 5: Sexual Behaviour**9 hrs**

Sexual dimorphism, mate choice; Intra-sexual selection (male rivalry); Inter-sexual selection (female choice); Courtship behaviour, Parental care, sexual conflict in parental care, Infanticide.

Practical**(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. To study nests and nesting behaviour of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Study of different tools, techniques and methods used in preparing ethogram.
6. To study courtship behaviour in insects and birds from short videos/movies.

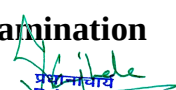
Essential/recommended readings

1. Alcock, J. (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
2. Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, Vith Edition, Cambridge University Press, UK
3. McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK

Suggestive readings

1. Rubenstein, D. (2022) Animal Behavior, XIIth Edition, Sinauer Associates, Oxford University Press, UK.
2. Gadagkar, R. (2021) Experiments in Animal Behaviour: Cutting-Edge Research at Trifling Cost, Indian Academy of Sciences.

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SEMESTER - VI

BSc. (H) Zoology DSC-Animal Biotechnology Zoo-DSC-16

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Animal Biotechnology Zoo-DSC-16	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to introduce students to the principle, practices and application of biotechnology.
- to familiarize the students with the basic concept of genetic engineering.
- to enable students to solve problems focusing on health, medicine, agriculture and environment etc.
- to learn scientific and engineering principles related to the processing/production of the recombinant proteins.
- to equip the students with the skills advanced tools and techniques used in biotechnology to acquire skills to pursue a career in biotechnology.
- to make the students aware of the scope of biotechnology which encompasses almost every field of science like engineering, research, commercialization and academics.

Learning Outcomes

By studying this course, students will be able to:

- Enable students to make a strategy to manipulate genetic structure of an organism for improvement of any trait.
- Comprehend the ethical and social issues regarding GMOs.
- Gain knowledge of DNA isolation, Agarose gel electrophoresis, PCR, transformation etc.
- Execute the application of recombinant DNA technology in designing research project.
- Acquire technical skills required for joining research labs/industry/institute/pharmaceutical etc. including entrepreneurship.

SYLLABUS OF DSC-16

UNIT- 1: Overview of Biotechnology

1 hr

Aim and scope; applications in biotechnology.

UNIT- 2: Basic Tools for Gene Manipulation

10 hrs

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics); Restriction enzymes; DNA modifying enzymes; Transformation techniques: Calcium chloride method, electroporation and biolistic methods, construction of genomic and cDNA libraries and screening by colony and plaque hybridization.

UNIT- 3: Advance Tools and Techniques

3 hrs

Gene Editing Tool: Zinc Finger, TALEN, Clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system.

UNIT- 4: Genetically Modified Animals

8 hrs

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection; Applications of transgenic animals; Production of pharmaceuticals, production of donor organs, knock-out mice.

UNIT- 5: Applications of Genetic Engineering

8 hrs

Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia): RFLP based, Allele specific oligonucleotide dot blot method, PCR- Oligonucleotide ligation assay; Recombinant DNA in medicines: recombinant insulin and human growth hormone, Gene therapy.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Isolation of genomic DNA from *E. coli*.
2. Isolation of plasmid (pUC 18/19) from *E. coli*.
3. Detection/ Visualization of DNA using Agarose gel electrophoresis.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from calcium chloride method.
6. Study of different blotting techniques: Southern, Northern and Western.
7. DNA sequencing: Sanger method, Next generation sequencing (Illumina).
8. Study of Polymerase Chain Reaction (PCR) and DNA microarrays.
9. Study and interpretation of DNA fingerprinting.
10. Submission of Project report based on any of the topics above (theory/practical)

Essential/recommended readings

1. Brown, T.A. (2010) Gene Cloning and DNA Analysis. VI Edition, Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
3. Primrose, S.B., and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. VII Edition, Blackwell publishing (Oxford, UK)

Suggestive readings

1. Clark, D. P. and Pazdernik, N.J. (2012) Biotechnology, Academic Press.
2. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007) Recombinant DNA Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.

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DISCIPLINE SPECIFIC CORE COURSE -17 – :
Methods in Biostatistics
Zoo-DSC-17

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Methods in Biostatistics Zoo-DSC-17	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to provide an overview of the fundamental concepts of biostatistics.
- to apprise students to the various statistical methods and software tools for understanding data analysis in biological sciences.
- to familiarize students with basic training and develop skills required for analysis of experimental data in biological sciences.
- to encourage students to pursue higher studies or career in biostatistics as Data Analyst, Data Scientist, Software Developer, Machine Learning Analyst, Research Scientist, Academicians, etc.

Learning Outcomes

By studying this course, students will be able to

- better understand the basic concepts of Biostatistics and its various applications in different fields of biological sciences.
- acquire basic skills to set up hypothesis and design research studies.
- enable students to differentiate among various experimental designs and apply appropriate statistical tests.
- develop the skills to collect and represent data in tabular and graphical forms.
- analyze data and interpret experimental results using calculator, spread sheets software and online/offline software tools.

Syllabus of DSC-17

UNIT- 1: Introduction to Biostatistics

1 hr

Aim and scope; applications in biological sciences.

UNIT- 2: Statistical Data

4 hrs

Sampling methods; Primary and secondary data; Qualitative and quantitative data;

Discrete and continuous data; Presentation of data- graphical representation of data

UNIT- 3: Descriptive Statistics **9 hrs**

Concepts of statistical population and samples, parameter and statistics; Measures of Central tendency and Dispersion - Mean, Median and Mode (grouped and ungrouped data); Variance, Standard Deviation and Standard Error; Coefficient of Variance.

UNIT- 4: Probability and Distributions **2 hrs**

Normal, Binomial and Poisson; Skewness and Kurtosis.

UNIT- 5: Testing of Hypothesis **4 hrs**

Null and Alternative hypotheses; Concepts of statistical errors - Type I and Type II errors; Confidence Intervals and Confidence levels.

UNIT- 6: Statistical tests **6 hrs**

Chi Square tests; Z test, t Tests - paired and unpaired; F test (one way ANOVA).

UNIT- 7: Correlation and Regression **4 hrs**

Correlation Coefficient; Linear regression analysis.

Practical **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. To learn calculation and graphical representation of data with computers (e.g. MS Excel/SPSS/SigmaStat/Prism).
2. To compute Coefficient of Variance from data collected and measure variability.
3. To collect data on different parameters (e.g. height/weight) of animal/plant samples and test for significance, difference between mean, mode and median.
4. To compute 'test of independence' and 'goodness of fit' with samples/data provided using Chi square test.
5. To perform Z test/ F test (ANOVA) for given samples/data provided.
6. Submission of Project report based on field studies (sample collection, data analysis and interpretation using above statistical tests).

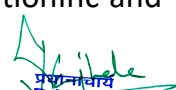
Essential/recommended readings

1. Daniel, W.W. and Cross, C.L. (2018) Biostatistics: Basic Concepts and Methodology for the Health Sciences 11th Edition, John Wiley & Sons, Inc.
2. Motulsky, H. (2016) Essential Biostatistics: A Non-mathematical Approach Oxford University Press

Suggestive readings

1. Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA

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DISCIPLINE SPECIFIC CORE COURSE– 18:**Evolutionary Biology****Zoo-DSC-18****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Evolutionary Biology Zoo-DSC- 18	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to understand evolutionary forces leading to the variations and diversification of species.
- to learn about deciphering evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.
- to gain knowledge of the processes and patterns of biological evolution.
- to get acquainted with origin and evolution of man.
- to acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.

Learning Outcomes

By studying this course, students will be able to:

- gain knowledge about the relationship of the evolution of various species and the environment they live in.
- apply knowledge gained, on populations in real time, while studying speciation, behaviour and susceptibility to diseases.
- better understand the study of variations, genetic drift to ensure that conservation efforts for small threatened populations are focused in right direction.
- predict the practical implication of various evolutionary forces acting on the human population in the field of human health, agriculture and wildlife conservation.
- use various software to generate interest towards the field of bioinformatics and coding used in programming language.

SYLLABUS OF DSC-18

UNIT- 1 Historical Review of Evolutionary Concepts

2 hrs

Lamarckism, Darwinism, Neo-Darwinism

UNIT- 2: Beginning of Life

3 hrs

Chemogeny, RNA world, biogeny, origin of photosynthesis, endo-symbiotic theory

UNIT- 3: Evidences of Evolution

5 hrs

Palaeontological: geological time scale; phylogeny of horse;

Molecular: neutral theory of evolution, molecular clock, example of globin gene family, rRNA/Cyt c.

UNIT- 4: Raw Material for Evolution

3 hrs

Variations: Heritable variations and their role in evolution

Unit 5: Process of Evolution

6 hrs

Qualitative studies: Natural selection, types of natural selection, artificial selection, kin selection, adaptive resemblances, sexual selection, frequency dependent selection.

Quantitative studies: Natural selection (concept of fitness, selection coefficient), genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load).

UNIT- 6: Product of Evolution

4 hrs

Speciation: micro-evolutionary changes (inter-population variations, clines, Ring species, races), species concept, isolating mechanisms.

UNIT- 7: Extinction

3 hrs

Mass extinctions (events, causes and effects), Detailed explanation of K-T extinction

UNIT- 8: Origin and Evolution of Man

4 hrs

Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular evidences in evolution of modern human.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Study of fossils (types, forms and dating) from models/pictures.
2. Study of homology, analogy and homoplasy from suitable specimens.
3. Study different modes of speciation and Adaptive radiation/macroevolutionary suitable examples.

4. Study of variations in a sample human population: (a) Continuous variation: Height/Weight in relation to age and sex (b) Discontinuous variation: Ability/Inability to taste Phenylthiocarbamide (PTC).
5. Study of Hardy-Weinberg Equilibrium: statement, assumptions, derivation of the equation and its verification by chi square analysis.
6. Demonstration of role of natural selection and genetic drift in changing allelic frequencies using simulation studies.
7. Construction of cladograms based on morphological characters.
8. Introduction and construction of Phylogenetic trees with the help of bioinformatics tools (Clustal X/W, Phylip, MLK/MP/NJ) and its interpretation.

Essential/recommended readings

1. Roberts, A. (2018) Evolution: the human story, Dorling, Kindersley Ltd.
2. Hall, B.K. and Hallgrimson, B. (2013). Evolution. V Edition, Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B. (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
4. Barton N.H., Briggs D.E.G., Eisen J.A., Goldstein D.B. and Patel N.H., (2007) 1st Ed. Evolution, Cold Spring Harbor Laboratory Press.

Suggestive readings

1. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Ed. Evolutionary Biology, Oxford University Press.
2. Zimmer C. and Emlen D. J., (2013) 1stEd. Evolution: Making Sense of Life, Roberts & Co.
3. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition, Wiley Blackwell.
4. Ridley, M. (2004). Evolution. III Edition, Blackwell publishing.

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POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES

SEM VI

ZOOLOGY- DSE-14: Nanobiotechnology

ZOOLOGY- DSE-15: Human Endocrinology

ZOOLOGY- DSE-16: Toxicology

ZOOLOGY- DSE-17: Research Methodology

DISCIPLINE SPECIFIC ELECTIVES (DSE-14): Nanobiotechnology Zoo-DSE-14

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nano-biotechnology Zoo-DSE-14	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to make the students aware of concept of Nanobiotechnology.
- to acquire the knowledge to introspect and understand the core concepts of nanotechnology.
- to equip the students with the concepts of biotechnology required for understanding the behaviour of nano-biomaterials.
- to develop a holistic understanding of the complex cellular processes occurring after treatment with nanoparticles.
- to provide in-depth knowledge of the body's response to nanotherapeutics.
- to appreciate the potential benefits and challenges of nanomedicine.

Learning Outcomes

By studying this course, students will be able to

- better understand the basics of nanobiotechnology and the nanoscale paradigm in terms of properties at the nanoscale dimension.
- acquire skills to optimize the synthesis of nanoparticles.
- appreciate the interaction between biomolecules and nanoparticle surface and their applications.
- analyze the process of nanoparticle internalization inside the cell and to evaluate

the process and interactions of nanoparticles within the cells.

- better understand the practical, real world biosensing technologies such as enzyme-based biosensors.
- ability to understand the ethical, societal responsibilities and identify the risk assessments involved in using bio-nanobiomaterials.
- to provide a critical and systematic understanding of cutting-edge technology at the forefront.

SYLLABUS OF DSE-14

UNIT- 1: Introduction to Nanobiotechnology,

2 hrs

Overview of nanobiotechnology - timelines and progress.

UNIT- 2: Fundamentals of Nanobiomaterials

12 hrs

Properties of Materials: Bulk materials vs nanomaterials, Biomaterials and synthetic materials; Types of nanocarriers/nanoparticles: Metals, Lipids, Polymeric nanoparticles (Liposomes, polymeric micelles, quantum dots, iron nanoparticles, carbon nanotubes), nanoscale assembly of microorganisms (virus, diatoms, bacteria); Nanofabrication: Top-down- Ball Milling; Bottom- up approaches-synthesis of metal oxides by green synthesis and chemical synthesis; nano-herbal formulations.

UNIT -3: Nanocarriers for Drug Delivery

10 hrs

Drug Delivery Systems (DDS): Oral delivery, Systemic delivery, Controlled drug release; Transdermal drug delivery (Examples: Intranasal Drug Delivery and Ocular Drug Delivery); Active and passive nanocarriers- Concept of targeting, Multifunctional Nanoparticles: Inorganic and organic nanoparticles and their biomedical applications; Improvements in pharmacokinetics, bioavailability, biodistribution.

UNIT- 4: Applications of Nanobiotechnology

14 hrs

Health and Diseases - Infectious and chronic diseases; Vaccines - Lipid nanoparticles, Viral nanoparticles

Diagnostics: Enzyme Biosensors and Diagnostics, DNA-Based Biosensors and Diagnostics, nano-immunosensors. Improved diagnosis by *in vivo* imaging- detection of tumours and genetic defects.

Environmental Pollution: Environmental Nanoremediation Technology- Thermal, Physico-Chemical and Biological Methods, nanofiltration for treatment of waste removal of organics, inorganics and pathogens.

UNIT- 5 Nanotoxicity:

7 hrs

Basics of cellular toxicity: Effect of size, shape, surface properties and composition on the toxicity of nanoparticles; genotoxicity and carcinogenicity – Mechanisms and

Tests. Risk assessment of Nanoparticle exposure, Prevention and control of nanoparticles exposure.

Practical

(30 hrs)

(Laboratory periods: 15 classes of 2 hours each)

1. Biosynthesis of nanoparticles: plants/microbial and its follow up with visible spectroscopy.
2. Synthesis of Iron oxide nanoparticles by using chemical methods.
3. Characterization of nanoparticles: Electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, spectroscopic techniques including spectrophotometer.
4. Cell counting and cell viability study of a non-adherent cell (Hepatocyte) culture.
5. Antibacterial studies of nanoparticles by minimum inhibitory concentration (MIC) method.
6. Isolation of DNA and demonstration of apoptosis by DNA fragmentation.
7. Study of cell and nanoparticle interaction (Video demonstration).
8. Enzyme-based biosensors, e.g., the blood glucose sensor (Video demonstration).
9. Array-based DNA "biochip" sensors with fluorescence detection (video demonstration).

Essential/recommended readings

1. Niaounakis, M. (2015) "Biopolymers: Applications and Trends", 1st Edition, Elsevier.
2. Guterres, N., Silvia S., Alves, O. L. (Eds.) (2014) Nanotoxicology: Materials, Methodologies, and Assessments, Springer New York, USA.
3. Hillery, A. M. et al. (2010) "Drug Delivery and Targeting", CRC Press.
4. Torchillin, V. (2006) Nanoparticulates as Drug Carriers, Imperial College Press,

Suggestive readings

1. Kesharwani, P., Singh, K. K. (Eds) (2021) Nanoparticle Therapeutics: Production Technologies, Types of Nanoparticles, and Regulatory Aspects; Academic Press Inc.
2. Pieter Stroeve and Morteza Mahmoudi (2018) Drug Delivery Systems, World Scientific Series: From Biomaterials towards Medical Devices, Vol I.
3. Mao Hong Fan, Chin-Pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. (2010) Environanotechnology; Elsevier.
4. N. Yao and Z. L. Wang, Handbook of Microscopy for Nanotechnology, Springer New York, NY (2005).

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DISCIPLINE SPECIFIC ELECTIVES (DSE-15): Human Endocrinology Zoo-DSE-15

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Human Endocrinology Zoo-DSE- 15	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to enable students to learn endocrinology with special emphasis on the human endocrine system covering the anatomy, physiology and biochemistry of the system, biological phenomenon at cellular level
- to provide detailed information on the release, effect and functioning of hormones.
- to acquire knowledge about the role of hormones as therapeutic agents.
- to acquaint students with experimental skills used in clinical and research laboratories

Learning Outcomes

By studying this course, students will be able to:

- comprehend the endocrine system and properties of hormones.
- understand the importance of endocrine system and its role in maintenance of homeostasis.
- gain in-depth knowledge of the molecular mechanism of hormone action and its regulation.
- better appreciate the regulation of physiological process and its implication in diseases.
- acquire information about human endocrine disorders.

SYLLABUS OF DSE- 15

UNIT- 1: Introduction to Endocrine Physiology

8 hrs

Introduction to the endocrine system and major glands (pituitary, pineal, adrenal, thyroid, parathyroid, testis, pancreas, ovaries, and GI tract), Classes of hormones, Modes of hormone secretion.

UNIT- 2: Neuroendocrinology**12 hrs**

General organization of nervous system and neuroendocrine organs; Neurons: Structure, types, distribution and characteristics; Introduction to Neuropeptides, Neurosteroids and neurohormones.

The hypothalamo-hypophyseal axis; Hypothalamo-vascular system; hypothalamic hormones: chemistry, physiology and its regulation. Hypothalamo-hypophyseal interactions with the gonads, adrenal and other endocrine glands.

Neuroendocrine regulation of immune system; Stress hormones and immune response. Neuroendocrine disorders: genetic *versus* environmental causes (sleep apnea, precocious puberty).

UNIT- 3: Molecular Endocrinology**10 hrs**

Hormones as chemical messengers for control and regulation of physiological processes. Structure and biosynthesis of peptide, protein and steroid hormones; Storage, secretion and regulation of hormones; Mechanisms of hormone action: Receptor and non-receptor mediated signalling; Feedback mechanisms in signalling pathways.

UNIT- 4: Hormones as Therapeutic Agents**15 hrs**

Therapeutic use of hormones in health and disease (cancer, biological clock regulation, metabolic dysfunction, stress management, growth hormone disorders).

Current developments in design and production of hormonal contraceptives.

Recombinant protein hormones: production and application in regulation of fertility (Hormone replacement therapy, hypogonadism, PCOS/PCOD, xeno-estrogens and its effects on male fertility).

Practical**(30 hrs)****(Laboratory periods: 15 classes of 2 hours each)**

1. Simulation of dissection and virtual display of endocrine glands in rat model.
2. Study of the permanent slides of the major (pituitary, pineal, adrenal, thyroid, parathyroid, testis, pancreas, ovaries, and GI tract) endocrine glands.
3. Estimation of plasma level of any hormone using Immunoblot/ELISA.
4. Chromatographic separation of steroid hormones using paper chromatography.
5. Visit to endocrine laboratory/hospitals/clinics.
6. Project work/survey-based project on any endocrine disorder.

Essential/recommended readings

1. David O. Norris, James Carr (2021) Vertebrate Endocrinology, V Edition, Elsevier.
2. J. Larry Jameson, Leslie De Groot (2010). Endocrinology, VI Edition, Elsevier.
3. Hadley, M.E. and Levine J.E. (2009). Endocrinology. VI Edition. Pearson Education Inc., New Jersey.
4. Franklin F. Bolander (2004) Molecular Endocrinology. III Edition, Academic Press, USA.

Suggestive readings

1. Handbook of Physiology published by American Physiological Society by Oxford University Press, Section 7: Multiple volumes set, 1998.
2. Endocrinology: An Integrated Approach. BIOS Scientific Publishers
(<https://www.ncbi.nlm.nih.gov/books/NBK22/>).
3. Turner, D. (1977) General Endocrinology. VI Edition, Saunders.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-16): Toxicology

Zoo-DSE-16

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Toxicology Zoo-DSE- 16	04	03	Nil	01	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to gain insight about basic toxicology, nature and classification of toxins and its mechanism.
- to learn about daily exposure types, dose response curve and toxicity episodes of toxic substances.
- to understand the chemistry, kinetics, metabolism and excretion of toxins.
- to enable the students to understand the aspects of environmental, medical and forensic toxicology.
- to elucidate the role of instruments and techniques in studying toxicology.

Learning Outcomes

By studying this course, students will be able to:

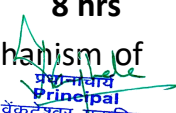
- acquire in-depth knowledge of the principles of toxicology, exposure and dose-response assessment.
- use technical and analytical skills to quantify the level and effect of xenobiotics on environment.
- better understand the mechanism of action and effects of toxic chemicals at multiple levels of biological organization.
- identify relationship between chemical exposure and its effect on physiological system.
- perform, analyse and interpret technical aspects and experimental approaches for toxicological research testing and risk assessment.

SYLLABUS OF DSE- 16

UNIT- 1: Principles of Toxicology

History and scope of toxicology, nature and classification of toxins, mechanism of toxicity, risk assessment-animal bioassays, dose-response assessment.

8 hrs


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UNIT- 2: Toxicokinetics:**10 hrs**

Transportation, absorption, distribution, metabolism and excretion of toxins, enzyme mediated biotransformation (hydrolysis, reduction, oxidation, conjugation), and toxicokinetics (one-and two-compartment, elimination, clearance, saturation).

UNIT-3: Applied Toxicology**20 hrs**

Environmental Toxicology: Ecotoxicology, Food, Agrochemical and Industrial Toxicology- Fertilizers and pesticide toxicology, Heavy metal toxicity, solvent & vapors toxicity, radiation/ radioactive toxicity.

Medical, and Forensic Toxicology: Organ's responses to toxins (pulmonary, hepatic, renal, cerebral, cardiac-blood vascular, nervous system, organs of immune system, ocular, dermal, reproductive and endocrine systems) toxicity, Poisons: definition, classification of poisons, types of poisoning, mode of action, antidotes & factors modifying the action of poisons, Nanotoxicology, Carcinogens, Immunotoxicity (immune modulation, xenobiotic-induced hypersensitivity & autoimmunity).

Developmental and Occupational Toxicity: Dosemetrics, Dymorphogenesis, maternal & environmental effects on fetus, workplaces, associated agents, routes and span of exposures and standards, dose determination, diseases/ ailments, risk evaluation.

UNIT- 4: Tools and Techniques in Toxicology:**4 hrs**

Instruments (Chromatography- TLC, GLC, HPLC), Soxhlet apparatus, flash evaporator, Lyophilization

UNIT- 5: Regulatory Units**3 hrs**

Role of institutes viz. EPA (Environmental Protection Agency), TERI, CSE (Center for science and environment) and CPCB, FAO, European union norms etc.

Practical**(30 hrs)****(Laboratory periods: 15 classes of 2 hours each)**

1. Determination of the LD₅₀ /LC₅₀ with the help of data.
2. Minimum inhibitory concentration of a toxin/ pesticide/ heavy metal/ tobacco.
3. Effect of a toxin/ pesticide/ heavy metal on any live organism (microbes/ animal/ plants).
4. Comparative study of normal and intoxicated sections of organs with the help of permanent slides/ pictorial representation (pulmonary, hepatic, renal, cerebral, cardiac-blood vascular, nervous system, organs of immune system, ocular, dermal, reproductive and endocrine systems - any three organs).
5. Separating techniques for toxin/s- Chromatography: Paper/ Thin Layer/ Column.
6. Techniques of HPLC, GLC (Dry Lab).
7. Routes of administration of drugs for the treatment regimens (Dry Lab).

8. Project work based on visit to institute of toxicology/ forensic science/ public health/ laboratory /hospital.

Essential/recommended readings

1. Woolley, D. and Woolley, A. (2017). Practical Toxicology- Evaluation, Prediction and Risk, Third edition, CRC press, Taylor and Francis Group/
2. Stine, K. E. and Brown, T. M. (2015). Principles of Toxicology, Third edition, CRC press, Taylor and Francis Group
3. Hayes, W. and Kruger, C. L. (2014). Hayes' Principles and Methods of Toxicology, VI edition, CRC press, Taylor and Francis Group.
4. Eroschenko, V. P. (2008), De Fiore's Atlas of Human Histology with functional correlations, Eleventh edition, Wolter Kluwer, Lippincott William and Wilkins.
5. Tortora, G.J. & Grabowski, S (2006) Principles of Anatomy & Physiology, XI edition. John Wiley & Sons.

Suggestive readings

1. Pani, B (2019). Textbook of Toxicology, Dreamtech press.
2. Gad, S. C. (2018). Regulatory Toxicology, III edition, CRC press, Taylor and Francis Group.
3. Casarett & Doull's Essentials of Toxicology (2015), III Edition, A & L Lange Series.
5. Pandey, G. and Sahni, Y. (2013) Toxicology Laboratory manual. International E-Publication.
6. Freifelder, D. (1999). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, Second Edition, W. H. Freeman and Company.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-14): Model Organisms in Research Zoo-GE-14

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Model Organisms in Research Zoo-GE-14	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to make the students aware about the requirement of model organisms in biological research.
- to understand the simulation of human traits in model organisms.
- to familiarize the students about the suitability and availability of different model organisms.
- to aware students about the ethical issues involved in using animals for research in laboratories.
- to give insight about the database systems available of different model organism.

Learning Outcomes

By studying this course, students will be able to

- better understand the concept of model organisms and their advantages.
- appreciate various types of model organisms used in biological research.
- gain better knowledge of how the model organisms can be used for modelling of human diseases.
- have an insight on the ethical issues related to handling and maintaining laboratory animals and plants.
- design simple experiments with model organism.
- determine the type of model organisms that are suitable to answer the specific research questions.

SYLLABUS OF GE-14

UNIT- 1: Introduction

2 hrs

Model organisms: Definition, requirement, characteristics and selection.

UNIT- 2: Commonly used Model Organisms

20 hrs

Characteristics, establishment and maintenance, specific application of following model organisms in research:

Viruses (Bacteriophage λ -phage, T4); Bacteria (*Escherichia coli*); Fungi (*Saccharomyces cerevisiae*); Ciliates (*Tetrahymena*); Annelids (*Caenorhabditis elegans*, *Lumbric terrestris*); Arthropods (*Drosophila melanogaster*); Pisces (*Danio rerio*); Amphibians (*Xenopus laevis*); Mammals [Rodents (*Mus musculus*), *Rattus rattus* (Rat) and Primates]; Plants (*Arabidopsis thaliana*).

UNIT- 3: Model organism specific databases

6 hrs

Saccharomyces genome Database, EcoCyc, Flybase, Xenbase, Wormbase, Zfin, Mouse genome informatics, *Tetrahymena* genome Database, The *Arabidopsis* Information Resource etc.

UNIT- 4: Ethical consideration

2 hrs

Brief introduction about CPCSEA, IAEC and related regulatory bodies.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Preparation of culture medium for *E. coli* and study the growth kinetics of *E. coli*.
2. Preparation of culture medium for *Drosophila* and study different stages of life cycle of *Drosophila*.
3. Preparation of culture medium for ciliates and their growth kinetics.
4. Study different phases of cell cycle in ciliates.
5. Culturing of *C. elegans*/ earthworm and Zebra fish and perform eco-toxicological studies.
6. Demonstration of culturing of mammalian cell lines/ visit to eukaryotic cell culture facility.
7. Visit to animal house and/ or plant culture facility and prepare the report on maintenance of laboratories animal/plant.

Essential/recommended readings

1. Jarret, R. L. and McCluskey, K. (2021) The Biological Resources of Model Organisms, 1st Ed, CRC Press.

2. Ankeny, R. A. and Leonelli, S. (2020) Concept of Model Organisms; Cambridge University Press.
3. Emerging model organisms: A laboratory manual, Volume 2, lab manual edition (2010), New York, USA: Cold Spring Harbor Laboratory Press.

Suggestive readings

1. Wang, W., Rohner, N., Wang, Y. (2023) Emerging Model Organisms; SpringerLink.
2. Jarret, R. L. and McCluskey, K. (2021) The Biological Resources of Model organisms, Taylor and Francis group.
3. Carroll, P. M. and Fitzgerald, K. (2003) Model Organisms in Drug Discovery, Wiley.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-15): Nanobiology

Zoo-GE-15

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nanobiology Zoo-GE-15	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts of Nanobiology.
- to equip the students with the concepts, properties and behaviour of nano-biomaterials.
- to provide a critical and systematic understanding of cutting-edge technology.
- to give an overall concept regarding the prominence of nanomaterials and their classification, synthesis process

Learning Outcomes

By studying this course, students will be able to

- better understand the interaction of biomolecules with surfaces of different chemical and physical species.
- appreciate the different applications of various types of nanostructured materials.
- gain knowledge of the types of nanoparticles based on size, shape, surface properties and composition.
- interpret/ analyse and get insight into the applications in the field of medicine.
- use basic principles of microfluidics to solve biotechnical and bioanalytical problems.
- appreciate the multidisciplinary nature of Nanobiology.
- develop skills in high-tech instrumental techniques suited for characterization of the micro/nano- structural properties.

SYLLABUS OF GE-15

UNIT- 1: Nanobiology

2 hrs

Definition and concepts, Development of nanobiotechnology/nanobiology, timelines and progress.

UNIT- 2: Biomaterials

Bulk materials vs nanomaterials. Different types of materials used for the synthesis of nanoparticles, Top-down approach, and bottom-up approach. Classification

nanoparticles based on size, shape, surface properties and composition; bio-inspired nanomaterials. Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus, diatoms, bacteria).

UNIT- 3: Nanomedicine

10 hrs

Drug encapsulation, drug delivery and gene delivery, Active and passive targeting by ligands and receptor-mediated delivery, Interactions of nanoparticles with biological membranes and ion channels. Applications of nanomedicines in diagnostics: biosensor-based techniques like optical, colorimetric, and electrochemical, point-of-care diagnostics tools like lab-on-chip device, lateral flow immunoassay.

UNIT- 4: Environmental applications

6 hrs

Nanoadsorbents, release of nutrients and pesticides, Nanoremediation, Nanopollution: air - water - soil contaminants, Treatment of industrial wastewaters using nanoparticles.

UNIT- 5: Nanotoxicity

4 hrs

Effect of nanomaterials on human health, nanomaterial-cell interaction, Concept of cytotoxicity and genotoxicity, Future perspectives of Nanobiology.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Synthesis of silver/gold nanoparticles from plants extracts and follow up with visible spectroscopy.
2. Synthesis of Iron oxide nanoparticles by using chemical methods (Tyndall effect).
3. Characterization of nanoparticles: Electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, electrochemical analyzer, flow cytometry, spectroscopic techniques including spectrophotometer, spectro-fluorimeter.
4. Cell counting and cell viability study of a non-adherent cell (Hepatocyte) culture.
5. Study of cell and nanoparticle interaction (video demonstration).
6. Antibacterial studies of nanoparticles by MIC method.
7. Assessing cytotoxicity of nanoparticles by MTT.
8. Isolation of DNA and demonstration of apoptosis by DNA fragmentation.
9. Nano microbial degradation of various xenobiotics (e.g. pesticides, organochlorines, pyrethroids, PAH).

Essential/recommended readings

1. Kesharwani, P., Singh, K. K. (Eds) (2021) Nanoparticle Therapeutics: Production Technologies, Types of Nanoparticles, and Regulatory Aspects; Academic Press Inc.
2. Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair (2008) "Biomedical Nanostructures" Wiley-Interscience, John Wiley & Sons Inc.
3. Niemeyer, C.M. (2006) Nanobiotechnology: Concepts, Applications and

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Perspectives; Wiley VCH.

4. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith Eds. (2005) Nanoscale Technology in Biological Systems, CRC PRESS, Taylor & Francis.

Suggestive readings

1. Stroeve, P and Mahmoudi (2018) Drug Delivery Systems, World Scientific Series: From Biomaterials towards Medical Devices, Vol I.
2. Hillery, and Anya M et al. (2010 "Drug Delivery and Targeting", CRC Press.
3. Hong-fan, M, Huang, C.P., Bland, A. E., Honglin, W. Z., Sliman,R., Wright, I (2010) Enviro-nanotechnology; Elsevier.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-16): Forensic Biology
Zoo-GE-15

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre- requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Forensic Biology Zoo-GE-16	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to introduce the concept of forensic biology and DNA analysis.
- to identify and analyse the crime scene for biological evidence.
- to familiarize the students about the scientific methods in forensic biology.
- to emphasis on the practical techniques of biological principles that includessample recovery, sample handling, different analytical techniques and DNA profile comparison.
- to highlight the importance and application of forensic science.

Learning Outcomes

By studying this course, students will be able to

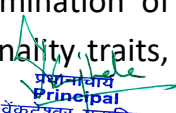
- Comprehend the fundamentals of forensic biology and DNA analysis.
- better understand the concepts of proper collection and preservation of biological.
- exhibits and crime scene investigation of biological evidence.
- rationalize the significance of criminal profiling.
- Develop skills based on the practical techniques of biological principles that includes sample recovery, sample handling, different analytical techniques and DNA profile comparison.

SYLLABUS OF GE-16

UNIT- 1: Principles of DNA Forensics and DNA Typing

8 hrs

Definition and fundamental concepts of forensic biology, DNA as biological blueprint of life, Structure of DNA, collection of DNA sample, extraction, profiling, restriction fragment length polymorphism (RFLP), polymerase chain reaction (PCR), short tandem repeat markers, single nucleotide polymorphism markers (SNP), determination of ethnicity, determination of physical appearance, determination of personality traits, mitochondrial DNA, RNA and DNA database. Result interpretation.


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UNIT- 2: Parentage Testing

4 hrs

Principles of heredity, genetics of paternity, DNA testing in disputed paternity, Mendelian laws of parentage testing.

UNIT- 3: Biological Evidence

12 hrs

Nature and importance of study of biological evidences in crime cases:

- a) Forensic examination of hair: Transfer, persistence and recovery of hair evidence, Structure of human hair, Comparison of hair samples, Morphology and biochemistry of human hair.
 - b) Comparison of human and animal hair.
 - c) Identification of wild life materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods, Identification of Pug marks of various animals
 - d) Types and identification of microbial organisms of forensic significance
 - e) Forensic odontology: structural variation in teeth (human and non-human), types of teeth and their functions, determination of age from teeth: eruption sequence, Gustafson's method, dental anomalies, their significance in personal identification.
- Bites marks:** Forensic significance, collection and preservation of bite marks, photography and evaluation of bite marks, Lip prints in forensic investigations.

UNIT- 4: Forensic Importance of Body fluids

6 hrs

Blood: Composition and functions, Collection and preservation of blood evidence, Distinction between human and non-human blood, Determination of blood groups; Forensic characterization of bloodstains, typing of dried stains;

Semen: Forensic significance of semen, Composition, functions and morphology of spermatozoa, Collection, evaluation and tests for identification of semen, Individualization on the basis of semen examination.

Other Fluids: Composition, functions, identification tests and forensic significance of saliva, sweat, milk and urine.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Prepare slides of scale pattern of human hair and examine morphology of hair to determine the species to which the hair belongs.
2. Chemical identification of human blood.
3. Determination of blood group from fresh and dried blood samples.
4. Crime scene Blood Stain Pattern Analysis, using photographs and videos.
5. Identification of saliva and urine.
6. Separation of amino acids by thin layer chromatography (TLC).
7. Case study of evidences based on: DNA finger printing (disputed paternity marks/ Hair).
8. Visit to any Forensic Lab/Institute.

Essential/recommended readings

1. Tilstone, W.J., Hastrup, M.L. and Hald, C. (2013) Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton.
2. Saferstein, R. (2010) Criminalistics: An Introduction to Forensic Science (10th Edition), Pearson.
3. Butler, J.M. (2005) Forensic DNA Typing, Elsevier.
4. L. Stryer, (1988) Biochemistry, 3rd Edition, W.H. Freeman and Company, New York.
5. Chowdhuri, S. (1971) Forensic Biology, BPRD, New Delhi.

Suggestive readings

1. Duncan, G.T. and Tracey, M.I. (1997) Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton.
2. Inman K. and Rudin, N. (1997) An Introduction to Forensic DNA Analysis, CRC Press, Boca Raton.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. (Life Science) - Zoology Component (Semester - IV)

DISCIPLINE SPECIFIC CORE COURSE-12 (Zoo-LS-DSC-12):– Fundamentals of Human Physiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Fundamentals of Human Physiology Zoo-LS-DSC-12	04	02	Nil	02	Passed Class XII with Chemistry/ Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to learn the fundamentals that underpins the health and well-being of living organisms.
- to study the internal working of organs and organ systems.
- to expand their knowledge with respect to functioning of various organ systems such as muscular, nervous, digestive, circulatory, respiratory, excretory, reproductive and endocrine in humans.

Learning Outcomes

By studying this course, students will be able to

- Have an enhanced knowledge and appreciation of human physiology
- Recognize and identify principal tissue structures and functions
- Better understand the functions of important physiological systems including the nervous system, muscular system, endocrine and reproductive system
- Learn an integrative approach to understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanism.

SYLLABUS OF DSC- 12

UNIT- 1: Nerve and Muscle

7 hrs

Structure of a neuron, Resting membrane potential, Graded potential, Origin of action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction.

UNIT- 2: Digestion

Physiology of digestion in the alimentary canal; Absorption of proteins, lipids.

UNIT- 3: Respiration**4 hrs**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood.

UNIT- 4: Excretion**4 hrs**

Structure of nephron, Mechanism of urine formation, Counter-current Mechanism.

UNIT- 5: Cardiovascular system**5 hrs**

Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle.

UNIT- 6: Reproduction and Endocrine Glands**6 hrs**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal gland.

Practical:**60 hrs****(Laboratory periods: 15 classes of 4 hours each)**

1. Preparation of haemin and haemochromogen crystals.
2. Estimation of WBC and RBC count of blood.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Determination of Blood Pressure by Auscultatory method.
5. Lung function tests using Spirometry (Determination of Vital Capacity, Peak Expiratory Flow Rate. Lung Volumes and Capacities).
6. Measurement of oxygen saturation by pulse oximetry before and after exercise.
7. Experiments on superficial (plantar) and deep (knee jerk) reflex.
8. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, duodenum, liver, lung, kidney, bone, cartilage.
9. Project on Family planning devices.

Essential/recommended readings

1. Tortora, G.J. and Derrickson, B.H. (2009) Principles of Anatomy and Physiology, XIVth Edition, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Victor P. Eroschenko. (2008). Di Fiore's Atlas of Histology with Functional correlations. XII Edition.

Suggestive readings

1. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers
2. Prakash, G. (2012) Lab Manual on Blood Analysis and Medical Diagnostic Chand and Company Ltd.

**BSc. (Life Science) -
Zoology Component (Semester - V)**

DISCIPLINE SPECIFIC CORE COURSE-15 (Zoo-LS-DSC-15):– Evolutionary Ecology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Evolutionary Ecology Zoo-LS-DSC-15	04	02	Nil	02	Passed Class XII with Chemistry/ Biology/ Biotechnology	Basic concept of Ecology

Learning Objectives

The learning objectives of this course are as follows:

- to explore the interface of ecological and evolutionary forces that leads to the diversity of the form.
- to understand the function, and behaviour among animals.
- to impart an understanding of the evolutionary origin and drivers of biological variation and diversity, including the significance of genetic variation, natural selection, and genetic drift.
- to unravel the evolution of animals, sexual selection, the evolution of mating systems, animal interactions, reaction norms and plasticity.
- to learn about co-evolution between species and ecology from a phylogenetic perspective and compares evolutionary processes behind reproductive and ecological adaptations.
- to understand how communities and species interact with their environment at large spatial and temporal scales.

Learning Outcomes

By studying this course, students will be able to

- better understand the diverse relationships that the organisms have in the environment.
- analyze the patterns of distribution of animals in different regions and ecosystems.
- gain insight to the major events in history of life and major theories of evolution.
- know the fundamental concepts of natural selection, speciation, mass extinction and macro-evolution.
- explain the characteristics, dynamics, and growth of populations.
- appreciate the characteristics of the community, ecosystem development and climax theories.
- gain knowledge about the relationship of the evolution of various species and the environment they live in.

SYLLABUS OF DSC- 15

UNIT- 1: Introduction to Evolutionary Ecology

3 hrs

Introduction to the concepts of evolution and ecology and the relationship, evolutionary theories and origin of life, Levels of ecological hierarchy, heritability, natural selection, fitness and adaptation; Types of selection, Ecological adaptations of animals to their environment.

UNIT- 2: Population Ecology

7 hrs

Group attributes- Density, natality, mortality, dispersal and dispersion, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Population growth- Exponential and logistic growth, Life history traits - r and K selection. Population regulation - Density dependent and independent. Population interactions: Positive and negative interactions.

UNIT- 3: Community Interactions

6 hrs

Characteristics of community- species richness, dominance, diversity and abundance. Community organisation – habitat, niche, guilds, and dominant species. Interspecific interactions with examples. Species diversity indices. Types of ecological succession. Characteristics of climax community, Concept of keystone, flagship, umbrella species with examples.

UNIT- 4: Processes of Evolutionary Change and Species Concept

7 hrs

Natural selection and its types, Genetic drift, Artificial selection. Species concept, Isolating mechanisms, Modes of speciation (Allopatric, Sympatric, Parapatric and Peripatric), Adaptive radiation/macroevolution (Darwin finches).

UNIT- 5: Coevolution

4 hrs

Introduction to coevolution; types of coevolution (pairwise coevolution, diffuse coevolution, and gene-for-gene coevolution); Co-evolutionary interactions (Coevolution of competitors, Predator-prey coevolution, Host-parasite coevolution, Coevolution of mutualists); Evolutionary equilibria. Approaches to examine coevolution; Co-speciation and diversification.

UNIT- 6: Macroecology

3 hrs

Introduction to macroecology: patterns and constraints; macroecological datasets; statistical patterns of abundance, distribution and diversity; Allometry: metabolism, body size and temperature; Macroecology of humans; Conservation macroecology: assessing, prioritizing, and quantifying biodiversity at large scales; Extinction dynamics.

Practical:

(Laboratory periods: 15 classes of 4 hours each)

1. Study of the phytoplankton and zooplankton: Collection of specimens from an ecosystem (pond/river/lake/forest/garden) to study its biotic and abiotic components.
2. Measurement of temperature, turbidity/penetration of light, determination of pH, Dissolved Oxygen content (Winkler's method), chlorides, hardness, Chemical Oxygen Demand, free CO₂.
3. Gause's Principle with laboratory and field examples, Lotka-Volterra equation-significance in competition; Lotka-Volterra equation, functional and numerical responses in Predation.
4. Determination of population density in a natural/hypothetical community by quadrature method and calculation of Shannon-Weiner diversity index for the same community.
5. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
6. Catch, mark and recapture technique for finding the population size.
7. Study of homology, analogy and homoplasy from suitable specimens.
8. Construction of cladograms based on morphological characters.
9. Study and verification of Hardy-Weinberg Law by Chi-square analysis
10. Project report based on the visit to natural history museum/National Park/Biodiversity Park/Wildlife Sanctuary.

Essential/recommended readings

1. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Ed. Evolutionary Biology, Oxford University Press
2. Zimmer C. and Emlen D. J., (2013) 1st Ed. Evolution: Making Sense of Life, Roberts & Co.
3. Hall, B.K. and Hallgrimson, B. (2013) Evolution; 5th Edition, Jones and Barlett Publishers.
4. Chapman, J., and Reiss, M. (2012). Ecology Principles and Applications; Cambridge University Press.
5. Miller, T., and Spoolman, S. (2008) 12th Edition Environmental Science- Problems, Concepts and Solutions; Thomson Brooks/Cole.
6. Odum, E. P. and Barrette, G. W. (2008) Fundamentals of Ecology; 5th Indian edition; Brooks/Cole

Suggestive readings

1. Smith T. M. and Smith R. L. (2015). Elements of Ecology. 9th International Edition. Publisher: Benjamin Cummings.
2. Ridley, M. (2004). Evolution. III Edition, Blackwell publishing.
3. Southwood, T. R. E., & Henderson, P. a. (2000). Ecological Methods, 3rd Edition, Blackwell Science Ltd. (Vol. 278, Issue 5705).

BSc. (Life Science) - Zoology Component (Semester - VI)

DISCIPLINE SPECIFIC CORE COURSE-18 (Zoo-LS-DSC-18):– Basics of Immunology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Basics of Immunology Zoo-LS-DSC-18	04	02	Nil	02	Passed Class XII with Chemistry/ Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to understand the components and functions of immune system of the body.
- to learn how the immune system responds to various infections and foreign substances that adversely affect our body.
- to help comprehend the concept of hypersensitivity and vaccines.
- to acquaint the students on the role of immune system in prevention and altered response to diseases.

Learning Outcomes

By studying this course, students will be able to

- acquire knowledge of immunogenicity and antigenicity.
- better understand innate and acquired immunity.
- appreciate and analyze the various humoral and cellular components of the immune system.
- comprehend the role of immune system in health and disease.
- gain knowledge of autoimmunity, immunodeficiency and hypersensitivity.
- have an enhanced understanding of vaccine and vaccination.

SYLLABUS OF DSC- 18

UNIT-1: Immune System and its components

6 hrs

Instructional and clonal selection theory; Innate immunity: components and defensive barriers of innate immunity. Adaptive immune system: Components and attributes of acquired immunity, humoral and cell mediated immunity, active and passive immunity, primary and secondary immune response.

UNIT- 2: Antigens, Immunogens and Antibodies

Antigens and immunogens; antigenicity and immunogenicity; factors affecting immunogenicity; antigenic determinants (B- and T-cell epitopes); concepts of

antigen recognition by B- and T-cells. Structure and function of different classes of antibodies.

UNIT- 3: Antigen Processing and Presentation

4 hrs

Structure and functions of MHC (MHC I & MHC II); endogenous and exogenous pathways of antigen processing and presentation.

UNIT- 4: Cytokines & Complement System

4 hrs

Properties and functions of cytokines; Pathways of complement activation and its biological consequences.

UNIT- 5: Role of immune system in Prevention of Diseases

8 hrs

Gell and Coomb's classification of hypersensitivity; autoimmunity; immune dysfunctions and immunodeficiency with suitable examples. Vaccines and their types.

Practical:

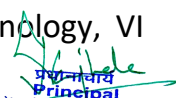
60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. To study the structure and function of lymphoid organs of the immune system.
2. Histological study of spleen, thymus and lymph nodes through slides/ photomicrographs.
3. To study haematopoiesis and role of cells in immune response through flowchart.
4. To study various types of blood cells using Leishman's/Giemsa/Crystal violet stained blood smear.
5. Cell counting and viability test (trypan blue dye exclusion test) from splenocytes* from rat/mouse/any other species.
6. To understand the antigen and antibody interactions by
 - i) ABO Blood group antigen determination by heamagglutination test.
 - ii) Ouchterlony's double immunodiffusion method.
 - iii) Production of monoclonal antibodies by HAT selection.
 - iv) Demonstration of ELISA.
 - v) Demonstration of Immuno electrophoresis.
 - vi) FACS
 - vii) RIA
7. Project on any topic/ Project report on visit to any research institute/laboratory to study the immunological techniques

Essential/recommended readings

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006) Immunology, VI Edition, W.H. Freeman and Company
2. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006) Immunology, VI Edition, Mosby, Elsevier Publication.


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3. Janeway's Immunobiology 9th Edition, by Kenneth Murphy, Casey Weaver, Garland Science
4. Kenneth Murphy, Casey Weaver (2016) Janeway's Immunobiology; 9th Edition, Garland Science
5. Abbas, K. Abul and Lichtman H. Andrew (2003) Cellular and Molecular Immunology, V Edition, Saunders Publication.

Suggestive readings

1. Punt, J., Stranford, S., Jones, P., Owen, J.A. (2018) Kuby Immunology, VIII Edition, WH Freeman and Company
2. 1. Singh, I. K. and Sharma, P. [Eds.] (2022) An Interplay of Cellular and Molecular Components of Immunology. Taylor & Francis group, CRC Press.
3. Kaur, H., Toteja, R., and Makhija, S. (2021) Textbook of Immunology, I.K International Publishing House and Wiley India Ltd
4. Singh, I. K. and Sharma, P. [Eds.] (2022) Essentials of Immunology, Laboratory Manual; Prestige Publishers.
5. Hay, F.C., Westwood, O.M.R (2005) Practical Immunology– Fifth Edition. John Wiley and Sons Ltd.

Sd/-
REGISTRAR

UNIVERSITY OF DELHI

CNC-II/093/1(28)/2023-24/283

Dated: 08.11.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14-1-6/-(6) dated 09.06.2023 and 27-1-1/-(7) dated
25.08.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-IV, V and VI of the following Programmes of Department of Chemistry under Faculty of Science based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23 :

- (i) BSc. (Hons.) Chemistry
- (ii) BSc. (Physical Science) with Chemistry as one of Core Discipline
- (iii) BSc. (Life Science) with Chemistry as one of the Core Discipline
- (iv) BSc. (Industrial Chemistry) – Chemistry Component
- (v) BSc (Hons.) Applied Life Sciences with Agrochemicals and Pest Management.

DEPARTMENT OF CHEMISTRY

SEMESTER IV

B Sc. (Hons) Chemistry

DISCIPLINE SPECIFIC CORE COURSE - 10(DSC-10): Coordination Chemistry and Reaction Mechanism

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre- requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Coordination Chemistry and Reaction Mechanism (DSC-10: Inorganic Chemistry - IV)	04	03	--	01	Class 12 th with Physics, Chemistry, Mathematics	--

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with coordination compounds which find manifold applications in diverse areas.
- To acquaint the student with the concept of Inorganic reaction mechanism.

Learning Outcomes

By studying this course, the students will be able to:

- Explain the terms- ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds.
- Discuss the various types of isomerism possible in such compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.

- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin complexes and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on the basis of Crystal Field Theory.
- Explain the reaction mechanism of coordination compounds and differentiate between kinetic and thermodynamic stability.

SYLLABUS OF DSC-10

Unit-1: Coordination Chemistry

(Hours: 28)

Werner's Coordination theory, simple problems based on this theory

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds (coordination numbers 4 and 6). Valence bond theory and its application to complexes of coordination numbers 4 and 6.

Crystal field theory, measurement of Δ_o . Calculation of CFSE in weak and strong fields, concept of pairing energies, factors affecting the magnitude of Δ_o . Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry: Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory (for octahedral σ -donor, π - acceptor and π - donor complexes).

Unit-2: Stability of complexes and Inorganic Reaction Mechanism: (Hours: 17)

Brief discussion of thermodynamic and kinetic stability, Factors affecting stability of complexes, such as chelate effect, macrocyclic effect, resonance effect etc., trends in step wise formation constant, interpretation of lability and inertness based on VBT and CFT.

Introduction to inorganic reaction mechanisms, concept of reaction pathways, transition state, intermediate and activated complex. Substitution reactions in square planar complexes, factors affecting the rate of Substitution reactions in square planar complexes- such as charge effect, solvent effect and Trans- effect (Theories of trans-effect).

Practical component

Practical:

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

(A) Argentometry

Estimation of Cl^-

- By Mohr's method
- By Vohlard's method and
- By Fajan's method

(B) Complexometric Titrations:

- Complexometric estimation of Mg^{2+} / Zn^{2+} using EDTA
- Estimation of total hardness of water samples

- (iii) Estimation of Ca^{2+} in solution by substitution method
- (iv) Estimation of Ca/Mg in drugs or biological samples.

(C) Properties of Complexes

Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, dimethyl glyoxime, glycine) by substitution method.

Essential/recommended readings

Theory:

1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
2. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, Fifth Edition, Pearson.
3. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
4. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry**, John Wiley & Sons.
5. Cotton, F.A.; Wilkinson, G.(1999), **Advanced Inorganic Chemistry**, Wiley-VCH.
6. Sodhi G.S. (2018), **Principles of Inorganic Chemistry**, Viva Books India.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons,
2. Harris, D. C.; Lucy, C. A. (2016), **Quantitative Chemical Analysis**, 9th Edition, Freeman and Company.
3. Day, R. A.; Underwood, A. L. (2012), **Quantitative Analysis**, Sixth Edition, PHI Learning Private Limited.
4. Marr, G.; Rockett, B.W. (1972), **Practical Inorganic Chemistry**, Van Nostrand Reinhold.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -11 (DSC-11): Carbohydrates, Lipids and Heterocyclic Compounds

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Carbohydrates, Lipids and Heterocyclic Compounds (DSC-11, Organic Chemistry IV)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The Objectives of this course are as follows:

- To familiarize students with the chemistry of carbohydrates, lipids, and heterocyclic compounds
- To enable students to develop novel, efficient, convenient, selective and environmentally benign synthetic methods for synthesis of heterocyclic compounds.

Learning outcomes

By studying this course, the students will be able to:

- Describe uses and applications carbohydrates, lipids and heterocycles
- Use the knowledge gained from study of carbohydrates, lipids and heterocycles to propose greener and better synthetic routes.
- Use the chemistry and biology of carbohydrates, lipids and heterocycles to better serve the mankind.

SYLLABUS OF DSC-11

Unit-1: Carbohydrates & Lipids

(Hours: 24)

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Linkage between monosaccharides: Comparative study of the structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch, cellulose and glycogen) excluding their structure elucidation. Reactions of disaccharides-reducing property, hydrolysis, methylation and acetylation.

Lipids: Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega-3&6 fatty acids, trans fats, hydrogenation, hydrolysis, acid value, saponification value, iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit-2: Heterocyclic Compounds

(Hours:21)

Classification and nomenclature of heterocyclic compounds (containing only one hetero atom). Structure, aromaticity in 5-membered and 6-membered rings containing one heteroatom; Basicity and relative reactivity towards electrophilic substitution reactions (amongst five membered and six membered rings).

General methods of synthesis for: furan, thiophene, pyrrole (Paal-Knorr synthesis, Hantzsch synthesis), pyridine (Hantzsch synthesis), indole (Fischer Indole synthesis), quinoline (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis)

Properties: Physical properties, discussion on the following reaction (with mechanism) for furan, pyrrole, thiophene, pyridine, indole and quinoline: Electrophilic substitution- nitration, sulphonation, halogenation, formylation, acylation, mercuration and carboxylation. Oxidation, reduction, addition, reactions showing acidic /basic character, reaction with diazonium salts, ring opening, ring expansion and nucleophilic substitution reaction wherever applicable should be discussed.

Practical:

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

1. Estimation of sugars by using Fehling solution.
2. Functional group tests for amine, nitro and amides.
3. Determination of saponification value of the given oil.
4. Determination of iodine number of the given oil.
5. Systematic qualitative analysis of the given organic compounds containing monofunctional groups (carboxylic acids, carbonyl compounds, carbohydrates and esters) and preparation of one suitable derivative.

Essential/recommended readings

Theory:

1. Berg, J.M., Tymoczko, J.L., Stryer, L. (2019), **Biochemistry**, 9th Edition W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M., Lehninger, A.L. (2017), **Principles of Biochemistry**. W.H. Freeman and Co., International Edition.
3. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
4. Parashar, R.K., Negi, B. (2016) **Chemistry of Heterocyclic Compounds**, Ane Books Pvt Ltd.
5. Kuashik, S., Singh, A. (2023), **Biomolecules: From Genes to Proteins**, 1st Edition, Berlin, Boston: De Gruyter.
6. Finar, I.L., (2012), **Organic Chemistry** Volume 1, 6th Edition, Pearson Education.
7. Singh J, Awasthi S K, Singh J, **Fundamentals of Organic Chemistry**, Pragati Prakashan Meerut.

Practical:

1. Vogel, A.I. (2012), **Quantitative Organic Analysis**, Part 3, Pearson Education.
2. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
4. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**, University Press
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
6. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE-12 (DSC-12): Electrochemical Cells, Chemical Kinetics and Catalysis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electrochemical Cells, Chemical Kinetics and Catalysis (DSC-12, Physical Chemistry IV)	04	03	--	01	Class 12 th with Physics, Chemistry, Mathematics	--

Learning Objectives

The Objectives of this course are as follows:

- To provide a detailed understanding about galvanic cells and their types
- To explain the applications of galvanic cells and EMF measurements.
- To get an understanding of the kinetics of simple and complex chemical reactions
- To give basic concept about catalysts and enzymes.
- To teach the working of potentiometer and different electrodes for performing potentiometric titrations
- To explain the experimental study of kinetics of simple reactions

Learning outcomes

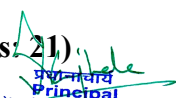
By studying this course, the students will be able to:

- Explain the working of electrochemical cells and different types of galvanic cell.
- Devise a spontaneous galvanic cell using various combinations of half-cells.
- Understand the concept of concentration cell
- Use the appropriate galvanic cell to measure pH, calculate thermodynamic parameters and perform potentiometric titrations.
- Write rate law and derive rate equations for simple and complex reactions and understanding of theories of reaction rates.
- Understand different types of catalysts and mechanism of enzyme catalysis.
- Perform potentiometric titrations using appropriate electrodes for quantitative analysis.
- Set up experiments to study the kinetics of simple reactions.

SYLLABUS OF DSC-12

Unit-1: Electrochemical Cells

(Hours: 21)


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Rules of oxidation/reduction of ions based on half-cell potentials, Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $\text{SbO/Sb}_2\text{O}_3$ electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). Structure of electric double layer (qualitative aspects only).

Unit-2: Chemical Kinetics

(Hours: 18)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods for determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates, introduction to electrode kinetics (qualitative aspects only).

Unit-3: Catalysis:

(Hours: 6)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Practical:

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

(A) Potentiometry:

Perform the following potentiometric titrations:

1. Strong acid vs. strong base
2. Weak acid vs. strong base
3. Dibasic acid vs. strong base
4. Mixture of strong and weak acid vs strong base
5. Potassium dichromate vs. Mohr's salt

(B) Chemical Kinetics:

Study the kinetics of the following reactions

1. Iodide-persulphate reaction by Initial rate method
2. Acid hydrolysis of methyl acetate with hydrochloric acid.
3. Saponification of ethyl acetate by conductometric measurements.

Suggested experiments

1. To study the kinetics of Iodide-persulphate reaction using integrated rate method.
2. Comparison of the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate.

Essential/recommended readings

Theory:

1. Atkins, P.W.; Paula, J.de. (2014), **Atkin's Physical Chemistry Ed.**, 10th Edition, Oxford University Press.
2. Ball, D. W. (2017), **Physical Chemistry**, 2nd Edition, Cengage Learning, India.
3. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
4. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 3, 6th Edition, McGraw Hill Education.
5. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 5, 3rd Edition, McGraw Hill Education.
6. Laidler K.J. (2003), **Chemical Kinetics**, 3rd Edition, Pearson Education India.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER-V

BSC. (HONS.) CHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE -13 (DSC-13): Basics of Organometallic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basics of Organometallic Chemistry (DSC-13)-Inorganic Chemistry-V	04	03	--	01	Class 12 th with Physics, Chemistry, Mathematics	-

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with the interactions of metal atom with organic molecules (or not so typical organic molecule), which is in an entirely different fashion as compared to coordination compounds.
- To familiarize the students with the structure and bonding in organometallic compounds
- To familiarize the student with how organometallic compounds can act as good catalysts for organic transformations and hence have industrial importance associated with medicines, bioorganic synthesis, and energy production.

Learning Outcomes

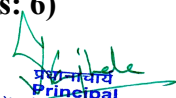
By studying this course, the students will be able to:

- Identify and classify organometallic compounds of different types.
- Explain the stability of organometallic compounds and hence the requirement of special experimental conditions for their synthesis.
- Explain the bonding modes through VBT and MOT in these compounds.
- Explain the chemical nature of these compounds through various reactions thus acquiring skills to understand their applications.
- Explain the mechanism of catalysis by these compounds. This may prepare the student to predict the catalytic pathways for new reactions

SYLLABUS OF DSC-13

Unit-1: Introduction to Organometallic Chemistry

(Hours: 6)


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Definition, brief history, classification of organometallic compounds on the basis of bond type. Common notation used in organometallic chemistry, concept of hapticity of organic ligands, importance of organometallic chemistry, organometallic compounds as reagents, additives, and catalysts. Introduction to the 18-electron rule or effective atomic number rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series and finding metal-metal bonds.

Unit-2: Structure and Bonding in Organometallic Compounds (Hours : 12)

Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.

Molecular orbital theory applied to organometallic compounds, description of bonding of two electron ligands to transition metals. π -acceptor behavior of CO (MO diagram of CO to be discussed), π -bonding of CO with metal (synergic effect) and use of IR data to explain extent of back bonding, bonding modes of CO, symmetry of metal carbonyls.

Bonding between metal atoms and organic π - systems: linear (ethylene, allyl, butadiene) and cyclic (cyclopentadiene, benzene), Zeise's salt and comparison of synergic effect with that in carbonyls.

Metal alkyls and Metal-carbene complexes

Unit-3: Synthesis, Reactions and Applications of Organometallic Compounds (Hours: 16)

General methods of synthesis of metal carbonyls: direct carbonylation, reductive carbonylation, thermal and photochemical decomposition, of mono and binuclear carbonyls of 3d series.

Reaction of metal carbonyls: reduction, oxidation, photochemical substitution, migratory insertion of carbonyls, and nucleophilic addition of CO.

Synthesis of metal-alkene complexes through ligand addition, reduction and substitution and reaction of metal bound alkenes, Zeise's salt

Metal-sandwich compounds: Ferrocene: synthesis, physical properties and reactions: acylation, sulfonation, alkylation metallation, acetylation, chloromercuration, Mannich reaction, comparison of aromaticity and reactivity of ferrocene with that of benzene.

Synthesis and reactions of Metal alkyls and Metal-carbenes

Unit-4: Catalysis by Organometallic Compounds (Hours: 11)

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis. (Catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, (catalytic poisons and promoter).

Organometallic catalysis of the following reactions of commercial importance and their mechanism:

1. Alkene hydrogenation (using Wilkinson's Catalyst)
2. Synthetic gasoline preparation (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst
4. Wacker oxidation process (Smid process)
5. Hydroformylation reaction (Oxo-process)
6. Monsanto Acetic Acid process

Theoretical aspects of enlisted practicals are also to be included in the theory paper.

Practical component

Practical:

(Laboratory periods: 15 classes of 2 hours each)

Credits: 01

1. To study and compare the UV-Vis spectrum of ferrocene (in methanol or acetonitrile) and potassium ferrocyanide (in water).
2. To study the cyclic voltammogram of ferrocene.
3. Preparation of Bis(acetylacetonato)copper(II) complex and characterisation through UV-Visible spectrum of its aqueous solution..
4. Preparation of tris(acetylacetonato)manganese(III) complex.
5. Preparation of Potassium tris(oxalato)ferrate(III) complex.
6. Preparation of Tetraamminecopper(II) sulphate monohydrate complex.
7. Preparation of Pentaamminechloridocobalt(III) chloride.
8. Preparation of Hexaamminecobalt(III) chloride
9. Determination of number of chloride ions in ionisation sphere to confirm the formula of complexes prepared in (6) and (7) through potentiometric titration or conductance measurements. (See reference 5 & 6 of Practicals)
10. Compare and interpret the visible spectrum of complexes prepared in (6) and (7) for shifts in wavelength maxima.

Any other organometallic compounds synthesised from time to time may also be included.

Essential/recommended readings

Theory:

1. Gary L Miesler, Paul J Fiesher, and Donald A Tarr, **Inorganic Chemistry** 5th Edition, Pearson.
2. Shriver & Atkins **Inorganic Chemistry**, Edn V, W.H. Freeman and Company.
3. F.A. Cotton & G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
4. William W. Porterfield, Inorganic Chemistry, 1st Edition.
5. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
6. Principles of Organometallic Chemistry by M.L.H Green, Coward, G.E Coates and K.Wade 3rd Edition.
7. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition, Wiley India.
8. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier.
9. Gupta, B. D., Elias, A. J., (2013) **Basic Organometallic Chemistry: Concepts, Syntheses and Applications**, 2nd Edition, Universities Press.

Practicals:

1. ChemTexts (2020) 6:22, <https://doi.org/10.1007/s40828-020-00119-6>
2. J. Chem Education: 1971, Volume 48(2), 133
3. Front. Chem. Sci. Eng. 2013, 7(3): 329–337, DOI 10.1007/s11705-013-1339-0
4. Orbital: Electron. J. Chem. 2019, 11 (6): 348-354

6. Vogel's text book of quantitative chemical analysis. Edn V

Note: Examination scheme and mode shall be as prescribed by the Examination Branch,
University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE - 14 (DSC-14): Nucleic Acids, Amino Acids, Proteins and Enzymes

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nucleic Acids, Amino Acids, Proteins and Enzymes (DSC-14, Organic Chemistry- V)	04	02	--	02	Class 12 th with Physics, Chemistry	--

Learning Objectives

The objectives of this course are as follows:

- To familiarize students with the fascinating chemistry and biology of biomolecules, *i.e.*, nucleic acids and proteins etc..
- To develop the interest of students in the basic concepts of heredity, which are imparted through replication, transcription, and translation processes.
- To discuss basic fundamentals of enzyme action and inhibition, which forms the basis of drug action.

Learning outcomes

By studying this course, the students will be able to:

- Demonstrate how structure of biomolecules determines their reactivity and biological role.
- Gain insight into concepts of heredity through the study of genetic code, replication, transcription, and translation
- Demonstrate basic understanding of enzyme action and role of inhibitors
- Use knowledge gained to solve real world problems.

SYLLABUS OF DSC-14

Unit-1: Nucleic Acids

(Hours: 8)

Structure of components of nucleic acids: Bases, Sugars, Nucleosides and Nucleotides.

Nomenclature of nucleosides and nucleotides, structure of polynucleotides (DNA and RNA) and factors stabilizing them, biological roles of DNA and RNA; Concept of heredity: Genetic Code, Replication, Transcription and Translation.

Unit-2: Amino Acids, Peptides and Proteins

(Hours: 14)

Amino acids and their classification; α -amino acids - Synthesis, ionic properties, and reactions. zwitterions, pKa values, isoelectric point, and electrophoresis; Study of peptides: determination of their primary structure-end group analysis; Synthesis of peptides using N-protecting, C-protecting and C-activating groups, Solid-phase synthesis; Overview of primary, secondary and tertiary structures of proteins, protein denaturation.

Unit-3: Enzymes

(Hours: 8)

Introduction, classification, and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as an example), factors affecting enzyme action, coenzymes, and cofactors (including ATP, NAD, FAD), specificity of enzyme action (including stereospecificity). Enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive, and non-competitive inhibition including allosteric inhibition).

Practical component

Practical:

Credits: 02

(Laboratory periods: 15 classes of 4 hours each)

1. Study of the titration curve of glycine.
2. Estimation of glycine by Sorenson Formol Titration
3. Qualitative analysis of proteins- Ninhydrin test, Biuret test, Millon's reagent test, Xanthoproteic test.
4. Estimation of proteins by Lowry's method.
5. Study of the action of salivary amylase on starch at room temperature.
6. Effect of temperature on the action of salivary amylase.
7. Effect of pH on the action of salivary amylase
8. Study the inhibition of α -Amylase by copper sulphate
9. Isolation and estimation of DNA using cauliflower/onion.

Essential/recommended readings

Theory:

1. Berg, J.M., Tymoczko, J.L., Stryer, L. (2019), **Biochemistry**, Ninth Edition W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M., Lehninger, A.L. (2017), **Principles of Biochemistry**. W.H. Freeman and Co., International Edition.
3. Murray, R.K., Granner, D.K., Mayes, P.A., Rodwell, V.W. (2009), **Harper's Illustrated Biochemistry**. Lange Medical Books/McGraw-Hill.
4. Brown, T.A. (2018), **Biochemistry**, (First Indian Edition) Viva Books.
5. Kuashik, S., Singh, A. (2023), **Biomolecules: From Genes to Proteins**, First Edition, Berlin, Boston: De Gruyter.
6. Voet, D., Voet, J.G. (2010), **Biochemistry**, Fourth Edition, Wiley.

7. Singh J, Awasthi S K, Singh J, **Fundamentals of Organic Chemistry**, Pragati Prakashan Meerut.

Additional Resources:

1. Finar, I.L. (2008), **Organic Chemistry**, Volume 2, Fifth Edition, Pearson Education.
2. Bruice, P.Y. (2020), **Organic Chemistry**, Eighth Edition, Pearson Education.

Practicals:

1. **Manual of Biochemistry Workshop** (2012), Department of Chemistry, University of Delhi.
2. Kumar, A., Garg, S., Garg, N. (2015), **Biochemical Tests: Principles and Protocols**. Viva Books.
3. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume-II**, I K International Publishing house Pvt. Ltd, New Delhi

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE-15 (DSC-15): Quantum Chemistry and Organic Chemistry IV Covalent bonding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Quantum Chemistry and Covalent bonding (DSC-15, Physical Chemistry V)	04	03	--	01	Class 12 th with Physics, Chemistry, Mathematics	

Learning objectives

The objectives of this course are as follows:

- To make students understand the limitations of classical mechanics and the need of quantum chemistry
- To familiarize the students with the postulates of quantum chemistry
- To explain how to apply the postulates to derive equations for various models and extend to hydrogen atom and hydrogen like atoms.
- To explain the valence bond and molecular orbital theories and their applications to simple molecules
- To explain the use of some computational software

Learning outcomes

By studying this course, students will be able to:

- Explain the limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
- Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle
- Set up Schrodinger equations for different types of systems
- Explain the concept of covalent bonding based on valence bond theory and molecular orbital theory.
- Perform calculations using different software and plot different wavefunctions and probability distribution curves.
- Perform simple calculations using appropriate quantum mechanical methods in different computational software

SYLLABUS OF DSC-15

Unit-1: Quantum Chemistry

(Hours: 22)

Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Schrödinger equation and its application to free particle and particle in a box (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three-dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar coordinates (derivation not required). Separation of variables. Spherical harmonics. Discussion of solution (Qualitative).

Unit-2: Hydrogen atom

(Hours: 08)

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part and quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Zeeman effect, Introduction of spin quantum number and magnetic spin quantum number Setting up of Schrödinger equation for many electron atoms (He, Li), Indistinguishability of electrons and Pauli exclusion principle, Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Unit-3: Covalent bonding

(Hours: 15)

Setting up of Schrödinger equation, Born-Openheimer approximation, LCAO-MO treatment of H_2^+ and its qualitative extension to H_2 , Valence bond (VB) treatment of H_2 , Comparison of LCAO-MO and VB wave functions of H_2 and their refinements, Qualitative description of LCAO-MO of homonuclear and heteronuclear diatomic molecules- HF and LiH .

Practical component

Practical:

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

1. Plot the radial wavefunctions and probability distribution for H atom's 1s, 2s, 2p orbital using software like EXCEL.
2. Using a software such as ArgusLab, plot HOMO, LUMO and ESP maps of various molecules.
3. Draw probability plots for a particle in a 1-dimensional box for different values of quantum number n - commenting on the number of points of zero probability and then correlate them with the correspondence principle.
4. Plot the electron density contour maps of sigma molecular orbitals for diatomic homonuclear molecules.
5. Plotting of the wave function and probability curve for simple harmonic motion and interpret the results for first two levels.

6. Plotting energy as a function of distance for simple harmonic motion - parabolic curve.
7. Using software such as ArgusLab calculate properties such as dipole moment and Mulliken charges using quantum mechanical methods.

Note: Any other suitable software may also be used .

Essential/recommended readings

Theory:

1. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, McGraw Hill Education, Vol 4, 5th Edition, McGraw Hill Education.
2. House, J.E. (2004), **Fundamentals of Quantum Chemistry**, 2nd Edition, Elsevier.
3. McQuarrie, D.A. (2016), **Quantum Chemistry**, Viva Books.
4. Chandra, A. K. (2001), **Introductory Quantum Chemistry**, Tata McGraw-Hill.
5. House, J.E. (2004), **Fundamentals of Quantum Chemistry**, 2nd Edition, Elsevier

Suggested Readings

1. Atkins, P.W.; Friedman, R. (2010), **Molecular Quantum Mechanics**, 5th Edition, Oxford University Press.

Practical:

1. McQuarrie, D. A. **Mathematics for Physical Chemistry** University Science Books (2008).
2. Mortimer, R. **Mathematics for Physical Chemistry**. 3rd Ed. Elsevier (2005).
3. Steiner, E. **The Chemical Maths Book** Oxford University Press (1996).
4. Yates, P. **Chemical Calculations**. 2nd Ed. CRC Press (2007).
5. Levie, R. de, **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press (2001) 487 pages.
6. Noggle, J. H. **Physical Chemistry on a Microcomputer**. Little Brown & Co. (1985).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER-VI

BSC. (HONS.) CHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE -16 (DSC-16): Principles in Qualitative Analysis and Bioinorganic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles in Qualitative Analysis and Bioinorganic Chemistry (DSC-16: Inorganic Chemistry -VI)	04	02	--	02	Class 12 th with Physics, Chemistry, Mathematics	--

Learning Objectives

The Objectives of this course are as follows:

- To discuss the principles of qualitative analysis
- To understand the concept of solubility products and the common ion effect on the separation of cations.
- To discuss the importance of metal ions in biological systems.
- To discuss the applications of iron in physiology, including iron transport and storage.

Learning Outcomes:

By the end of the course, the students will be able to:

- Explain the basic principles of qualitative inorganic analysis.
- Discuss the influence of solubility products and the common ion effect on the separation of cations.
- Discuss the identification of interfering anions and their removal.
- Explain and discuss the importance of metal ions in biological systems, through discussions on metal-containing enzymes, the sodium-potassium pump.
- Discuss the applications of iron in physiology, including iron transport and storage system.

Unit-1: Theoretical Principles in Qualitative Analysis

(Hours: 12)

Basic principles involved in analysis of cations and anions. Solubility product, common-ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate), need to remove them after Group II and methods of removal. Analysis of insoluble substances.

Unit-2: Bioinorganic Chemistry

(Hours: 18)

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / potassium pump, conduction of nerve impulses, Ca-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug.

Iron and its application in bio-systems, Haemoglobin, Myoglobin, cytochrome-C-oxidase ; Storage and transfer of iron.

Practical:

Credits: 02

(Laboratory periods: 15 classes of 4 hours each)

(A) Qualitative semi-micro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions.

The following radicals are suggested:

CO_3^{2-} , NO_2^- , S^{2-} , SO_3^{2-} , SO_4^{2-} , $\text{S}_2\text{O}_3^{2-}$, CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$, PO_4^{3-} , NH_4^+ , K^+ , Pb^{2+} , Cu^{2+} , Cd^{2+} , Bi^{3+} , Sn^{2+} , Sb^{3+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+}

(B) Mixtures should preferably contain one interfering anion, or insoluble component (BaSO_4 , SrSO_4 , PbSO_4 , CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-} , NO_2^- and NO_3^- , Cl^- and Br^- , Cl^- and I^- , Br^- and I^- , NO_3^- and Br^- , NO_3^- and I^- . Spot tests should be done whenever possible.

Essential/recommended readings

1. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, 7th Edition, Prentice Hall.
2. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O. K. (2009), **Inorganic Chemistry Principles of Structure and Reactivity**, Pearson Education.
3. Lippard, S.J.; Berg, J.M. (1994), **Principles of Bioinorganic Chemistry**, Panima Publishing Company.
4. *Biological Inorganic Chemistry* by **RR Crichton** in additional books
5. *Bioinorganic Chemistry- Inorganic Elements in the Chemistry of Life: An Introduction and Guide*, 2nd Edition by **Wolfgang Kaim, Brigitte Schwederski, Alex Klein**
6. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), 5th Edition, Oxford University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 17 (DSC-17): Polynuclear Hydrocarbons, Photochemistry, Pericyclic Reactions, and Spectroscopy of Organic Compounds

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Polynuclear Hydrocarbons, Photochemistry, Pericyclic Reactions, and Spectroscopy of Organic Compounds (DSC-17, Organic Chemistry-VI)	04	03	--	01	Class 12 th with Physics, Chemistry	-

Learning objectives

The objectives of this course are as follows:

- To provide thorough knowledge of the chemistry of polynuclear hydrocarbons .
- To detail the basic principles and applications of pericyclic reactions and photochemistry
- To familiarize students with the various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiations viz. UV-Visible, IR and NMR spectroscopy.

Learning outcomes

By studying this course, students will be able to:

- Discuss and use the chemistry of polynuclear hydrocarbons for application in real world problems.
- Discuss and use the pericyclic reactions and photochemistry for research and other applications.
- Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds.

SYLLABUS OF DSC-17

Unit-1: Polynuclear Hydrocarbons

(Hours: 6)

Introduction, classification, structure, nomenclature and uses. Aromaticity of polynuclear hydrocarbons, structure elucidation of Naphthalene and general methods of preparation of naphthalene and anthracene (including Haworth method, Friedel Craft acylation, Diels Alder reaction, Elbs reaction). Relative reactivity of naphthalene and anthracene in comparison to benzene.

Discussion on the following reactions (with mechanism) for Naphthalene and Anthracene: Addition reactions, Oxidation, Electrophilic substitution- Friedel Craft reaction, Chloromethylation, Halogenation, Formylation, Nitration and sulphonation. Reduction reaction and Diels Alder reaction.

Unit-2: Photochemistry and Pericyclic reactions

(Hours: 12)

Photochemistry

Introduction and basic principles of photochemistry, photochemical energy, photolytic cleavage, photochemistry of carbonyl compounds (Norrish type 1, Norrish type 2 and Petero Buchi reactions)

Pericyclic Reactions

Introduction: Types of pericyclic reactions (Electrocyclic, Cycloaddition and Sigmatropic Rearrangements), Symmetry in σ and π molecular orbitals, Frontier Molecular Orbitals.

Electrocyclic Reactions: Conrotatory and Disrotatory motion in ring opening and ring closing reactions in $(4n)$ and $(4n+2)$ π electron systems, FMO method, Woodward Hoffmann rule.

Cycloaddition Reactions: $[2+2]$ and $[4+2]$ π cycloaddition reactions, Diels Alder reaction (electron rich and electron poor dienes and dienophiles, Stereochemistry, Alder rule of endo addition).

Sigmatropic Reactions: $[1,3]$, $[1,5]$ and $[3,3]$ sigmatropic rearrangements, Cope rearrangement, Claisen Rearrangements.

Unit-3: Spectroscopy of Organic Compounds

(Hours: 27)

UV-Visible Spectroscopy: Types of electronic transitions, $\lambda_{\max}$, chromophores and Auxochromes, bathochromic and hypsochromic shifts, intensity of absorption, factors affecting $\lambda_{\max}$ values, application of Woodward Rules for calculation of $\lambda_{\max}$ for the following systems: α , β -unsaturated aldehydes, ketones, carboxylic acids and esters; conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between *cis* and *trans* isomers by UV; Colour concept, Theory of colour and constitution-Witt's theory, valence bond and molecular orbital theory.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O and N containing functional groups; effect of H-bonding, conjugation, resonance and ring size on IR absorptions; fingerprint region and its significance, application of IR in functional group analysis.

$^1\text{H-NMR}$ Spectroscopy: Basic principles of proton magnetic resonance, chemical shift and factors, influencing it; equivalent and non-equivalent protons (chemical and magnetic equivalence), Spin-Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics. Interpretation of NMR spectra of simple compounds containing AX, AX_2 , AX_3 , A_2X_3 spin systems, special case of 1-nitropropane.

Applications of IR, UV and $^1\text{H-NMR}$ Spectroscopy for identification of simple organic compounds (spectra to be provided for some representative compounds).

Practical component

Practical:

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

1. Systematic qualitative analysis of the given organic compounds containing monofunctional groups (Aryl halides, nitro compounds, amines and amides) and simple

bifunctional compounds like salicylic acid, cinnamic acid, *p*-nitro phenol etc. and preparation of one suitable crystalline derivative.

2. Differentiation between of *o*-/*p*-hydroxybenzaldehyde by IR spectroscopy (Spectra to be provided).
3. Differentiation between of benzoic acid and cinnamic acid by UV spectroscopy (Spectra to be provided).

Essential/recommended readings

Theory:

1. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. **Organic Chemistry** Volume 1, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Finar, I.L. **Organic Chemistry** Volume 2, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
4. Solomons, T.W.G., Fryhle, C.B.; Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.
5. Silverstein R.M. (2005), **Spectrometric Identification of organic compounds**, 7th edition, John Wiley and Sons,
6. Kemp W. (2019), **Organic Spectroscopy**, Third Edition, MacMillan.
7. Pavia, D. (2015), **Introduction to Spectroscopy**, Fifth Edition, Cengage Learning India Pvt. Learning.
8. Scheinmann, F., **Introduction to spectroscopic methods for identification of organic compounds**, Volume 2, Pergamon Press.
9. Ahluwalia, V.K., Parashar, R.K. (2011), **Organic Reaction Mechanisms**, 4th Edition, Narosa Publishing House.
10. Horspool, W.M. (1976) **Aspects of Organic Photochemistry**, Academic Press.
11. Singh J, Awasthi S K, Singh J, **Fundamentals of Organic Chemistry**, Pragati Prakashan Meerut.

Practical:

1. Vogel, A.I. (2012), **Quantitative Organic Analysis**, Part 3, Pearson Education.
2. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Fifth Edition, Pearson.
4. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
5. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**, University Press
6. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
7. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

DISCIPLINE SPECIFIC CORE COURSE-18 (DSC-18): Photochemistry and Spectroscopy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Photochemistry and Spectroscopy (DSC-18, Physical Chemistry VI)	04	02	-	02	Class XII with Physics, Chemistry and Mathematics	

Learning Objectives:

The Learning Objectives of this course are as follows:

- To make students understand the laws of photochemistry and their applications
- To understand the basis of molecular spectroscopy
- To study different types of spectroscopic techniques and their applications

Learning Outcomes:

By studying this course, students will be able to:

- Explain low and high quantum yield
- Explain photosensitized reactions
- Apply the concept of quantization to spectroscopy.
- Interpret various types of spectra and know about their application in structure elucidation

SYLLABUS OF DSC-18

Unit-1: Introduction to Molecular Spectroscopy and Photochemistry (Hours: 6)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Characteristics of electromagnetic radiation. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Unit-2: Rotational, Vibrational, Raman and Electronic Spectroscopy (Hours: 14)

Rotational spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic molecules, isotopic substitution, classification of molecules based on moment of inertia, applications of rotation spectroscopy (e.g. microwave appliances)

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy

Franck-Condon principle, electronic transitions, singlet and triplet states, Jablonski diagrams, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Unit-3: NMR and ESR

(Hours: 10)

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low-resolution spectra, different scales (δ and τ), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules like methanol, ethanol and acetaldehyde.

Principles of ESR spectroscopy, hyperfine structures, ESR of simple radicals

Practical component

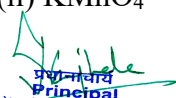
Practical:

Credits: 02

(Laboratory periods: 15 classes of 4 hours each)

(A) Colorimetry :

1. Verify Lambert-Beer's law and determine the concentration of (i) CuSO_4 (ii) KMnO_4 (iii) $\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration


Principal
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- Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.
- Study the kinetics of iodination of propanone in acidic medium.
- Determine the amount of iron present in a sample using 1,10-phenanthroline.
- Determine the dissociation constant of an indicator (phenolphthalein).
- Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide

(B) UV/Visible spectroscopy:

- Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
- Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$.
- Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

(C) Analysis of the given vibration-rotation spectrum of HCl(g)

Essential/recommended readings

Theory:

- Banwell, C.N.; McCash, E.M. (2006), **Fundamentals of Molecular Spectroscopy**, Tata McGraw- Hill.
- Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, McGraw Hill Education, Vol 4, 5th Edition, McGraw Hill Education.
- Kakkar, R. (2015), **Atomic & Molecular Spectroscopy**, Cambridge University Press.

Suggested Readings:

- Engel, T.; Reid, P. (2013), **Quantum Chemistry and Spectroscopy**, Pearson

Practical:

- Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
- Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York
- Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DSE FOR III/IV/V/VI SEMESTER

DISCIPLINE SPECIFIC ELECTIVE COURSE - 1 (DSE-1): Inorganic Materials of Industrial Importance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Inorganic Materials of Industrial Importance (DSE-1)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The objectives of this course are as follows:

- To make students understand the diverse roles of inorganic materials in the industry and to give an insight into how these raw materials are converted into products used in day-to-day life.
- To make students learn about silicates, fertilizers, surface coatings, batteries, engineering materials for mechanical construction.
- To develop the interest of students in the frontier areas of inorganic and material chemistry.

Learning outcomes

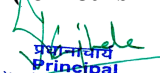
By studying this course, the students will be able to:

- State the composition and applications of the different kinds of glass.
- State the composition of cement and discuss the mechanism of setting of cement.
- Defend the suitability of fertilizers for different kinds of crops and soil.
- Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings.
- Describe the principle, working and applications of different batteries.
- Evaluate the synthesis and properties of nano-dimensional materials, various semiconductor and superconductor oxides.

SYLLABUS OF DSE-1

Unit 1: Silicate Industries

(6 Hours)


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Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, coloured glass, photosensitive glass, photochromic glass, glass wool and optical fibre.

Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.

Unit 2: Fertilizers

(6 Hours)

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime and potassium nitrate.

Unit 3: Surface Coatings

(18 Hours)

Brief introduction to and classification of surface coatings, paints and pigments: formulation, composition and related properties, pigment volume concentration (PVC) and critical pigment volume concentration (CPVC), fillers, thinners, enamels and emulsifying agents. Special paints: heat retardant, fire retardant, eco-friendly paints, plastic paints, water and oil paints. Preliminary methods for surface preparation, metallic coatings (electrolytic and electroless with reference to chrome plating and nickel plating), metal spraying and anodizing.

Contemporary surface coating methods like physical vapor deposition, chemical vapor deposition, galvanising, carburizing, sherardising, boriding, nitriding and cementation.

Unit 4: Batteries

(9 Hours)

Primary and secondary batteries, characteristics of an Ideal Battery, principle, working, applications and comparison of the following batteries: Pb- acid battery, Li-metal batteries, Li-ion batteries, Li-polymer batteries, solid state electrolyte batteries, fuel cells, solar cells and polymer cells.

Unit 5: Nano dimensional materials

(6 Hours)

Introduction to zero, one and two-dimensional nanomaterial: Synthesis, properties and applications of fullerenes, carbon nanotubes, carbon fibres, semiconducting and superconducting oxides.

Practical component

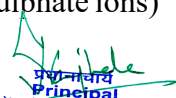
Practicals:

Credits:

01 (Laboratory periods:15 classes of 2 hours each)

(At least four experiments to be performed)

1. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis and determine its free acidity.


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2. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.
3. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) and estimation of phosphoric acid content.
4. Analysis of (Cu, Ni) in alloy or synthetic samples (methods involving Gravimetry and Spectrophotometry).
5. Analysis of (Cu, Zn) in alloy or synthetic samples (Multiple methods involving Iodometry, and Potentiometry).
6. Synthesis of pure ZnO and Cu doped ZnO nanoparticles.
7. Synthesis of silver nanoparticles by green and chemical approach methods and its characterization using UV-visible spectrophotometer

Essential/recommended readings

Theory:

1. West, A. R. (2014), **Solid State Chemistry and Its Application**, Wiley
2. Smart, L. E.; Moore, E. A. (2012), **Solid State Chemistry An Introduction**, CRC Press Taylor & Francis.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
4. Kent, J. A. (ed) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
5. Poole Jr.; Charles P.; Owens, Frank J.(2003), **Introduction to Nanotechnology**, John Wiley and Sons.

Practical:

1. Svehla, G.(1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
2. Banewicz, J. J.; Kenner, C.T. **Determination of Calcium and Magnesium in Limestones and Dolomites**, Anal. Chem., 1952, 24 (7), 1186–1187.
3. Ghorbani, H. R.; Mehr, F.P.; Pazoki, H.; Rahmani B. M. **Synthesis of ZnO Nanoparticles by Precipitation Method**. Orient J Chem 2015;31(2).
4. Orbaek, W.; McHale, M.M.; Barron, A.R. **Synthesis and characterization of silver nanoparticles for an undergraduate laboratory**, J. Chem. Educ. 2015, 92, 339–344.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2 (DSE-2): Green Chemistry in Organic Synthesis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Green Chemistry in Organic Synthesis (DSE-2)	04	03	--	01	Class 12 th with Physics, Chemistry	Basic knowledge of organic reactions

Learning objectives

The objectives of this course are as follows:

- To create awareness about the chemistry that is not harmful for human health and the environment.
- To provide thorough knowledge of the green chemistry principles that can be used to develop chemistry in greener way.
- To familiarize students with new remediation technologies for the cleaning up of hazardous substances.
- To use green chemistry for boosting profits, increase productivity and ensure sustainability with absolute zero waste.
- To learn about innovations and applications of green chemistry in education that helps companies to gain environmental benefits as well as to achieve economic and societal goals also
- The objective of the practical component is to develop basic skills to be able to design, develop and run chemical processes in a sustainable way.

Learning outcomes

By studying this course, students will be able to:

- List the twelve principles of green chemistry and build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- State the uses of catalyst over stoichiometric reagents
- Debate and use green solvents, renewable feedstock, and renewable energy sources for carrying out safer chemistry
- Use green chemistry for problem solving, innovation and finding solutions to environmental problems.

- Design safer processes, chemicals, and products through understanding of inherently safer design (ISD)
- Discuss the success stories and use real-world cases to practice green chemistry

SYLLABUS OF DSE-2

UNIT – 1: Introduction

(3 Hours)

Introduction to Green Chemistry, some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. Green chemistry in sustainable development.

UNIT – 2: Application of Green Chemistry Principles

(36 Hours)

Principles of Green Chemistry and designing a chemical synthesis

Concept familiarization and application of green chemistry principles using specific examples

1. Prevention of waste/ by products; waste or pollution prevention hierarchy
2. Green metrics to assess greenness of a reaction: Calculation of atom economy of the rearrangement, addition, substitution, and elimination reactions; calculation of E-factor for industrial processes
3. Prevention/ minimization of hazardous/ toxic products
4. Safer Solvent and Auxiliaries: Problems associated with conventional reaction media
Some Common Green solvents: Introduction, application, advantages, and disadvantages of green solvents in organic synthesis (taking suitable examples). Special emphasis on the following:
 - i. Super Critical Fluids (with special reference to carbon dioxide)
 - ii. Water: Concept of In-water, and on-water reactions (with special reference to synthesis of terpinol and linalool in water, Benzoin condensation, Heck reaction)
 - iii. Ionic Liquids: Physical properties and classification of Ionic Liquids (with special reference to Diels Alder reaction and Coumarin synthesis in ionic liquids)
 - iv. Biomass derived Solvents: Physicochemical properties, Use of glycerol and its derivatives (Mizoroki–Heck reaction) and 2-methyltetrahydrofuran (Suzuki–Miyaura reaction).
5. Design for energy efficiency: Phenomenon of accelerating organic reactions by using the following Green Chemistry tools (taking suitable examples) and its advantages:
 - i. Mechanochemistry
 - ii. Ultrasound assisted reactions: Taking examples like Simmons Smith reaction, Diels–Alder reaction,
 - iii. Microwave assisted reactions: Special emphasis on solvent-free synthesis- copper phthalocyanine and aspirin, In-water reactions-Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction;
 - iv. Electrocatalysis: Taking examples like adiponitrile synthesis, synthesis of 3-bromothiophene.
 - v. Visible light induced Reactions: with examples such as, syntheses of caprolactam and vitamin D₃, cis-trans isomerization of alkenes
6. Use of renewable starting materials: Illustrate with few examples such as biodiesel, bioethanol, polymers from renewable resources (PLA from corn), Synthesis and

properties of 2-Methyltetrahydrofuran, furfural and 5-Aminolevulinic acid (DALA) from levulinic acid

7. Avoidance of unnecessary derivatization – careful use of blocking/protecting groups (taking specific examples like selective oxidation of aldehydic group and synthesis of 6-Aminopenicillanic Acid (6-APA) from penicillin G
8. Catalysis and green chemistry
Introduction to Catalysis (including concept of selectivity, turnover frequency and turnover number), Types of Catalysts: Heterogeneous catalysis and homogeneous catalysis (H-beta and zeolites in organic synthesis), General catalytic cycle for heterogeneous catalysis; Asymmetric catalysis (Monsanto route to L-dopa via asymmetric hydrogenation, synthesis of carbapenem via Asymmetric reduction); Photocatalysis (with special reference to TiO₂); Biocatalysis (Synthesis of adipic acid/catechol using biocatalyst) and Nanocatalysis (oxazole synthesis using nanocatalyst)
9. Design for degradation: (Illustrate with the help of examples: soaps and detergents, pesticides, polymers)
10. Real Time monitoring of chemical processes using inline, offline, and online techniques
11. Inherently safer design/chemistry:
Principle and subdivision of ISD, Bhopal Gas Tragedy (safer route to carbaryl) and Flixiborough accident (safer route to cyclohexanol, Asahi Process)

UNIT – 3: Industrial Applications and Success Stories

(6 Hours)

- Vitamin C Synthesis using enzymes (Hoffman La Roche)
- Zolof -Presidential Chemistry Award Winning Innovation (Pfizer)
- Methyl Methacrylate syngas process (Eastman Chemicals)
- Synthesis of herbicide disodium iminodiacetate
- Rightfit pigments azo dyes synthesis and their applications
- Healthier Fats and oils by Green Chemistry: Enzymatic Interesterification for production of No Trans-Fats and Oils.
- Synthesis of anti-tuberculosis drug Paramycin from waste water stream

Practical component

Credits:

01 (Laboratory periods:15 classes of 2 hours each)

Note: Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using p-toluidine and o-vanillin/p-vanillin.
6. Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.

7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (cis-trans isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.
10. Preparation of dibenzalacetone by cross aldol condensation reaction using base catalysed green method.

Essential/recommended readings

Theory:

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry**, American Chemical Society, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practicals:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
4. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
5. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.
6. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.
7. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
8. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

DISCIPLINE SPECIFIC ELECTIVE COURSE -3(DSE-3): Solutions, Colligative properties, Phase Equilibria and adsorption

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Solutions, Colligative properties, Phase Equilibria and adsorption (DSE-3)	04	03	-	01	Class 12 th with Physics, Chemistry	

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the students understand the various properties of dilute solutions.
- To make the students understand the thermodynamic basis of colligative properties.
- To explain the concept of phase, co-existence of phases, phase diagram for various types of system, CST and distribution law.
- To introduce the concept of adsorption, its dependence on various conditions and applications

Learning outcomes

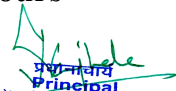
By studying this course, students will be able to:

- Explain different types of phase equilibrium, draw a well labelled phase diagram.
- Predict the existence of a substance in a given phase under different conditions of temperature and pressure
- Apply the concepts of phase, solutions and distribution law while studying other chemistry courses and every-day life processes.
- Explain the type of adsorption that can take place in different systems and predict the conditions to get maximum adsorption.

SYLLABUS OF DSE-3

UNIT-1: Solutions and Colligative Properties

(12 Hours


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Dilute solutions; lowering of vapour pressure, Raoult's law, Henry's law. Thermodynamic basis of the colligative properties - lowering of vapour pressure, elevation of Boiling Point, Depression of Freezing point and Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions, van't Hoff factor and its applications. Concept of activity and activity coefficients.

UNIT-2: Phase Equilibria

(24 Hours)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O and S), with applications. A comparison between the phase diagram of CO_2 and H_2O . Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions (excluding partial miscibility). Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), Konovalov's laws, azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Three component systems, water-chloroform-acetic acid system, triangular plots.

UNIT-3: Surface chemistry

(9 Hours)

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Multilayer adsorption, BET equation derivation, thermodynamic treatment of adsorption-Gibbs equation.

Practical component

Credit: 01

(Laboratory periods: 15 classes of 2 hours each)

Practical

Phase Equilibrium

1. Determination of critical solution temperature and composition at CST of the phenol water system
2. To study the effect of impurities of sodium chloride and succinic acid on the CST of phenol-water system.
3. To study the cooling curves for the following systems:
 - (i) simple eutectic
 - (ii) congruently melting systems.

Adsorption

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Essential/recommended readings

Theory:

1. Peter, A.; Paula, J. de. (2011), **Physical Chemistry**, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 3, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 5, 6th Edition, McGraw Hill Education.
5. Ball, D. W. (2017), **Physical Chemistry**, 2nd Edition, Cengage Learning, India.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

1. Levine, I.N. (2010), **Physical Chemistry**, Tata Mc Graw Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4): Nuclear and Environmental Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nuclear and Environmental Chemistry (DSE-4)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The Objectives of this course are as follows:

- To make students know more about nuclear chemistry
- To familiarise the students about environmental chemistry, especially with respect to air and water

Learning outcomes

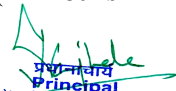
By studying this course, the students will be able to:

- Gain knowledge about Nuclear chemistry, radioactive decay, nuclear disasters, and nuclear waste and their disposal.
- Describe the composition of air, various air pollutants, effects and control measures of air pollutants.
- List different sources of water, water quality parameters, impacts of water pollution, water treatment.
- Identify different industrial effluents and their treatment methods.

SYLLABUS OF DSE-4

Unit-1 : Nuclear Chemistry

(21 Hours)


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The nucleus: subatomic particles, e liquid drop model; forces in nucleus-mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements.

Radioactive decay- α -decay, β -decay, γ -decay; neutron emission, positron emission; unit of radioactivity (curie); half life period; radioactive displacement law, radioactive series.

Measurement of radioactivity: ionization chamber, Geiger Counters, Scintillation counters.

Nuclear reactions: Nuclear fission-theory of nuclear fission; chain reaction; nuclear fusion; nuclear reactors-fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear reactors in India.

Applications: Dating of rocks and minerals, carbon dating, neutron activation analysis, isotopic labeling studies, nuclear medicine- ^{99m}Tc radio pharmaceuticals.

Nuclear disasters – Chernobyl disaster, Three Mile Island Disaster, Disposal of nuclear waste and its management.

UNIT – 2: Air Pollution

(12 Hours

Major regions of atmosphere, chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature, Major sources of air pollution, Pollution by SO_2 , CO_2 , CO , NO_x , H_2S and other foul-smelling gases, methods of estimation of CO , NO_x , SO_x and control procedures.

Chemistry and environment impact of the following: Photochemical smog, Greenhouse effect, Ozone depletion

Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs).

UNIT – 3 : Water Pollution: **Hours)**

(12

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for wastewater, industrial water and domestic water.

Practical component

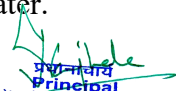
Practical:

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

(At least four experiments to be performed)

1. Determination of dissolved oxygen in a given sample of water.
2. Determination of Chemical Oxygen Demand (COD) in a given sample of water.
3. Determination of Biological Oxygen Demand (BOD) in a given sample of water.


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4. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO_3 and potassium chromate).
5. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
6. Measurement of dissolved CO_2 in a given sample of water.
7. Determination of hexavalent Chromium Cr(VI) concentration in tannery wastes/ waste water sample using UV-Vis spectrophotometry technique.

Essential/recommended readings

Theory:

1. Stanley E. Manahan, 10th edition, **Environmental chemistry**, CRC Press, Taylor and Francis Group, US, 2017
2. Baird, C. and Cann, M., **Environmental Chemistry**, (2012), Fifth Edition, W. H. Freeman & Company, New York, US.
3. VanLoon, G.W. and Duffy, J.S. (2018) **Environmental Chemistry - A global perspective**, Fourth Edition, Oxford University Press
4. Brusseau, M.L.; Pepper, I.L. and Gerba, C., (2019) **Environmental and Pollution Science**, Third Edition, Academic Press.
5. Masters, G.M., (1974) **Introduction to Environmental Science and Technology**, John Wiley & Sons.
6. Masters, G.M., (2015) **Introduction to Environmental Engineering and Science**. JPrentice Hall India Learning Private Limited.
1. 7. Arnika, H.J., (1987), Second Edition, **Essentials of Nuclear Chemistry**, Wiley Blackwell Publishers
7. Arnika, H.J.; Rajurkar, N. S., (2016) **Nuclear Chemistry through Problems**, New Age International Pvt. Ltd.
8. De, A.K. (2012), **Environmental Chemistry**, New Age International Pvt., Ltd.
9. Khopkar, S.M. (2010), **Environmental Pollution Analysis**, New Age International Publisher.
10. Das, A. K. (2010), **Fundamentals of Inorganic Chemistry**, Volume 1, Second Edition, CBS Publishers & Distributors Pvt Ltd.
11. Das, A. K. (2012), **Environment Chemistry with Green chemistry**, Books and Allied (P) Ltd.

Practical:

1. Vowles, P.D.; Connell, D.W. (1980), **Experiments in Environmental Chemistry: A Laboratory Manual**, Vol.4, Pergamon Series in Environmental Science.
2. Gopalan, R.; Anand, A.; Sugumar R.W. (2008), **A Laboratory Manual for Environmental Chemistry**, I. K. International.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 5 (DSE-5): Reactions, Reagents and Chemical Process

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Reactions, Reagents and Chemical Process (DSE-5)	04	03	--	01	Class 12 th with Physics, Chemistry	Basic knowledge of organic reactions

Learning objectives

The objectives of this course are as follows:

- To study the important organic name and rearrangement reactions that are crucial for the synthesis of valuable organic compounds.
- To give the knowledge belonging to the role of reagents in organic reactions for the synthesis of chemo-, diastereo- and enantio-selective products.
- To impart the knowledge of process chemistry that is a key part of the large-scale synthesis of chemical products essential for day-to-day life

Learning outcomes

By studying this course, students will be able to:

- Explain the reaction mechanism of various name and rearrangement reactions
- Discuss the role of the reagents in organic synthesis and apply these reagents for the bulk chemical synthesis
- Debate and use oxidizing and reducing reagents for selective synthesis organic products
- Apply the learnt techniques to chemical processes
- Acquire skills for human resource building especially in the chemical industry.

SYLLABUS OF DSE-5

UNIT – 1: Name Reactions

(15 Hours)

Application, scope and mechanism of following reactions: Prevost Reaction, Chugaev Reaction, Maukaiyama Aldol Reaction, Mozingo Reaction, Ramberg Backlund Reaction, Shapiro Reaction, Barbier Reaction, Clark- Eschweiler Reaction, Darzen's Reaction, Julia-Olifination Reaction, Tiffeneaus Damjanov Reaction, Darkin West Reaction, Bischler-Napieralaski Reaction, Birch reduction of aromatic compounds, Appel Reaction, Mitsunobu

Reaction, Corey Kim Oxidation, Azide-alkyne 1,3-dipolar cycloaddition reaction, Olefin metathesis: Grubbs reaction, Heck Reaction, Suzuki coupling and Wittig reaction.

UNIT – 2: Reducing Reagents

(9 Hours)

Reactions, mechanism and applications of following reducing agents: Sodium borohydride, Lithium aluminium hydride, NaBH_3CN , DIBALH, lithium-tri-*tert*-butoxyaluminum hydride, Red-Al $\text{Na}[\text{AlH}_2(\text{OCH}_2\text{OCH}_2\text{OCH}_3)_2]$, Zinc borohydride, L and K selectrides, LiBHEt_3 and KBHEt_3 , Luche Reagent $\text{NaBH}_4\text{-CeCl}_3$, $\text{K}[\text{BH}(\text{OAc})_3]$, *bis*-Boric Acid (BBA), Catecholborane, DEMS (Diethoxymethylsilane), 3-Mercapto propionic acid, Polymethylhydrosiloxane (PMHS), Schwartz's Reagent (Zirconocene chloride hydride).

UNIT – 3: Oxidizing Reagents

(9 Hours)

Reactions, mechanism and applications of following oxidizing agents: Jones Reagent (CrO_3 , H_2SO_4 , H_2O), Swern Reagent (DMSO, oxalyl chloride), Dess Martin, TEMPO, TPAP (Tetrapropyl ammonium perruthenate), Fetizon's Reagent, Fenton's Reagent [$\text{H}_2\text{O}_2 + \text{Fe(II)}$ ion], Sodium perborate NaH_2BO_4 , Sodium Bismuthate NaBiO_3 , ABNO (9-Azabicyclo[3.3.1]nonane N-oxyl), DEAP (Diethyl allyl phosphate, $\text{CH}_2=\text{CH}-\text{CH}_2-\text{OPO}(\text{OEt})_2$), AZADO (2-Azaadamantane N-oxyl), Wacker oxidation.

UNIT – 4: Process Chemistry

(12 Hours)

1. Process chemistry a) Introduction, stages of scale up process: Bench, pilot, and large-scale process with at least two examples of scale up process of API. b) In-process control and validation of large-scale process.
2. Unit Processes: The following unit processes should be studied with mechanism and one example of each process Nitration: Nitrating agents, process equipment for technical nitration. Halogenation: Types of halogenations, catalytic halogenations. Reduction: Catalytic hydrogenation, hydrogen transfer reactions, metal hydrides. Oxidation: Types of oxidative reactions, and non-metallic oxidizing agents such as H_2 , sodium hypochlorite, oxygen gas, ozonolysis.

Practical component

Credits:

01 (Laboratory periods:15 classes of 2 hours each)

1. Oxidation of alcohols to acid using Jones reagent.
2. Reduction of acetophenone and its derivatives to 1-phenyl ethanol derivatives by NaBH_4 .
3. Reduction of 4-*tert*-butyl-cyclohexanone to *cis* and *trans* 4-*tert*-butyl-cyclohexanol.
4. Synthesis of 2,5-dimethyl-2,5-hexanediol from *tert*-butanol using Fenton's reagents.
5. Wittig reaction of benzyltriphenylphosphonium chloride and 4-bromobenzaldehyde using potassium phosphate (tribasic).
6. Substitution ($\text{S}_{\text{N}}2$) reaction of 1-iodobutane and 2-naphthol.
7. Aldol condensation reaction: solventless synthesis of chalcones.
8. Borohydride reduction of a ketone: hydrobenzoin from benzil.
9. Visit to chemical industry of the demonstration of pilot scale.

Essential/recommended readings

Theory:

2. Clayden, J. Greeves, N., Warren, S. **Organic Chemistry**, South Asian Edition, Oxford University Press, USA
3. Gadamasetti K., **Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate-An Overview**, Vol-2, CRC Press, London.
4. Murphy R.M., **Introduction to Chemical Processes: Principles, Analysis, Synthesis**, McGraw-Hill Education, New York.
5. Harrington P. J., **Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale up**, John Wiley and Sons, Inc, New Jersey.
6. Parashar, R.K.; Ahluwalia, V.K. (2018), **Organic Reaction Mechanism**, 4th Edition, Narosa Publishing House.

Practical:

1. Mann F.G, Saunders, B.C., **Practical Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), Singapore.
2. Vogel A.I., **Elementary Practical Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), Singapore.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE - 6 (DSE- 6): Polymers, Colloids, Surfaces and Interfaces

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Polymers, Colloids, Surfaces and Interfaces (DSE- 6)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The objectives of this course are as follows:

- To give students a comprehensive coverage of important physical aspects of polymers chemistry, colloids, emulsions, surfaces and interfaces.
- to study the applications of these aspects.

Learning outcomes

By studying this course, the students will be able to:

- Explain the types of polymers, kinetics of polymerization and polymer properties.
- Understand and apply the concepts of properties of polymer solutions and their thermodynamics.
- Comprehend the basic concepts of surface chemistry specifically in relation to colloids.
- Have a thorough understanding of applications of colloids in various areas.

SYLLABUS OF DSE-6

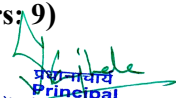
UNIT 1: Introduction to polymers

(Hours: 6)

Recapitulation of basic concepts of polymers. Types of polymerizations and their mechanism and kinetics: Free radical, ionic, step-growth, coordination, copolymerization. Polymerization techniques: Bulk, solution, suspension, and emulsion.

UNIT 2: Polymer solution

(Hours: 9)


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Polymer solution – solubility parameter, properties of dilute solutions and their criteria, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change. Flory Huggins theory.

UNIT 3: Introduction to Colloid Chemistry

(Hours: 9)

Recapitulation of basic concepts of Adsorption, Distinction among true solutions, colloids and suspensions, Components of Colloids, classification of colloids - lyophilic, lyophobic; Preparation methods and properties of lyophobic solutions, Hydrophile-lyophile balance (HLB), multi molecular, macromolecular and associated colloids (micelles formation), preparation and properties of colloids - Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Charge on Colloidal particles and Electrical double layer concept, Suspensions and their characteristics, Emulsions and their characteristics.

UNIT 4: Surface chemistry in relation to colloids

(Hours: 12)

Surface film on liquid surface, surface potential, monomolecular films, Langmuir Blodgett layers. Emulsions, foams and aerosols; electrical aspects of surface chemistry; Surface of solids, solid-liquid interface, stability of dispersions, stabilization of suspensions

UNIT 5: Application of colloids

(Hours: 9)

Characterization of colloidal particles, Role of colloid chemistry in Nanotechnology (wet colloid chemical approach, “bottom up” fabrication of nanoparticles and nanostructured materials), applications of colloid chemistry in petroleum recovery, coating and painting, food, pharmaceuticals and cosmetic industry, medicinal chemistry (use in drug formulations), Sewage disposal, Purification of water, cleansing action of soap, Formation of Delta, Smoke precipitation, Photography, Artificial rain

Practical component

Practicals:

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA).
2. Preparation of nylon 6,6
3. Determination of molecular weight of polyvinyl propylidene in water by viscometry.
4. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
5. Determination of molecular weight by end group analysis of polymethacrylic acid.
6. Estimation of the amount of HCHO in the given solution by sodium sulphite method.
7. Preparation of Colloidal Sols of following
 - A. Arsenic sulphide,

- B. Antimony sulphide
 - C. Ferric chloride
 - D. Aluminium hydroxide
8. To find out the precipitation values of arsenious sulphide sol by using monovalent, bivalent and trivalent cations.
 9. To determine the nature of charge on particle in given colloidal solution and their electrophoretic velocity and zeta potential.
 10. To prepare lyophilic sol of starch.

Essential/recommended readings

Theory:

1. Carraher, C. E. Jr. (2013), **Seymour's Polymer Chemistry**, Marcel Dekker, Inc.
2. Odian, G. (2004), **Principles of Polymerization**, John Wiley.
3. Billmeyer, F.W. (1984), **Text Book of Polymer Science**, John Wiley
4. Myers D., Surface, interfaces and colloids Principles and Applications, 2nd Edition, Wiley-VCH
5. V.R. Gowarikar (2010), **Polymer Science**, New Age International Publishers Ltd.

Practical:

1. Sperling, L.H. (2005), **Introduction to Physical Polymer Science**, John Wiley & Sons

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -7 (DSE-7): Novel Inorganic Solids

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Novel Inorganic Solids (DSE-7)	04	03	--	01	Class 12th with Physics, Chemistry	--

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with the characterization techniques of inorganic solids
- To familiarize the students with use and manifold applications of composites, carbon or high-tech ceramics

Learning Outcomes:

By studying this course, the students will be able to:

- Explain the mechanism of solid-state synthesis.
- Explain about the different characterization techniques and their principle.
- Explain the importance of composites and their applications.
- Discuss and explain the usage of solid materials in various instruments, batteries, etc. which would help them to appreciate the real-life importance of these materials

SYLLABUS OF DSE- 7

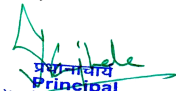
Unit 1: Synthesis of inorganic solids

(Hours: 5)

Conventional heat and beat method, Co-precipitation method, Sol-gel method, Hydrothermal method, Chemical vapor deposition (CVD), Ion-exchange and Intercalation method.

Unit 2: Characterization techniques of inorganic solids

(Hours: 10)


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Powder X-ray Diffraction, UV-visible spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Fourier-Transform Infrared (FTIR) spectroscopy, Brunauer–Emmett–Teller (BET) surface area analyser, Dynamic Light Scattering (DLS)

Unit 3: Pigments

(Hours: 10)

Cationic, anionic and mixed solid electrolytes and their applications. Inorganic pigments – coloured, white and black pigments.

One-dimensional metals, molecular magnets, inorganic liquid crystals.

Unit 4: Composite materials

(Hours: 10)

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, bio-nanocomposites, environmental effects on composites, applications of composites.

Unit 5: Speciality polymers

(Hours: 10)

Speciality polymers: Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene, polyaniline. and polypyrrole, applications of conducting polymers, ion-exchange resins and their applications.

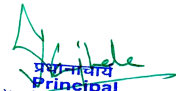
Ceramic & Refractory: Introduction, classification, properties, manufacturing and applications of ceramics, refractory and superalloys as examples.

Practicals

Credits: 01

(Laboratory periods: 15 classes of 2 hours each)

1. Preparation of polyaniline and its characterization using UV-visible spectrophotometer.
2. Intercalation of hydrogen in tungsten trioxide and its conductivity measurement using conductometer-
3. Synthesis of the following inorganic pigments:
 - (i) PbCrO_4 / chrome yellow
 - (ii) Barium white
 - (iii) Prussian Blue
 - (iv) Malachite
- 4.- Preparation of zeolite A and removal of Mg and Ca ions from water samples quantitatively using zeolite.
5. Determination of exchange capacity of cation exchange resins and anion exchange resins.


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6. Determination of a mixture of cobalt and nickel (UV-visible spectroscopy).
7. Preparation of a disc of a ceramic compound using ball milling, pressing and sintering, and study its XRD.

Essential/recommended readings

Theory:

1. West, A. R. (2014), **Solid State Chemistry and Its Application**, Wiley.
2. Smart, L. E.; Moore, E. A., (2012), **Solid State Chemistry: An Introduction** CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J. (1997), **New Direction in Solid State Chemistry**, Cambridge University Press.
4. Poole Jr.; Charles P.; Owens, Frank J. (2003), **Introduction to Nanotechnology**, John Wiley and Sons.

Practicals:

1. Orbaek, W.; McHale, M.M.; Barron, A. R.; **Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory**, J. Chem. Educ. 2015, 92, 339–344.
2. MacDiarmid, G.; Chiang, J.C.; Richter, A.F.; Somasiri, N.L.D.(1987), **Polyaniline: Synthesis and Characterization of the Emeraldine Oxidation State by Elemental Analysis**, L. Alcaer (ed.), Conducting Polymers, 105-120, D. Reidel Publishing.
3. Cheng, K.H.; Jacobson, A.J.; Whittingham, M.S. (1981), **Hexagonal Tungsten Trioxide and Its Intercalation Chemistry**, Solid State Ionics, 5, 1981, 355-358.
4. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; **Synthesis of ZnO Nanoparticles by Precipitation Method**, Orient J Chem 2015, 31(2).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 8 (DSE-8): Applied Organic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applied Organic Chemistry (DSE-8)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The objectives of this course are as follows:

- To make students aware of the importance of organic compounds in daily life.
- To familiarize students with the chemistry and uses of dyes, polymers, terpenoids, alkaloids, steroids and pharmaceutical compounds and their direct or indirect effect on human life and health

Learning outcomes

By the end of this course the students will be able to:

- Discuss and demonstrate the chemistry and uses of commercially important and naturally occurring compounds like dyes, polymers, terpenoids, alkaloids, steroids and pharmaceuticals.
- Appreciate the chemistry of biodegradable and conducting polymers and their importance to human life and society.
- Comprehend the chemistry of dyeing and dyes. Explain why some dyes are better than others. Describe the applications of various types of dyes including those in foods and textiles.
- Comprehend the synthetic routes and mode of action of some selected pharmaceutical compounds
- Use the knowledge gained to solve real world problems

SYLLABUS OF DSE-8

Unit 1: Dyes

(Hours: 7)

Nomenclature of commercial dyes with at least one example. Suffixes - G, O, R, B, 6B, L, S; colour index and colour index number. Classification of dyes based on structure and application; Chemistry of dyeing.

Synthesis and applications of the following types of dyes: Azo dyes - Methyl orange, Congo red; Triphenyl methane dyes-Malachite green, Rosaniline and Crystal violet; Phthalein Dyes - Phenolphthalein; Natural dyes - Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes (natural and synthetic) with examples and effect of synthetic food colours on health.

Unit 2: Polymers

(Hours:12)

Introduction and classification based on origin, monomer units, thermal response, mode of formation, structure, application and tacticity; di-block, tri-block and amphiphilic polymers; Weight average molecular weight, number average molecular weight, glass transition temperature (T_g) of polymers; Polymerisation Reactions-Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes.

Preparation and applications of: Plastics -thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics -natural (cellulose and synthetic derivatives of cellulose like rayon and viscose); synthetic (acrylic, polyamide, polyester); Rubbers-natural and synthetic: Buna-N, Buna-S, Neoprene, silicon rubber; Vulcanization; Polymer additives; Introduction to Specialty Polymers: electroluminescent (Organic light emitting diodes), Conducting, biodegradable polymers and liquid crystals.

Unit 3: Natural Product Chemistry- An Introduction to Terpenoids, Alkaloids and Steroids (Hours: 12)

Terpenes: Introduction, occurrence, classification, uses, isoprene and special isoprene rule; structure elucidation, synthesis and industrial application of citral.

Alkaloids: Introduction, occurrence, classification, uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.

Steroids: Introduction, occurrence, structure, Diel's hydrocarbon, nomenclature of steroid hydrocarbons, structure and biological functions of the following steroids- Cholesterol, Sex Hormones (Estrogen, androgen and progesterone), Adrenocortical hormones (Cortisone and cortisol) and Ergosterol (antirachitic effect).

Unit 4: Pharmaceutical Compounds

(Hours:14)

Introduction, classification; Synthesis, uses, mode of action and side effects of the following drugs:

Antipyretics -Paracetamol; Analgesics- Ibuprofen; Antimalarials - Chloroquine; Antitubercular drugs - Isoniazid.

An elementary treatment of Antibiotics and detailed study of chloramphenicol including mode of action. Structure and medicinal uses of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Practical component

Practical:

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

(At least five experiments to be performed)

1. Synthesis of urea formaldehyde resin and test the solubility.
2. Preparation of Starch-PVA Film.
3. Preparation of Methyl orange.
4. Separation of a mixture of dyes by Thin Layer Chromatography (TLC).
5. Isolation and estimation of the content of aspirin in a commercial tablet.
6. Synthesis of 4-methyl-7-hydroxycoumarin by condensation of resorcinol with ethyl acetoacetate.
7. Synthesis of 3,5-dimethyl pyrazole by condensation of acetylacetone and hydrazine.
8. Synthesis of benzimidazole.
9. Synthesis of 2,3-diphenylquinoxaline.
10. Synthesis of paracetamol

Essential/recommended readings

Theory:

1. Finar, I.L. Fifth Edition **Organic Chemistry**, Volume 2, Pearson Education, 2008.
2. Saunders, K. J., (1988), **Organic Polymer Chemistry**, Second Edition Chapman & Hall, London.
3. Campbell, Ian M., (2000), **Introduction to Synthetic Polymers**, Second Edition, Oxford University Press, USA.
4. Bahadur, P. and Sastry, N.V. (2002) **Principles of Polymer Science** Narosa, New Delhi
5. Patrick, G. **An Introduction to Medicinal Chemistry** (2013), Fourth Edition, Oxford University Press.
6. Beale J.M. Block J., (2010) **Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry**, Twelfth Edition, Lippincott Williams and Wilkins.
7. Alagarsamy, V. (2010), **Textbook of Medicinal Chemistry**, Volume II, Second Edition, Reed Elsevier India Private Limited.

Practical:

1. Sciam, A.J. **TLC of mixture of dyes**; *J. Chem. Educ.*, **1985**, 62(4), 361.
<https://pubs.acs.org/doi/10.1021/ed062p361>.
2. McKone, H.T.; Nelson, G.J. **Separation, and identification of some FD &C dyes by TLC. An undergraduate laboratory experiment**, *J. Chem. Educ.*, **1976**, 53(11), 722.
DOI: 10.1021/ed053p722.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE- 9 (DSE-9): Applications of Computers in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applications of Computers in Chemistry (DSE 9)	04	03	-	01	Class 12 th with Physics, Chemistry	

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with the fundamental building blocks and syntax of coding in Python with
- To apply python programming to solve simple Chemistry problems by thinking algorithmically and coding structurally

Learning outcomes

By studying this course, the students will be able to:

- Understand the importance of python programming in chemistry and its applications in the field of AI and ML
- Perform simple computations in python after learning the basic syntax, loop structure, string data manipulation etc.
- Solve chemistry problems such as finding pKa of a weak acid, solving Schrodinger's equation etc.
- Plot experimental data and perform regression analysis

SYLLABUS OF DSE-9

UNIT-1: Basic Computer system

(Hours: 3)

Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and

Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Software languages: Low level and High-Level languages (Machine language, Assembly language; QBASIC, C, C++, FORTRAN 90&95); Compiled versus interpreted languages. Debugging Software Products (Office, chemsketch, scilab, matlab, and hyperchem), internet application

UNIT-2: Introduction to Python

(Hours: 3)

Why Python? Python coding environment setup, Python as an interpreted language, Brief history of Python, Uses of Python (including artificial intelligence and machine learning), Applications of Python in Chemistry

UNIT-3: Coding in Python

(Hours: 18)

(i) Basic syntax including constants and variables, Operators, Data Types, Declaring and using Numeric data types: int, float, string etc. (ii) Program Flow Control Conditional blocks: if, else and else if, simple FOR loops, FOR loop using ranges, string, list and dictionaries. Use of while loops, Loop manipulation using pass, continue, break and else. (iii) Complex data types: String, List, Arrays, Tuples and Dictionary, String operations and manipulation methods, List operations including slicing, in-built Python Functions. (iv) Python packages - usage of numpy and scipy for mathematical computations.

UNIT-4: Plotting graphs

(Hours: 9)

Matplotlib for Plotting - Simple plots, formatting of plots, multiple plots, histograms, bar graphs, distributions, curve fitting – linear regression.

UNIT-5: Numerical Methods in Chemistry

(Hours: 12)

Solution of quadratic equation, polynomial equations (formula, iteration, Newton – Raphson methods and binary bisection) with examples of polynomial equations used in chemistry; Numerical differentiation – finite difference method (backward, central and forward), Numerical integration - Trapezoidal and Simpson's rule to calculate area under the curves for chemistry problems, e.g., entropy calculations, Simultaneous equations, Statistical analysis-mean, variance, standard deviation, error, Curve fitting – linear regression, Solving Schrödinger's equation using Python packages.

Practical component

Practicals: Python Programming for Chemists

Credits: 01

4. Writing simple programs using scipy and numpy

- a. syntax, data types
- b. loop structure, conditional loops

- c. To learn string data manipulation
- d. Array and lists
- e. Sorting, matrix manipulations

5. Plotting graphs using matplotlib

- a. Planck's distribution law
- b. Maxwell-Boltzmann distribution curves as a function of temperature and mass
- c. Radial distribution curves for hydrogenic orbitals
- d. Gas law Isotherms – Ideal and Real
- e. Data from phase equilibria studies
- f. Wavefunctions and Probabilities as multiplots
- g. Kinetics data with linear fitting

6. Numerical Methods in Chemistry

- a. Solving equations involved in chemical equilibria such as pH of a weak acid at a given concentration, cubic equation obtained from solving van der Waals equation of real gases using Iteration, Newton-Raphson, and Binary Bisection Method
- b. Numerical Differentiation – finding equivalence point given pH metric and potentiometric titrations data by finding the first and the second derivative using the finite difference method
- c. Numerical Integration – Trapezoidal and Simpson's 1/3 rule to calculate enthalpy and entropy of an ideal gas
- d. Statistical Analysis – Calculating Mean, Variance, Standard Deviation
- e. Solving Schrodinger's Equation

Essential/recommended readings

Theory:

- 7. Dr. M. Kanagasabapathy(2023), **Python for Chemistry: An introduction to Python algorithms, Simulations, and Programing for Chemistry** (English Edition), BPB Publications
- 8. Robert Johansson (2021), **Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib**, 2nd Edition, Apress

Practical

- 1. Urban M., Murach J., **Murach's Python programming**, 2nd Indian reprint 2018, Shroff publishers and distributors
- 2. Gaddis T., **Starting out with python plus My programming Lab** with Pearson e-text-Access card package, 3rd ed.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE - 10(DSE-10): Analytical Methods in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analytical Methods in Chemistry (DSE-10)	04	03	--	01	Class 12 th with Physics, Chemistry	-

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with concept of sampling, Accuracy, Precision, Statistical test data-F, Q and t test.
- To familiarize the students with the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectra.
- To familiarize the students with important separation methods like solvent extraction and chromatography

Learning Outcomes:

By studying this course, the students will be able to:

- Perform experiment with accuracy and precision.
- Develop methods of analysis for different samples independently.
- Test contaminated water samples.
- Use basic principle of instrument like Flame Photometer, UV-Visible spectrophotometer learnt for practical applications.
- Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.
- Determine composition of soil.
- Estimate macronutrients using Flame photometry.

SYLLABUS OF DSE-10

Unit 1: Qualitative and Quantitative Aspects of Analysis:

(Hours: 5)

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.

Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit 2: Optical Methods of Analysis

(Hours: 25)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Transmittance. Absorbance and Beer-Lambert law

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs). Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal, Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit 3: Thermal methods of analysis

(Hours: 5)

Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser. Techniques for quantitative estimation of Ca and Mg from their mixture.

Unit 4: Separation techniques

(Hours:10)

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation, Technique of extraction: batch, continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography: Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion-exchange

Practicals

Credits 01

(Laboratory periods: 15 classes of 2 hours each)

1. Separation of constituents of leaf pigments by Thin Layer Chromatography
2. Solvent Extractions
 - (i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration by spectrophotometry.
3. Analysis of soil:
 - (i) Total soluble salt
 - (ii) Estimation of exchangeable calcium and magnesium
 - (iii) Estimation of carbonate and bicarbonate
 - (iv) Qualitative detection of nitrate and phosphate
4. Separation of amino acids from organic acids by ion exchange chromatography.
5. Spectrophotometry
 - (i) Verification of Lambert-Beer's law and determination of concentration of a coloured species (CuSO_4 / KMnO_4 / CoCl_2 / CoSO_4)
 - (ii) Spectrophotometric analysis of caffeine and benzoic acid in a soft drink
 - (iii) Determination of concentration of coloured species via following methods;
 - (a) Graphical method, (b) Epsilon method, (c) Ratio method, (iv) Standard addition method
6. Flamephotometry
 - (i) Estimation of potassium, calcium and magnesium using flame photometry

Essential/recommended readings

Theory:

1. Willard, H.H.(1988),**Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C.(2007),**Quantitative Chemical Analysis**,6th Edition, Freeman.
4. Khopkar, S.M. (2008), **Basic Concepts of Analytical Chemistry**, New Age International Publisher.
5. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),**Vogel's Textbook of Quantitative Chemical Analysis**,John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE - 11 (DSE-11): Basic Principles of Food Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Principles of Food Chemistry (DSE-11)	04	03	--	01	Class 12 th with Physics, Chemistry	--

Learning Objectives

The objectives of this course are as follows:

- To make students understand the sources, importance, stability and transformations of food components during handling and processing.
- To make students aware about nature and importance of additives in food chemistry.

Learning outcomes

By studying this course, the students will be able to:

- Develop a strong understanding of basic fundamentals of food chemistry
- Discuss and demonstrate how alterations /transformations during processing and handling affect the quality and stability of food
- Develop an elementary idea on the nature and importance of additives in food chemistry.
- Apply the knowledge gained to real world problems

SYLLABUS OF DSE-11

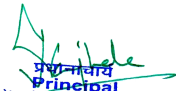
Unit 1: Introduction

(Hours:3)

What is food chemistry; An overview of the following: alterations during handling or processing (texture, flavour, colour), chemical and biochemical reactions leading to alteration in food quality (browning, oxidation, hydrolysis, protein denaturation), cause and effect relationship pertaining to food handling; factors governing stability of food (chemical and environmental factors) and role of food chemists.

Unit 2: Water

(Hours:3)


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 धौला कुर्ग, नई दिल्ली / Dhola Kuan, New Delhi-21

Definition of water in food, structure of water and ice, types of water, sorption phenomenon, water activity and packaging, water activity and shelf-life.

Unit 3: Carbohydrates

(Hours:6)

Introduction, sources, functions, deficiencies, structure and importance of polysaccharides in food chemistry (Agar and Agarose, Pectin, Hemicellulose, Cyclodextrins, Gums, Alginate, Starches, modified starches), Non-enzymatic browning and its prevention, caramelisation, formation of acrylamide in food, role of carbohydrates as sweeteners and comparison with artificial sweeteners.

Unit 4: Proteins

(Hours:6)

Introduction, sources, classification, functions, deficiencies, physico-chemical & functional properties of proteins, nature of food proteins (plant and animal proteins).

Unit 5: Lipids

(Hours:6)

Introduction, sources, classification and physical properties, functions, deficiencies, effect of frying on fat, reaction of lipids: hydrogenation, interesterification, hydrolysis, auto-oxidation and its prevention; flavour reversion, fat replacers: fat mimetics and fat substitutes.

Unit 6: Vitamins and Minerals

(Hours:6)

Vitamins: Introduction, sources, classification: water soluble and water insoluble vitamins, essential vitamins, physiological function, deficiencies, causes of variation and loss in foods, vitamin like compounds, effect of food processing.

Minerals: Introduction, sources, classification: major minerals and trace elements, physiological function, deficiencies, factors affecting mineral content of food, fortification and enrichment of foods with minerals, effect of food processing.

Unit 7: Food Additives

(Hours:15)

Additives: Introduction, importance, classification, antioxidants, emulsifiers, stabilizers, gelling agents, gums, thickeners, sweeteners, acidulants, preservatives, humectants, food toxins

Colouring Agents and Pigments: Introduction, natural food colourants: anthocyanins, carotenoids, chlorophyll, caramel, betalains; examples of pigments in common food; Nature-identical colourants: β -Carotene, canthaxanthin and riboflavin; artificial colouring agents; artificial/synthetic colourants: Azo dyes (e.g. amaranth dye, tatzazine, citrous red, Allura red); quinoline (e.g. quinoline yellow); phthalein (e.g. erythrosine); triarylmethanes and indigoid (e.g. indigo carmine), FD&C Dyes and lakes; properties of certified dyes, colours exempt from certification.

Food Flavor: Sensation of taste and odour, chemical dimension of basic types of taste (Salty, Sweet, Bitter, Sour, Umami taste), other sensations like astringency, coolness, pungency/pungency); non-nutritive sweeteners (aspartame, saccharin, sucralose, cyclamate) and nutritive sweeteners, molecular mechanism of flavour perception, biogenesis of fruits and vegetable flavors, taste inhibition, modification and enhancement, common vegetable and spice flavors.

Practical component

Practical:

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

(At least four experiments to be performed)

1. Determination of moisture in food products by hot air oven-drying method.
2. Paper chromatography of synthetic food dyes.
3. Quantitative determination of food dyes in powdered drink mixes by spectrophotometric method.
4. Colorimetric determination of Iron in vitamin / dietary tablets.
5. Determination of rancidity of edible oils by Kriess Test.
6. Estimation of Vitamin C in a given solution/ lemon Juice/chillies by 2, 6-dichlorophenol by Indophenol Method.
7. Isolation of casein from milk.
8. Qualitative estimation of cholesterol by Liebermann-Burchard method.
9. Detecting the presence of Vanaspati and rancidity in the given Ghee sample through qualitative tests.

Essential/recommended readings

Theory:

1. DeMan, J.M., Finley, J.W., Hurst, W.J., Lee, C.Y. (2018), **Principles of Food Chemistry**, Fourth Edition, Springer.
2. Msagati, T.A.M. (2013), **Chemistry of Food Additives and Preservatives**, Wiley-Blackwell.
3. Fennema, O.R. (2017), **Food Chemistry**, Fifth Edition, CRC Press.
4. Attokaran, M. (2017), **Natural Food Flavors and Colorants**, Second Edition, Wiley-Blackwell.
5. Potter, N.N., Hotchkiss, J.H, (1995) **Food Science**, Fifth Edition, Chapman & Hall.
6. Brannen, D., Davidsin, P.M., Salminen, T. Thorngate III, J.H. (2002), **Food Additives**, Second Edition, CRC Press.
7. Coultate, T. (2016), **Food: The Chemistry of its Components**, Sixth Edition, Royal Society of Chemistry.
8. Belitz, H. D.; Grosch, W. (2009), **Food Chemistry**, Springer.
9. [Course: Food Chemistry \(iasri.res.in\)](http://iasri.res.in)

Practical:

1. Ranganna, S. (2017). **Handbook of analysis and quality control for fruits and vegetable products**, Second Edition, McGraw Hill Education
2. Sawhney, S.K., Singh, R. (2001), **Introductory Practical Biochemistry**, Narosa Publishing House

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -12 (DSE-12): Computational Methods & Molecular Modelling

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Computational Methods & Molecular Modelling (DSE-12)	04	03	--	01	Class 12 th with Physics, Chemistry and Mathematics	--

Learning Objectives

The Objectives of this course are as follows:

- To make students learn the theoretical background of computational techniques in molecular modelling.
- To give the different flavours of computational chemistry by the end of this course.
- To provide hands-on experience in molecular modelling on various software

Learning outcomes

By studying this course, the students will be able to:

- Explain the theoretical background of computational techniques and selective application to various molecular systems.
- Compare computational and experimental results and explain deviations.
- Perform Optimization of geometry parameters of a molecule (such as shape, bond length and bond angle) through the use of software like Chem Sketch and Argus Lab in interesting hands-on exercises.
- Perform analysis of molecular properties using various software.

SYLLABUS OF DSE-12

UNIT-1 : Introduction

(Hours: 6)

Introduction to computational chemistry: Overview of Classical and Quantum Mechanical Methods (Ab initio, DFT, Semi-empirical, Molecular Mechanics, Molecular Dynamics, and Monte Carlo)

UNIT – 2: Potential Energy Surfaces

(Hours: 6)

Intrinsic Reaction Coordinates, Stationary points, Equilibrium points – Local and Global minima, Geometry optimization and energy minimization, the concept of transition state with examples, Hessian matrix

UNIT – 3 : Molecular Mechanics & Molecular Dynamics

(Hours: 9)

Molecular Mechanics

Force Fields (A brief explanation of all the terms of a basic force field), the basic idea of MM1, MM2, MM3, MM4, MM+, AMBER, BIO+, OPLS.

Molecular Dynamics

The concept of the periodic box, ensembles (microcanonical, canonical, isothermal – isobaric), steps in a typical MD simulation.

UNIT-4: Huckel Molecular Orbital Theory

(Hours: 6)

Huckel MO with examples: ethene and propenyl systems, Properties calculated – energy, charges, bond order, electronic energies, resonance energies.

UNIT- 5: Computational Methods

(Hours: 18)

Ab-initio methods

Antisymmetry principle, Slater determinants, SCF method, Hartree-Fock method.

Basis sets, Basis functions, STOs and GTOs, diffuse and polarization functions. Minimal basis sets, Basis set superposition error (BSSE) - Effective core potentials (ECP)

Advantages of ab initio calculations.

Density Functional Theory

A brief description of Density Functional Theory (DFT). Calculation of Electronic Properties in ground and Excited states

Semi-empirical methods

Basic idea about Zero differential overlap (ZDO) approximation

Some important concepts

Concepts of atomic charges, electrostatic potential maps, computation of thermodynamic properties and spectroscopic observables

Practical component

Practical:

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

- 1) Write the Z-Matrix of a given set of molecules.
- 2) Carry out geometry optimisation on H₂O, H₂S, H₂Se molecules compare the optimized bond angles and dipole moments from the results obtained. Obtain the ESP-mapped density surfaces and interpret the results obtained with reference to bonding in these molecules.

Suggestive: A comparative analysis of results of the above exercise may be carried out using different quantum mechanical methods.

- 3) Calculate the energy of the following chemical species and arrange them in order of increasing stability.

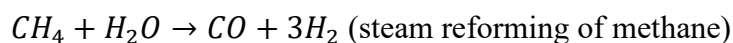
1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3- dimethyl-2-butene in order of increasing stability.

- 4) Carry out geometry optimisation on the following chemical species and compare the shapes and dipole moments of the molecules.

1-pentanol, 2-pentanol, 3-pentanol, 2-methylbutan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-2-ol, 2-methylbutan-3-ol and 2,2-dimethylpropanol.

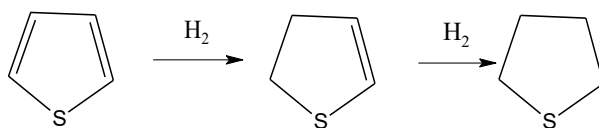
Correlate the computationally obtained values of the dipole moments with the experimental values of the boiling points: (118 °C, 100 °C, 108 °C, 82 °C, of 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2- propanol respectively).

- 5) Based on the implicit electronic structure calculations, determine the heat of hydrogenation of Propylene.
- 6) Based on the calculations of enthalpies of the participating chemical species on optimized geometry of the molecules, calculate the reaction enthalpy at 298 K for the following, industrially important reactions:



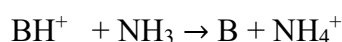
≡≡≡ (Haber-Bosch process)

- 7) Carry out geometry optimisation and determine the energy of the participating chemical species in the following reactions Using these results calculate the resonance energy of thiophene.



- 8) Carry out geometry optimisation & Energy calculations on the following species and obtain Frontier Molecular Orbitals. Visualize the Molecular Orbitals of these species and interpret the results for bonding in these molecules.
Benzene, Naphthalene, and Anthracene.

- 9) Compare the gas phase basicities of the methylamines by comparing the enthalpies of the following reactions:



Where B = CH_3NH_2 , $(\text{CH}_3)_2\text{NH}$, $(\text{CH}_3)_3\text{N}$

- 10) On the basis of results of geometry optimization and energy calculations, determine the enthalpy of isomerization of cis and trans 2-butene.
- 11) Perform a conformational analysis of butane. Plot the graph between the angle of rotation and the energy of the conformers using spreadsheet software.
- 12) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
- 13) Calculate the electronic UV/Visible absorption spectrum of Benzene.
- 14) Calculate the electronic absorption spectra of formaldehyde.
- 15) Plot the electrostatic potential mapped on electron density for benzene and use it to predict the type of stacking in the crystal structure of benzene dimer.
- 16) On a given set of molecules methylamine (CH_3NH_2) carry out geometry optimization, single point energy and NBO calculations and interpret the output results treated at the ab initio RHF/3-21G level.
- 17) Study the mechanism of $\text{S}_\text{N}2$ reaction between Cl^- and CH_3Br involving a Walden inversion computationally.

18) Perform a geometry optimization followed by a frequency assessment (opt+freq keyword) using the B3LYP method and 6-31-G(d) basis set on a given set of small molecules i.e. BH₃, CH₄.

Suggestive: A greater number of molecules may be studied as per instructions received from the concerned teacher.

19) Based on the fundamentals of conceptual DFT calculate the ionization potential (IP), electron affinity (EA), electronegativity and electron chemical potential of a given set of molecules.

20) Perform molecular docking of Sulfonamide-type D-Glucose inhibitor into MurrD active site using Argus Lab.

21) Perform molecular dynamics (MD) simulation of a given alkali metal ion in aqueous function (RDF)

Essential/recommended readings

Theory:

1. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
2. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
3. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.
4. Leach, A.R. (2001), **Molecular Modelling**, Prentice-Hall.
5. House, J.E. (2004), **Fundamentals of Quantum Chemistry**, 2nd Edition, Elsevier.
6. McQuarrie, D.A. (2016), **Quantum Chemistry**, Viva Books.
7. Levine, I. N.; **Physical Chemistry**, 5th Edition, McGraw –Hill.

Practical:

1. https://www.afs.enea.it/software/orca/orca_manual_4_2_1.pdf
2. <https://dasher.wustl.edu/chem430/software/avogadro/learning-avogadro.pdf>
3. <http://www.arguslab.com/arguslab.com/ArgusLab.html>
4. <https://barrett-group.mcgill.ca/tutorials/Gaussian%20tutorial.pdf>
5. <https://gaussian.com/techsupport/>
6. <https://gaussian.com/man/>
7. <https://gaussian.com/wp-content/uploads/dl/gv6.pdf>
8. <https://dasher.wustl.edu/chem478/software/spartan-manual.pdf>
9. <http://www.mdtutorials.com/gmx/>
10. <https://vina.scripps.edu/manual/>

Important Instruction Note on working approach:

- A student is required to perform/investigate a minimum of 10 exercises from the given set of exercises.
- The students may use open source softwares; ArgusLab, Avogadro and ORCA. In case a licenced version softwares is available, if procured by the college, other licenced softwares may also be used.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 13 (DSE-13): Research Methodology for Chemists

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Research Methodology for Chemists (DSE-13)	04	03	--	01	Class 12 th with Physics, Chemistry	

Learning objectives

The objectives of this course are as follows:

- To make the students aware of fundamental but mandatory ethical practices in chemistry.
- To introduce the concept of data analysis.
- To learn to perform literature survey in different modes.
- To make the students aware of safety handling and safe storage of chemicals.
- To make students aware about plagiarism and how to avoid it.
- To teach the use of different e-resources.

Learning outcomes

By studying this course, students will be able to:

- Follow ethical practices in chemistry
- Do Data analysis
- Literature survey in different modes
- Use e-resources.
- Avoid plagiarism, understand the consequences and how to avoid

SYLLABUS OF DSE-13

UNIT – 1: Scope of Research

(Hours: 3)

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.

UNIT – 2: Literature Survey, Databases and Research metrics

(Hours: 15)

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN

UNIT – 3: Communication in Science

(Hours: 12)

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis.

Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chems sketch etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

UNIT – 4: Research and Publication ethics

(Hours: 9)

Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkund etc), redundant duplications

Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals

IPR - Intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS)

UNIT – 5: Statistical analysis for chemists

(Hours: 6)

Types of data, data collection-Methods and tools, data processing, hypothesis testing, Normal and Binomial distribution, tests of significance: t-test, F-test, chi-square test, ANOVA, multiple range test, regression and correlation.

Features of data analysis with computers and softwares -Microsoft Excel, Origin, SPSS

Practical component

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

1. Collection of journal articles on a particular topic using Google Scholar and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
4. Drawing chemical structure, reactions and mechanisms using Chems sketch or ISIS draw or any other software.
5. Collection of chemical structure using ChemSpider and creating a database.
6. Curve fitting using freely available softwares/apps (any one)
7. Making of power point presentation
8. Experimental learning of safe storage hazardous chemicals
9. Experimental learning of handling of hazardous chemicals
10. Technical writing on topics assigned.
11. Demonstration for checking of plagiarism using recommended software

Essential/recommended readings:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
3. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
4. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
OSU safety manual 1.01

Note:

- Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.
- The students are required to opt one paper each from DSEs 1-3 in Semester 3, DSEs 4-6 in Semester 4, DSEs 7-9 in Semester 5 and DSEs 10-13 in Semester 6.
- Research Methodology (DSE 13) shall be offered as one of the DSE courses in semester VI or VII. If a student wishes to pursue four years Honours Degree with Research, he/she shall compulsorily opt for a Research Methodology course in either Semester VI or VII.

BSC. (PHYSICAL SCIENCES)- CHEMISTRY COMPONENT
SEMESTER - IV

DISCIPLINE SPECIFIC CORE COURSE CHEM-DSC -10: Chemistry- IV: Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles DSC-10: Chemistry-IV	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students learn about the chemistry of carboxylic acids and their derivatives (aliphatic and aromatic)
- To give basic understanding of amines (aliphatic & aromatic), diazonium salts
- To provide basic understanding of heterocyclic systems.

Learning outcomes

By studying this course, students will be able to:

- Understand reactions of carboxylic acids, esters, amides, amines and diazonium salts
- Understand the concept of protection and deprotection.
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Gain theoretical understanding of chemistry of heterocyclic compounds.

Syllabus

Unit 1: Carboxylic Acids and their Derivatives (aliphatic and aromatic) (1 3 Lectures)

Preparation: Oxidation reactions of alcohols, aldehydes and ketones, Acidic and alkaline

hydrolysis of esters; Reactions: Hell-Volhard Zelinsky reaction,

Carboxylic acid derivatives (aliphatic): Preparation: Acid chlorides, anhydrides, esters and amides from acids and their interconversion, Claisen condensation. Reactions: Relative reactivities of acid derivatives towards nucleophiles, Reformatsky reaction, Perkin condensation.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of ethyl acetoacetate

Unit 2: Amines (aliphatic & aromatic) and Diazonium Salts

(Hours:10)

Amines

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hoffmann bromamide reaction. Reactions: Hoffmann vs Saytzeff elimination, carbylamine test, Hinsberg test, reaction with HNO_2 , Schotten-Baumann reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation; basicity of amines.

Diazonium salt

Preparation: from aromatic amines; Reactions: conversion to benzene, phenol and dyes.

Unit 3: Heterocyclic Compounds

(Hours: 7)

Introduction, classification, structure, nomenclature and uses. Preparation and properties of the following heterocyclic compounds with reference to electrophilic and nucleophilic substitution: furan, pyrrole, thiophene, and pyridine.

Practical Component:

Credits: 02

(Laboratory periods: 60)

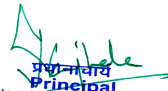
1. Systematic qualitative analysis and preparation of suitable crystalline derivative (carboxylic acids, carbonyl, alcohols, phenols, amines (1° , 2° , 3°) and amides).
2. Preparation:
 - a. Acetylation of Aniline and Phenols.
 - b. Benzoylation of Aniline and phenols

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References:

Theory:

1. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. **Organic Chemistry** (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).


Principal
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घोला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

Education).

3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), **Intermediate for Organic Synthesis**, I.K. International.
4. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016), **Organic Chemistry**, 12th Ed., Wiley.

Practical:

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry**, University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume II**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
6. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSC. (PHYSICAL SCIENCES)- CHEMISTRY COMPONENT
SEMESTER - V

DISCIPLINE SPECIFIC CORE COURSE CHEM-DSC -13: Chemistry- V: Coordination Chemistry and Organometallics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Coordination Chemistry and Organometallics DSC-13: Chemistry- V	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of coordination chemistry and organometallics which are of immense importance to biological systems, qualitative quantitative analysis, catalysis, medicines, paints and pigments etc.
- The students learn nomenclature, isomerism and bonding in coordination compounds with special emphasis on important coordination compounds in the biological system.
- To understand classification of organometallic compounds, the concept of hapticity and the 18-electron rule governing the stability of a wide variety of organometallic species with special emphasis on metal carbonyls.

Learning outcomes

By studying this course, students will be able to:

- Understand terms: ligand, denticity of ligands, chelate, coordination number.
- Systematically name coordination compounds.
- Discuss the various types of isomerism possible in Octahedral and Tetrahedral coordination compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.

- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
- Learn how IR data can be used to understand extent of back bonding in metal carbonyls.

Syllabus

Unit 1: Introduction to Coordination compounds

(Hours: 6)

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands. Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Unit 2: Bonding in Coordination Compounds

(Hours: 14)

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes, Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields, Crystal field stabilization energy (CFSE), concept of pairing energy, Factors affecting the magnitude of Δ , Spectrochemical series, Splitting of d orbitals in tetrahedral symmetry, Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry, Jahn-Teller distortion

Unit 3: Organometallic Chemistry

(Hours: 10)

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, sigma, pi and multicentre bonds), Structure and bonding of methyl lithium and Zeise's salt, Structure and bonding of ferrocene, mononuclear and polynuclear carbonyls of 3d metals, 18-electron rule as applied to carbonyls, π -acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Practical Component

Credits:02

(Laboratory periods:60)

1. Estimation of Mg^{2+} by direct complexometric titrations using EDTA.
2. Estimation of Zn^{2+} by direct complexometric titrations using EDTA.
3. Estimation of Ca^{2+} by direct complexometric titrations using EDTA.
4. Estimation of total hardness of a given sample of water by complexometric titration.
5. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1, 10-phenanthroline complex in solution by Job's method.

6. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1,10-phenanthroline complex in solution by mole ratio method
7. Preparation of the following inorganic compounds:
 - a). Tetraamminecopper(II) sulphate
 - b). Potassium trioxalatoferrate(III) trihydrate
 - c). Chrome alum
 - d). *Cis*- and *trans*-Potassium diaquadioxalatochromate(III)
8. Any suitable experiment (other than the listed ones) based upon complexation reactions.

References:

Theory:

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
4. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition, Wiley India.
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
6. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier.
7. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
8. Sodhi G.S., **Principles of Inorganic Chemistry**, 3rd Edition, Viva Books India.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Marr, G.; Rockett, B.W. (1972), **Practical Inorganic Chemistry**, Van Nostrand Reinhold.
3. Dua A, Manav N, **Practical Inorganic Chemistry**, (2017), Manakin Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSC. (PHYSICAL SCIENCES)- CHEMISTRY COMPONENT
SEMESTER -VI

DISCIPLINE SPECIFIC CORE COURSE -16: Chemistry -VI Quantum Chemistry and Spectroscopy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Quantum Chemistry and Spectroscopy DSC-16: Chemistry-VI	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the concepts and methodology of quantum mechanics
- Application of Quantum chemistry to spectroscopy
- To establish the relation between structure determination and spectra.

Learning outcomes

By studying this course, students will be able to:

- Understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions.
- Understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra.

Syllabus

Unit 1: Quantum Chemistry

(Hours: 16)

Postulates of quantum mechanics, quantum mechanical operators.

Schrodinger equation and its application to free particle and particle in a 1-D box (complete solution), quantization, normalization of wave functions, concept of zero-point energy.

Qualitative treatment of H and H like atoms. Setting up of Schrodinger equation for many electron atoms.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels.

Unit 2: Spectroscopy

(Hours: 14)

Electromagnetic radiation and its interaction with matter. Lambert-Beer's law, Jablonski's diagram. Florescence and Phosphorescence.

Difference between atomic and molecular spectra. Born- Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.

Microwave Spectroscopy: Microwave (pure rotational) spectra of diatomic molecules. Selection rules.

Structural information derived from rotational spectroscopy.

IR Spectroscopy: Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free electron model and its application to electronicspectra of polyenes. chromophores, auxochromes, bathochromic and hypsochromic shifts.

Practical component

Credits:02

(Laboratory periods: 60)

UV/Visible spectroscopy

1. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of

organic compounds.

Colorimetry

4. Verify Lambert-Beer's law and determine the concentration of CuSO_4 / KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$ / CoCl_2 in a solution of unknown concentration
5. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.
6. Study the kinetics of iodination of propanone in acidic medium.
7. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
8. Determine the dissociation constant of an indicator (phenolphthalein).
9. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

References:

Theory:

1. Banwell, C.N.; McCash, E.M.(2006), **Fundamentals of Molecular Spectroscopy**, Tata McGraw- Hill.
2. Kapoor, K.L.(2015), **A Textbook of Physical Chemistry**, McGraw Hill Education, Vol 4, 5th Edition, McGraw Hill Education.
3. McQuarrie, D.A.(2016), **Quantum Chemistry**, Viva Books.
4. Chandra, A. K.(2001), **Introductory Quantum Chemistry**, Tata McGraw-Hill.
5. Dua A and Tyagi P, **Molecular Spectroscopy: Quantum to Spectrum**, (2022) Atlantic Publishers & Distributors Pvt Ltd.
6. Dua A, Singh C, **Quantum Chemistry: Classical to Computational** (2015) ManakinPress.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Additional Resources:

1. Castellan, G. W .(2004), **Physical Chemistry**, Narosa.
2. Petrucci, R. H.(1989), **General Chemistry: Principles and Applications**, Macmillan Publishing

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POOL OF DISCIPLINE SPECIFIC ELECTIVES FOR SEMESTER -III/IV/V/VI

SEMESTER III

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -1: Main Group Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Chem-DSE 1: Main Group Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide basic understanding of the fundamental principles of metallurgy through study of the different methods of extraction and refining of metals.
- To illustrate the diversity and fascinating aspects of inorganic chemistry through the study of structure, properties and utilities of s- and p-block elements and their compounds.

Learning outcomes

By studying this course, students will be able to:

- Understand the basis of occurrence of metals in nature and the methods that can be applied on minerals to extract the metals from them.
- Explain the importance of free energy of formation of oxides with the choice of reducing agents for extracting the metals.
- Understand and explain the importance of refining of metals and the choice of a refining procedure.
- Explain the group trends observed for different properties of s and p block elements.
- Explain the structures and the bonding of compounds of s- and p- block elements
- Explain the unique properties of alkali metals and some other main group elements
- Understand and explain the polymerization mechanism of inorganic ions to generate inorganic polymers and the difference between organic and inorganic polymers.

Syllabus

Unit 1: General Principles of Metallurgy

(Hours: 6)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining.

Unit 2: General Properties

(4 Hours)

General group trends of s- and p-block elements with special reference to melting and boiling points, flame colour, metallic character and complex formation tendency, diagonal relationship and anomalous behaviour of first member of each group, Alkali metal solutions in liquid ammonia

Unit 3: Structure, Bonding, Properties and Applications

(Hours: 16)

Structure, bonding, properties (Acidic/Basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, thermal stability) and applications of the following:

Crown Ethers and cryptates of Alkali metals

Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.

Oxides: Oxides of nitrogen, phosphorus and sulphur.

Oxoacids: oxoacids of phosphorus, sulphur and chlorine

Halides of phosphorus

Unit 4: Inorganic Polymers

(4 Hours)

Preparation, properties, structure and uses of the following:
Borazine, Silicates and Silicones.

Practicals

Credits:02

(Laboratory periods:60)

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations (preferably 7-8 mixtures). Emphasis should be given to the understanding of the chemistry of different reactions.

The following radicals are suggested:

CO_3^{2-} , NO_2^- , S^{2-} , SO_3^{2-} , SO_4^{2-} , $\text{S}_2\text{O}_3^{2-}$, CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$, PO_4^{3-} , NH_4^+ , K^+ , Pb^{2+} , Cu^{2+} , Cd^{2+} , Bi^{3+} , Sn^{2+} , Sb^{3+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+} .

The mixtures may contain combination of anions/one interfering anion.

Spot tests should be preferred wherever applicable.

References:

Theory:

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Housecraft, E. H.; Sharpe, A.G. (2018), **Inorganic Chemistry**, 5th Edition, Pearson.
6. F.A. Cotton & G. Wilkinson (1999), **Advanced Inorganic Chemistry**, 6th Edition, John Wiley & Sons.

Practicals:

1. Vogel, A.I. (1972), **Qualitative Inorganic Analysis**, Longman.
2. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
3. Dua A, Manav N, **Practical Inorganic Chemistry**, (2017), Manakin Press.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -2: Green Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-2: Green Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the environmental status, public awareness in evolution, principles involved in green chemistry, bio-catalytic reactions, global warming and its control measures, availability of green analytical methods.
- To practice chemistry in the safest way possible
- To imbibe safeworking conditions in the laboratories as well as the chemical industry extending to society in a sustainable future for the planet.

Learning outcomes

By studying this course, students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- Appreciate the use of catalyst over stoichiometric reagents
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.
- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD)
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry

Syllabus

Unit 1: Introduction

(Hours: 8)

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

Need of green chemistry.

Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).

A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit 2: Twelve Principles of Green Chemistry

(Hours: 12)

The twelve principles of the Green Chemistry with their explanations Special emphasis on the following:

- Prevention of waste / by products, pollution prevention hierarchy.
- Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.
- Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.
- Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
- Green energy and sustainability.
- Real-time analysis for pollution prevention.

Prevention of chemical accidents, designing greener processes, principles of inherent safer design (ISD). Bhopal Gas Tragedy (safer route to carbaryl) and Flixborough accident (safer route to cyclohexanol), subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

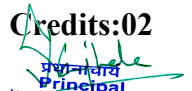
Unit 3: Real-world Cases in Green Chemistry

(Hours: 10)

Discussion of the following Real-world Cases in green chemistry: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Right fit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical Component

Credits:02


Principal
श्री वेङ्कटेश्वर महाविद्यालय
Sri Venkateswara College
दिल्ली विश्वविद्यालय / University of Delhi
घोला कुर्डी, नई दिल्ली / Dhoola Kuan, New Delhi-21

(Laboratory periods:60)

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using p-toluidine and o-vanillin/p-vanillin.
- 6 Microwave-assisted Knoevenagel reaction using anisaldehyde, ethyl cyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (cis-trans isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

References:

Theory:

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry**, American Chemical Society, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practicals:

7. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.

8. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
9. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series -for Organic chemistry.
10. Sindhwani I.T. (2015), **Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated**. DU Journal of Undergraduate Research and Innovation, 1(1),131-151. ISSN: 2395- 2334.
11. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.
12. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 3: Chemistry of Colloids and Adsorption

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 3: Chemistry of Colloids and Adsorption	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic concepts of colloids and colloidal phenomenon.
- Preparation and characterization of sols, understanding about applications of colloid in food, petroleum and cosmetic industry.
- Basic understanding of adsorption, types of adsorption, chemistry of adsorption and its applications.

Learning outcomes

By studying this course, students will be able to:

- Understand colloid solutions, preparation of sols.
- Understand the concept of Electrical double layer, charge on colloidal particles.
- Characterize the colloids sols, learn colloid phenomenon like Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation.
- Understand adsorption, types of adsorption. Characteristics, factors affecting adsorption and its applications

Syllabus

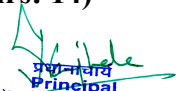
Unit 1: Colloidal State

(Hours: 8)

Distinction among true solutions, colloids and suspensions, components of Colloids, classification of colloids - lyophilic, lyophobic; Preparation methods and properties of lyophobic solutions, Hydrophile-lyophile balance (HLB), multi molecular, macromolecular and associated colloids (micelles formation), Schulze -Hardy law.

Unit 2: Preparation and Properties of Colloids

(Hours: 14)


Principal
 श्री वेंकटेश्वर महाविद्यालय
 Sri Venkateswara College
 दिल्ली विश्वविद्यालय / University of Delhi
 धौला कुर्जी, नई दिल्ली / Dhoola Kuan, New Delhi-21

Methods of preparation of colloids, Tyndall effect, Brownian movement, coagulation and flocculation; electrophoresis, dialysis.

Emulsification by surfactants, selection of surfactants as emulsifying agent, colloidal phenomenon in food chemistry, Protein based functional colloids.

Unit 3: Surface Chemistry

(Hours: 8)

Adsorption, Distinction between adsorption and absorption, Types of Adsorption, Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, Adsorption from solutions. Applications of Adsorption phenomenon in living systems.

Practical component

Credits: 02

(Laboratory periods: 60)

1. Preparation of Colloidal Sols of following
 - a. Egg Albumin
 - b. Starch /Gum
 - c. Ferric chloride
 - d. Aluminum hydroxide
 - e. Antimony Sulphide
2. To find out the precipitation values of Antimony Sulphide sol by using monovalent, bivalent and trivalent cations.
3. To verify the Schulze -Hardy law.
4. To verify the Freundlich's Adsorption isotherms.
5. Study of adsorption of HAc on charcoal and prove the validity of Langmuir's adsorption isotherms
6. Study of adsorption of Oxalic acid on charcoal and prove the validity of Langmuir's adsorption isotherms.

References:

Theory:

1. Puri B. R., Sharma L. R. and Pathania M.S., (2020) Principles of Physical Chemistry, Vishal Publishing Co. Jalandhar, Punjab, India.
2. Kapoor K L, **Text Book of Physical Chemistry, Vol. 4**, McGraw Hill Education (India) Private Limited, Chennai, India.
3. Evans D F and Wennerström's, **The Colloidal Domain**, Second Edition, John Wiley & Sons Inc.
4. Adamson A. W. and Gast A., **Physical Chemistry of Surfaces** (Main text) Sixth Edition, John Wiley & Sons Inc.
5. Berg J. C., **An Introduction to Interfaces and Colloids**, World Scientific Publishing Co., Inc. New Jersey.
6. Israelachvili J. N., **Intermolecular and Surface Forces**, Elsevier Inc.

Practical:

1. Giri, S; Bajpai, D.N.; Pandey, O.P. **Practical Chemistry**, S. Chand Limited.
2. Khosla, B.D.; Garg, V.C.; Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER IV

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -4: Nanoscale Materials and their Applications

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-4: Nanoscale Materials and their Applications	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce nanoscale materials and their applications.
- To provide an insight into bottom-up and top-down-approach, the methods of synthesis of nanoparticles, simple characterization techniques and applications of nanomaterials.

Learning outcomes

By studying this course, students will be able to:

- Understand the concept of nano dimensions.
- Know the various methods of preparation of nanomaterials.
- Understand the principles of optical and electron microscopy techniques of characterizing nanomaterials.
- Understand and appreciate the real life applications of nanomaterials.

Syllabus

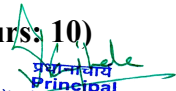
Unit 1: Introduction to Nanodimensions

(Hours: 12)

0D, 1D, 2D nanomaterials, Quantum Dots, Nanoparticles, Nanostructures (nanowires, thin films, nanorods), carbon nanostructures (carbon nanotubes, carbon nanofibers, fullerenes), Size Effects in nano systems, Quantum confinement and its consequences, Semiconductors. Band structure and band gap. Optical Properties Surface plasmon resonance

Unit 2: Preparation of Nanomaterials

(Hours: 10)


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Top down and Bottom up approach, Photolithography. Ball milling. Vacuum deposition. Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Thermal decomposition, Chemical reduction, Sol-Gel synthesis, Hydrothermal synthesis, Spray pyrolysis, Electrochemical deposition, Pulsed Laser deposition. Characterization of nanomaterials: Basic principle of optical methods and electron microscopy.

Unit 3: Applications of Nanomaterials

(Hours: 8)

Nanomaterials as Catalysts, semiconductor nanomaterials as photocatalysts, Nanocomposites as catalysts. Carbon nanostructures as catalytic nanoreactors, metal and metal oxides confined inside carbon nanostructures, Nanowires and thin films for photonic devices (LEDs, solar cells, transistors).

Practical Component

Credits:02

(Laboratory periods:60)

1. Synthesis of silver nanoparticles by chemical methods and characterization using UV-visible spectrophotometer.
 - a. Turkevich Method
 - b. Burst Method
2. Synthesis of silver nanoparticles by green approach methods (using soluble starch, glucose or cinnamon bark) and characterization using UV-visible spectrophotometer.
3. Synthesis of metal sulphide nanoparticles and characterization using UV-visible spectrophotometer.
 - a. MnS
 - b. ZnS
 - c. CuS
4. Intercalation of hydrogen in tungsten trioxide and its conductivity measurement using conductometer.
5. Synthesis of pure ZnO and Cu doped ZnO nanoparticles.
6. Phytochemicals mediated synthesis of gold nanoparticles (AuNPs) using tea leaves and to study the effect of size on color of gold/silver nanoparticles.
7. Preparation of magnetic nanoparticles (MNPs) of Fe_3O_4 using green tea leaf extract.
8. Any suitable experiment (other than the listed ones) based upon complexation reactions.

References:

Theory:

1. West, A. R. (2014), **Solid State Chemistry and Its Application**, John Wiley and Sons Inc.
2. Smart, L. E.; Moore, E. A., (2012), **Solid State Chemistry: An Introduction**, CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J. (1997), **New Direction in Solid State Chemistry**, Cambridge University Press.

4. Poole Jr.; Charles P.; Owens, Frank J. (2003), **Introduction to Nanotechnology**, John Wiley and Sons. Inc. Harris, D. C. (2007), **Quantitative Chemical Analysis**, 6th Edition, Freeman.
5. Chattopadhyay, K.K.; Banerjee, A. N. (2009), **Introduction to Nanoscience and Technology**, Prentice Hall India.

Practicals:

1. Orbaek, W.; McHale, M.M.; Barron, A. R.; **Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory**, J. Chem. Educ. 2015, 92, 339–344.
2. MacDiarmid, G.; Chiang, J.C.; Richter, A.F.; Somasiri, N.L.D.(1987), **Polyaniline: Synthesis and Characterization of the Emeraldine Oxidation State by Elemental Analysis**, L. Alcaer (ed.), Conducting Polymers, 105-120, D. Reidel Publishing.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -5: Molecules of Life

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-5: Molecules of Life	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To deliver information about the chemistry of carbohydrates, proteins & enzymes and its relevance in the biological system using suitable examples.
- To provide an insight into the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural details.

Learning outcomes

By studying this course, students will be able to:

- Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.
- Gain an insight into the mechanism of enzyme action and inhibition.
- Understand the basic principles of drug-receptor interaction and SAR.

Syllabus

Unit 1: Carbohydrates

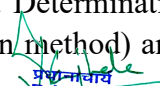
(Hours: 12)

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2: Amino acids, Peptides and Proteins

(Hours: 10)

Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by Edman method) and C-


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terminal amino acid (with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl) & C-activating groups (only DCC) and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.

Unit 3: Enzymes

(Hours: 4)

Classification of enzymes and their uses (mention Ribozymes). Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in enzyme action, specificity of enzyme action (including stereospecificity).

-

Unit 4: Nucleosides, Nucleotides and Nucleic Acids

(Hours: 4)

Components of Nucleic acids: Adenine, guanine, thymine, cytosine and uracil (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides; structure of DNA (Watson-Crick model) and RNA (types of RNA), difference between DNA and RNA.

Practical Component

Credits:02

(Laboratory periods:60)

1. Estimation of glucose by Fehling's solution.
2. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).
3. Study of the titration curve of glycine and determine the isoelectric point of glycine.
4. Estimation of proteins by Lowry's method.
5. Qualitative tests for amino acids, proteins and carbohydrates.
6. Separation and identification of mixture of sugars by paper chromatography.
7. Separation and identification of mixture of Amino acids by paper chromatography.
8. Study of the action of salivary amylase on starch under optimum conditions and find the enzyme activity.
9. Study the effect of temperature on activity of salivary amylase.
10. Extraction of DNA from onion/cauliflower.

References:

Theory:

1. Finar, I. L. **Organic Chemistry (Volume 1 & 2)**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry, 7th Edition**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education India).
3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry, 9th Ed.**, W. H. Freeman Co Ltd.

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's **Textbook of Practical Organic Chemistry**, Pearson Education India.
2. **Manual of Biochemistry Workshop, 2012**, Department of Chemistry, University of Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -6: Conductance, Electrochemistry and Chemical Kinetics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 6: Conductance, Electrochemistry and Chemical Kinetics	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of electrolytic and galvanic cells.
- Measurement of conductance and its applications, measurement of emf and its applications.
- To understand reaction rate, order, activation energy and theories of reaction rates.

Learning outcomes

By studying this course, students will be able to:

- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Understand the importance of Nernst equation, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.
- Understand rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.

Syllabus

Unit 1: Conductance

(Hours: 8)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions, Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, Conductometric titrations (only acid-base).

Unit 2: Electrochemistry

(Hours: 12)

Concept of reversible and irreversible electrochemical cells, Standard hydrogen electrode, standard electrode potential, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes (Reference and inert electrodes), electrochemical series.

Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. pH determination using glass electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Unit 3: Chemical Kinetics and Catalysis

(Hours: 10)

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, integrated rate equations for zero, first and second order reactions (derivation not required), half-life of a reaction, Concept of activation energy and its calculation from Arrhenius equation.

Catalysis: Types of catalyst, specificity and selectivity, generalized treatment of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Practical component

Credits:02

Laboratory periods: 60

1. Determination of molar conductance, degree of dissociation and dissociation constant of a weak acid.
2. Perform the following conductometric titrations: Strong acid vs strong base.
3. Perform the following conductometric titrations: Weak acid vs strong base.
4. Determination of TDS of water from different sources.
5. Determination of Soil pH of soil collected from various locations.
6. Perform the potentiometric titrations of strong acid vs strong base
7. Perform the potentiometric titrations of Weak acid vs strong base.
8. Perform the potentiometric titrations of Potassium dichromate vs. Mohr's salt.
9. Perform the potentiometric titrations of KMnO_4 vs. Mohr's salt.
10. Study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid.

References:

Theory:

1. Castellan, G. W .(2004), **Physical Chemistry**, Narosa Publications.
2. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.5, 3rd Edition, McGraw Hill Education.
4. Puri, B.R., Sharma, L.R. and Pathania M.S. (2020), **Principles of Physical Chemistry**, Vishal Publishing Co.

*

Practicals:

1. Khosla, B.D.; Garg, V.C.; Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGrawHill Education.
2. Batra, S.K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry**, Book Age series.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER V

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -7: Inorganic Materials of Industrial Importance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-7: Inorganic Materials of Industrial Importance	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- The course introduces learners to the importance of Inorganic compounds in Industries.
- To provide an insight into how the inorganic materials form a basis of the products used in day-to-day life like silicates, fertilizers, surface coatings.

Learning outcomes

By studying this course, students will be able to:

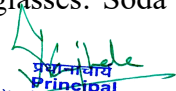
- Learn the composition and applications of the different kinds of glass.
- Understand glazing of ceramics and the factors affecting their porosity.
- Give the composition of cement and discuss the mechanism of setting of cement.
- Explain the suitability of fertilizers for different kinds of crops and soil.
- Understand and explain the polymerization of inorganic ions to generate inorganic polymers and the difference between organic and inorganic polymers.

Syllabus

Unit 1: Silicate Industries

(Hours: 10)

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime


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glass, lead glass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, coloured glass, photosensitive glass, photochromic glass, glass wool and optical fibre.

Ceramics: Brief introduction to types of ceramics. glazing of ceramics.

Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.

Unit 2: Fertilizers

(Hours: 8)

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate. Environmental impact of fertilizers.

Unit 3: Surface Coatings

(Hours: 12)

Brief introduction to and classification of surface coatings, paints and pigments: formulation, composition and related properties, pigment volume concentration (PVC) and critical pigment volume concentration (CPVC), fillers, thinners, enamels and emulsifying agents. Special paints: heat retardant, fire retardant, eco-friendly paints, plastic paints, water and oil paints. Preliminary methods for surface preparation, metallic coatings (electrolytic and electroless with reference to chrome plating and nickel plating), metal spraying and anodizing. Contemporary surface coating methods like physical vapor deposition, chemical vapor deposition, galvanising, carburizing, sherardising, boriding, nitriding and cementation.

Practical Component

Credits:02

(Laboratory periods:60)

1. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.
2. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) and estimation of phosphoric acid content.
3. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) and determination of composition of Dolomite (Complexometric titration).
4. Analysis of (Cu, Ni) in alloy or synthetic samples (Multiple methods involving Complexometry, Gravimetry and Spectrophotometry).
5. Analysis of (Cu, Zn) in alloy or synthetic samples (Multiple methods involving Iodometry, Complexometry and Potentiometry).
6. Preparation of following Inorganic Pigments:
 - a). Barium white
 - b). Chrome Yellow

- c). Malachite
 - d). Chromium oxide
 - e). Prussian Blue
7. Any suitable experiment other than the listed ones.

References:

Theory:

1. West, A. R. (2014), **Solid State Chemistry and Its Application**, Wiley & sons.
2. Smart, L. E.; Moore, E. A. (2012), **Solid State Chemistry An Introduction**, CRC Press Taylor & Francis.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010), **Inorganic Chemistry**, W. H. Freeman and Company.
4. Kent, J. A. (ed) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
5. Jain P.C., Jain M., **Engineering Chemistry**, Dhanpat Rai & Sons, Delhi.
6. Gopalan R., Venkappaya D., Nagarajan S., **Engineering Chemistry**, Vikas Publications, New Delhi.
7. Sharma, B.K., **Engineering Chemistry**, Goel Publishing House, Meerut.
8. Kingery W.D., Bowen H. K., Uhlmann, D.R., (1976), **Introduction to Ceramics**, Wiley & sons, Delhi.

Practicals:

1. Vogel A. I., Vogel's **Quantitative Inorganic Analysis**, Pearson Education.
2. Banewicz, J. J.; Kenner, C.T. **Determination of Calcium and Magnesium in Limestones and Dolomites**, Anal. Chem., 1952, 24 (7), 1186–1187.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 8: Polynuclear Hydrocarbons,
Pharmaceutical Compounds, UV- Visible & IR Spectroscopy**

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 8: Polynuclear Hydrocarbons, Pharmaceutical Compounds, UV- Visible & IR Spectroscopy	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide an insight to the fundamentals of polynuclear hydrocarbons and heterocyclic compounds
- The course introduces learners to IR and UV-Vis spectroscopic techniques and their importance in functional group identification.

Learning outcomes

By studying this course, students will be able to:

- Understand the fundamentals of polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
- Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
- Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules.

Syllabus

UNIT-1: Polynuclear Hydrocarbons

(Hours: 6)

Introduction, classification, uses, aromaticity of polynuclear compounds, Structure elucidation of naphthalene, preparation and properties of naphthalene and anthracene.


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UNIT-2: Pharmaceutical Compounds

(Hours: 12)

Introduction, classification, general mode of action of antipyretics and analgesics, aspirin; Synthesis, uses and side effects of the following drugs:

Antipyretics - Paracetamol (with synthesis and mode of action); Analgesics- Ibuprofen (with synthesis and overview of the mode of action); Antimalarials - Chloroquine (synthesis and mode of action).

An elementary treatment of Antibiotics and detailed study of chloramphenicol including mode of action. Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

UNIT-3: UV-Vis and IR Spectroscopy

(Hours: 12)

UV-Vis and IR Spectroscopy and their application to simple organic molecules. Electromagnetic radiations and their properties; double bond equivalence and hydrogen deficiency. UV-Vis spectroscopy (electronic spectroscopy): General electronic transitions, $\lambda_{\max}$ & $\epsilon_{\max}$, chromophores & auxochromes, bathochromic & hypsochromic shifts. Application of Woodward rules for the calculation of $\lambda_{\max}$ for the following systems: conjugated dienes - alicyclic, homoannular and heteroannular; α, β -unsaturated aldehydes and ketones, charge transfer complex.

Infrared (IR) Spectroscopy: Infrared radiation and types of molecular vibrations, the significance of functional group & fingerprint region. IR spectra of alkanes, alkenes, aromatic hydrocarbons (effect of conjugation and resonance on IR absorptions), simple alcohols (inter and intramolecular hydrogen bonding and IR absorptions), phenol, carbonyl compounds, carboxylic acids and their derivatives (effect of substitution on $>C=O$ stretching absorptions).

Practical component

Credit:02

(Laboratory periods: 15 classes of 4 hours each)

1. Isolation and estimation of the amount of aspirin in a commercial tablet.
2. Synthesis of ibuprofen.
3. Systematic qualitative identification and derivative preparation of organic compounds (Aromatic hydrocarbons, Aryl halides)
4. Detection of simple functional groups through examination of IR spectra (spectra to be provided). IR spectra of simple compounds like phenols, aldehydes, ketones, carboxylic acids may be given.
5. Differentiation between of o-/p-hydroxybenzaldehyde by IR spectroscopy (Spectra to be provided).
6. Differentiation between benzoic acid and cinnamic acid by UV spectroscopy.
7. Laboratory preparation of paracetamol.
8. Diel's Alder reaction using Anthracene and Maleic anhydride.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
4. Pavia, D.L. **Introduction to Spectroscopy**, Cengage learning (India) Pvt. Ltd.
5. Kemp, W. (1991), **Organic Spectroscopy**, Palgrave Macmillan.

Practicals

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry**, University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 9: Computer Applications in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 9: Computer Applications in Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to basic computer skills that will help them in solving chemistry problems using spreadsheets and BASIC language.
- To acquaint the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.
- To expose the students to the concept of molecular modelling, its applications to various molecular systems, energy minimization techniques, analysis of Mulliken Charge and ESP Plots.

Learning outcomes

By studying this course, students will be able to:

- Have knowledge of most commonly used commands and library functions used in programming in BASIC language.
- Develop algorithm to solve problems and write corresponding programs in BASIC language for performing calculations involved in laboratory experiments.
- Use various spreadsheet software to perform theoretical calculations and plot graphs

Syllabus

Unit 1: Programming using BASIC

(Hours: 20)

Programming Language – Elements of BASIC language, Numeric and string Constants and Variables, arithmetic expressions, hierarchy of operations, inbuilt functions. Syntax and use of the various QBASIC commands: REM, CLS, INPUT, PRINT, GOTO, IF, IF...THEN, IF...THEN..ELSE, IF and END IF, FOR

and NEXT etc., DIM, READ, DATA, GOSUB, RETURN, RESTORE, DEF FNR and Library Functions, Simple programs based on usage of the commands mentioned above.

Statistical analysis using BASIC: Mean, Least square fit - Linear regression, variance, standard deviation.

Unit 2 : Handling of Numerical Data

(Hours: 4)

Spreadsheet software: MS Excel. Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R^2 value, incorporating tables and graphs in Word files, graphical solution of equations, plotting pressure-volume curves of van der Waals gases, Maxwell-Boltzmann distribution, concentration versus time graphs, spectral data, titration curves, etc.

Unit 3: Molecular Modelling

(Hours: 6)

Introduction to molecular modelling, overview of classical and quantum mechanical methods (molecular mechanics, semi empirical, ab initio and DFT), general considerations and comparison of these methods.

Practical component

Credit:02

(Laboratory periods: 15 classes of 4 hours each)

Exercises of Programing

1. Calculate pressure of a real gas using Van der Waal's Equation.
2. Calculate the most probable speed, average speed and root mean square velocity of an ideal gas.
3. Roots of quadratic equations
4. Binomial coefficient using GOSUB statement.
5. Mean, standard deviation
6. Least square curve fitting method for linear equation.

Plotting graphs using a spreadsheet

1. Van der Waals isotherms
2. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight
3. Plot the conductometric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base
4. Plot the pH metric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base and determine the pK_a of the weak acid
5. Plot the graphs for the kinetics of first order reaction and determine the rate constant
6. Plot the UV-vis absorbance spectra and determine the molar absorption coefficient.

Molecular Modelling

1. Optimize and compare the geometry parameters of H_2O and H_2S using ArgusLab.
2. Compare the basicities of N atom in ammonia, methylamine, dimethylamine and trimethylamine using ArgusLab by comparing Mulliken charges and ESP map in ArgusLab.

3. Compare C-C bond lengths and bond order in ethane, ethene and ethyne using ArgusLab.
4. Determine enthalpy of isomerization of cis and trans-2-butene using ArgusLab.
5. Compare the HAH bond angles for the second row hydrides (BeH_2 , CH_4 , NH_3 , H_2O) and compare with the results from qualitative MO theory.

References:

Theory:

1. Levie, R. de. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press.
2. Venit, S.M. (1996), **Programming in BASIC: Problem solving with structure and style**. Jaico Publishing House.
3. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
4. Cramer, C.J.(2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
5. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.
6. Leach, A.R.(2001), **Molecular Modelling**, Prentice-Hall.

Practicals

1. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
2. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
3. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.

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SEMESTER VI

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -10: Analytical Methods in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-10: Analytical Methods in Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with the concepts of sampling, errors in analysis, accuracy, precision and introduce basics of statistical analysis.
- To introduces students to important instrumentation and separation techniques routinely used in the laboratory analysis of samples. The experiments expose students to instrumentation and they learn to detect and separate analytes in a mixture.

Learning outcomes

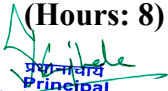
By studying this course, students will be able to:

- Understand various sources of errors in chemical analysis.
- Learn about methods to minimize error.
- Understand basic principle of instrumentation (Flame Photometer, UV-vis spectrophotometer, Atomic Absorption spectrophotometer).
- Apply the principles of analysis and instrumentation to analyse soil samples, soft drinks and synthetic mixtures provided in the laboratory.
- Learn basic principles of separation techniques (chromatography and solvent extraction) and apply them to separate mixtures.
- Understand principles of Gravimetric analysis and apply them in determination of Ni^{2+} and Al^{3+}
- Analyse samples independently in the laboratory.

Syllabus

Unit 1: Errors in Chemical Analysis

(Hours: 8)


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Types of errors, Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. The Gaussian distribution, mean and standard deviation, confidence intervals.

Unit 2: Optical Methods of Analysis

(Hours: 10)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, Beer's-Lambert Law.

UV-Vis Spectrophotometry

Basic principles of instrumentation for single and double beam instruments. Determination of concentration of unknown compounds, composition of metal complexes using Job's method of continuous variation and mole ratio method.

Flame Atomic Absorption and Emission Spectroscopy

Basic principles of instrumentation. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal.

Application of these techniques in analysis of samples.

Unit 3: Separation Techniques

(Hours: 12)

Solvent extraction

Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.

Chromatography

Principles of Chromatographic separations, Classification of Chromatographic techniques, Thin Layer Chromatography, Column Chromatography, efficiency of separation (Resolution, Efficiency of Resolution, Plate Height) Application of these techniques in analysis of samples.

Practical Component

Credits:02

(Laboratory periods:60)

1. Analysis of soil.
 - a. Determination of pH of soil, Total soluble salts, carbonate and bicarbonate, calcium and magnesium by titration.
 - b. Estimation of Potassium, calcium and magnesium by flame photometry.
2. Separation of constituents of leaf pigments by thin layer chromatography.
3. Determination of the ion exchange capacity of an anion exchange resin.
4. Determination of the ion exchange capacity of a cation exchange resin.
5. Separation of amino acids by ion exchange chromatography.

6. Spectrophotometric analysis of Co^{2+} and Ni^{2+} ions in a mixture.
7. Spectrophotometric analysis of Caffeine and Benzoic acid in a soft drink.
8. Gravimetric estimation of Ni^{2+} using Dimethylglyoxime or Al^{3+} using oxine.

References:

Theory:

1. Willard, H.H. (1988), **Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D. (2004), **Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C. (2007), **Quantitative Chemical Analysis**, 6th Edition, Freeman.
4. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.
5. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Christian, G.D. (2004), **Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C. (2007), **Quantitative Chemical Analysis**, 6th Edition, Freeman.
4. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 11: Chemistry of Polymers, Dyes and Natural Products

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 11: Chemistry of Polymers, Dyes and Natural Products	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the process of converting knowledge of chemistry into marketable products for commercial gain.
- To familiarize the basic nomenclature of polymers, dyes and natural products, classification and important terms.

Learning outcomes

By studying this course, students will be able to:

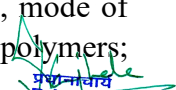
- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Comprehend the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.
- Understand the chemistry and applications of natural products like terpenoids and alkaloids.

Syllabus

Unit 1: Polymers

(Hours: 12)

Introduction and classification based on origin, monomer units, thermal response, mode of formation, structure, application and tacticity; di-block, tri-block and amphiphilic polymers;


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Weight average molecular weight, number average molecular weight, glass transition temperature (T_g) of polymers; Polymerisation Reactions-Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes.

Preparation and applications of: Plastics -thermosetting (phenol-formaldehyde, polyurethanes) and thermosoftening(PVC, polythene); Fabrics -natural (cellulose and synthetic derivatives of cellulose like rayon and viscose); synthetic (acrylic, polyamide, polyester); Rubbers-natural

and synthetic: Buna-N, Buna-S, Neoprene, silicon rubber; Vulcanization; Polymer additives; Introduction to Specialty Polymers: electroluminescent (Organic light emitting diodes), conducting, biodegradable polymers and liquid crystals.

Unit 2: Dyes

(Hours: 8)

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing. Synthesis and applications of Azo dyes – Methyl orange, Congo red; Triphenyl methane dyes- Crystal violet; Phthalein Dyes – Phenolphthalein; Natural dyes –Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

Unit 3: Natural Product Chemistry- An Introduction to Terpenoids and Alkaloids

(Hours: 10)

Terpenes: Introduction, occurrence, classification, uses, isoprene and special isoprene rule; structure elucidation, synthesis and industrial application of citral.

Alkaloids: Introduction, occurrence, classification, uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.

Practical component

Credits: 02

(Laboratory periods: 60)

1. Preparation of Methyl Orange.
2. Preparation of Malachite Green.
3. Recycling of Plastic: Moulding of plastic or Cracking of plastic.
4. Preparation of Urea-formaldehyde resin.
5. Preparation of Methyl Orange.
6. (a) Dyeing of different fabrics (cotton, wool, silk) using Alizarin or any other dye.
7. (b) Preparation of azo dye on the surface of the fabric.
8. Qualitative test for identification of alkaloids (Dragendorff's reagent and Mayer's reagent test) and terpenoids (Salkowski test).
9. Preparation of perchromic dye using p-amino phenol and p-nitro benzaldehyde.

References:

Theory:

1. Finar, I.L. (2008), **Organic Chemistry**, Vol 2, 5th Edition, Pearson Education

2. Saunders, K. J. (1988), **Organic Polymer Chemistry**, 2nd Edition Chapman & Hall, London
3. Campbell, Ian M., (2000), **Introduction to Synthetic Polymers**, 2nd Edition Oxford University Press, USA.
4. Bahadur, P. and Sastry, N.V. (2002) **Principles of Polymer Science**, Narosa, New Delhi
5. Patrick, G. **An Introduction to Medicinal Chemistry** (2013), 4th Edition, Oxford University Press.
6. Priscilla Abarca, Patricia Silva, Iriux Almodovar and Marcos Caroli ezende*Quim. Nova, Vol. 37, No. 4, 745-747, 2014.
<http://dx.doi.org/10.5935/0100-4042.20140120>

Practical:

1. Furniss B S., Hannaford A. J., Smith Peter W. G. & Tatchell Austin R., **Vogel's Textbook of Practical Organic Chemistry** Fifth Edition, Longman Scientific & Technical.
2. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -12: Phase Equilibria and Photochemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 12: Phase Equilibria and Photochemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of Phase, Component, Degree of freedom, basic principles of phase equilibria,
- To understand phase diagram of one and two component systems.
- The students will also gain an understanding of Binary solution, distillation of binary solution, CST and distribution law & its applications.

Learning outcomes

By studying this course, students will be able to:

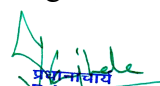
- Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation.
- Apply the concepts of phase, conductance and distribution law while studying other chemistry courses and every-day life.
- Explain low and high quantum yield, photosensitized reactions

Syllabus

Unit 1: Phase Equilibria

(Hours: 22)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, Phase diagram for one component systems (H_2O and S). Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points.


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Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 2: Photochemistry

(Hours: 8)

Characteristics of electromagnetic radiation. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, examples of low and high quantum yields

Photosensitized reactions, Jablonski's diagram. Role of photochemical reactions in biochemical processes, chemiluminescence.

Practical component

Credits: 02

(Laboratory periods: 60)

Phase Equilibrium

1. Determination of critical solution temperature and composition at CST of the phenol water system.
2. Effect of impurity on CST of phenol-water system (NaCl and succinic acid).
3. Construction of the phase diagram using cooling curves :
 - a. Simple eutectic.
 - b. Congruent melting system(s).
4. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.
5. Study of equilibrium of any one of the following reactions by distribution method:
 - (i) $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$
 - (ii) $Cu^{2+}(aq) + nNH_3 \rightleftharpoons [Cu(NH_3)_n]^{2+}$

References:

Theory:

1. Atkins, P.W.; Paula, J.de. (2014), **Atkin's Physical Chemistry Ed.**, 10th Edition, Oxford University Press.
2. Ball, D. W. (2017), **Physical Chemistry**, 2nd Edition, Cengage Learning, India.
3. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
4. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGrawHill Education.
5. Kapoor, K.L., **A Textbook of Physical Chemistry**, Vol 3, 5th Edition, McGraw Hill Education.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R.Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGrawHill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York

Additional Resources:

1. Moore, W.J. (1972), **Physical Chemistry**, 5th Edition, Longmans Green & Co. Ltd.
2. Glasstone, S. (1948), **Textbook of Physical Chemistry**, D. Van Nostrand company, New York.

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DISCIPLINE SPECIFIC ELECTIVE COURSE – 13 (DSE-13): Research Methodology for Chemists

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Research Methodology for Chemists (DSE-13)	04	03	--	01	Class 12 th with Physics, Chemistry	

Learning objectives

The objectives of this course are as follows:

- To make the students aware of fundamental but mandatory ethical practices in chemistry.
- To introduce the concept of data analysis.
- To learn to perform literature survey in different modes.
- To make the students aware of safety handling and safe storage of chemicals.
- To make students aware about plagiarism and how to avoid it.
- To teach the use of different e-resources.

Learning outcomes

By studying this course, students will be able to:

- Follow ethical practices in chemistry
- Do Data analysis
- Literature survey in different modes
- Use e-resources.
- Avoid plagiarism, understand the consequences and how to avoid

SYLLABUS OF DSE-13

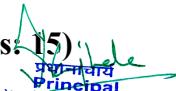
UNIT – 1: Scope of Research

(Hours: 3)

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.

UNIT – 2: Literature Survey, Databases and Research metrics

(Hours: 15)


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Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN

UNIT – 3: Communication in Science

(Hours: 12)

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis.

Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chems sketch etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

UNIT – 4: Research and Publication ethics

(Hours: 9)

Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkund etc), redundant publications

Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals

IPR - Intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS)

UNIT – 5: Statistical analysis for chemists

(Hours: 6)

Types of data, data collection-Methods and tools, data processing, hypothesis testing, Normal and Binomial distribution, tests of significance: t-test, F-test, chi- square test, ANOVA, multiple range test, regression and correlation.

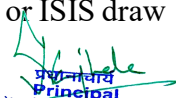
Features of data analysis with computers and softwares -Microsoft Excel, Origin, SPSS

Practical component

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

1. Collection of journal articles on a particular topic using Google Scholar and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
4. Drawing chemical structure, reactions and mechanisms using Chems sketch or ISIS draw or any other software.


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5. Collection of chemical structure using ChemSpider and creating a database.
6. Curve fitting using freely available softwares/apps (any one)
7. Making of power point presentation
8. Experimental learning of safe storage hazardous chemicals
9. Experimental learning of handling of hazardous chemicals
10. Technical writing on topics assigned.
11. Demonstration for checking of plagiarism using recommended software

Essential/recommended readings:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
3. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
4. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
OSU safety manual 1.01

BSC. (LIFE SCIENCE)- CHEMISTRY COMPONENT SEMESTER-IV

DISCIPLINE SPECIFIC CORE COURSE CHEM-DSC -10: Chemistry- IV: Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles DSC-10: Chemistry- 04	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the basics of coordination chemistry and which are of immense importance to biological systems, qualitative and quantitative analysis, catalysis, medicines, paints and pigments etc.
- Nomenclature, isomerism, bonding in coordination compounds has been dealt with in sufficient detail along with special emphasis on important coordination compounds in the biological system.

Learning outcomes

By studying this course, students will be able to:

- Understand terms: ligand, denticity of ligands, chelate, coordination number.
- Systematically name coordination compounds.
- Discuss the various types of isomerism possible in Octahedral and Tetrahedral coordination compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory
- Understand reaction mechanisms of coordination compounds and differentiate between kinetic and thermodynamic stability.
- Discuss the application of coordination compounds in the biological systems such as Hemoglobin, myoglobin and some enzymes

Syllabus

Unit 1: Carboxylic acids and their Derivatives (aliphatic and aromatic)

(Hours:13)

Preparation: Oxidation reactions of alcohols, aldehydes and ketones, Acidic and alkaline hydrolysis of esters; Reactions: Hell-Volhard Zelinsky reaction,

Carboxylic acid derivatives (aliphatic): Preparation: Acid chlorides, anhydrides, esters and amides from acids and their interconversion, Claisen condensation. Reactions: Relative reactivities of acid derivatives towards nucleophiles, Reformatsky reaction, Perkin condensation.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of ethyl acetoacetate

Unit 2: Amines (aliphatic & aromatic) and Diazonium Salts

(Hours:10)

Amines

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs Saytzeff elimination, carbylamine test, Hinsberg test, reaction with HNO_2 , Schotten-Baumann reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation; basicity of amines.

Diazonium salt

Preparation: from aromatic amines; Reactions: conversion to benzene, phenol and dyes.

Unit 3: Heterocyclic Compounds

(Hours:07)

Introduction, classification, structure, nomenclature and uses. Preparation and properties of the following heterocyclic compounds with reference to electrophilic and nucleophilic substitution: furan, pyrrole, thiophene, and pyridine.

PRACTICALS:

Credits: 02

(Laboratory periods: 60)

1. Systematic qualitative analysis and preparation of suitable crystalline derivative (carboxylic acids, carbonyl, alcohols, phenols, amines (1° , 2° , 3°) and amides).
2. Preparation:
 - a. Acetylation of Aniline and Phenols.
 - b. Benzoylation of Aniline and phenols.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References:

Theory:

1. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. **Organic Chemistry** (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), **Intermediate for Organic Synthesis**, I.K. International.
4. Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2016), **Organic Chemistry**, 12th Ed., Wiley.
5. Parashar, R.K., Negi, B. (2016) **Chemistry of Heterocyclic Compounds**, Ane Books Pvt Ltd.

Practical:

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry**, University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume II**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
6. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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BSC. (LIFE SCIENCE)- CHEMISTRY COMPONENT
SEMESTER-V

**DISCIPLINE SPECIFIC CORE COURSE CHEM-DSC -13: Chemistry- V: Coordination
Chemistry and its Application in Biological Systems**

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Coordination Chemistry and its Application in Biological Systems DSC-13 Chemistry- 5	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the basics of coordination chemistry and which are of immense importance to biological systems, qualitative and quantitative analysis, catalysis, medicines, paints and pigments etc.
- Nomenclature, isomerism, bonding in coordination compounds has been dealt with in sufficient detail along with special emphasis on important coordination compounds in the biological system.

Learning outcomes

By studying this course, students will be able to:

- Understand terms: ligand, denticity of ligands, chelate, coordination number.
- Systematically name coordination compounds.
- Discuss the various types of isomerism possible in Octahedral and Tetrahedral coordination compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory

- Understand reaction mechanisms of coordination compounds and differentiate between kinetic and thermodynamic stability.
- Discuss the application of coordination compounds in the biological systems such as Haemoglobin, myoglobin and some enzymes

Syllabus

Unit 1: Introduction to Coordination Compounds

(Hours: 6)

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands. Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Unit 2: Bonding in Coordination Compounds

(Hours: 14)

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes, Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields, Crystal field stabilization energy (CFSE), concept of pairing energy, Factors affecting the magnitude of Δ , Spectrochemical series, Splitting of d orbitals in tetrahedral symmetry, Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry, Jahn-Teller distortion.

Unit 3: Thermodynamic and Kinetic aspects of Metal Complexes

(Hours: 6)

A brief outline of thermodynamic and kinetic stabilities of metal complexes and factors affecting the stability. Substitution reactions of square-planar complexes – Trans effect: cisplatin and transplatin.

Unit 4: Application of coordination compounds in biological systems

(Hours: 4)

Haemoglobin, Myoglobin, carboxypeptidase, carbonic anhydrase

Practicals Component

Credits: 02

(Laboratory periods: 60)

1. Estimation of Mg^{2+} by direct complexometric titrations using EDTA.
2. Estimation of Zn^{2+} by direct complexometric titrations using EDTA.
3. Estimation of Ca^{2+} by direct complexometric titrations using EDTA.
4. Estimation of Zn^{2+} in zinc tablet.
5. Estimation of Ca^{2+} in milk sample.
6. Estimation of total hardness of a given sample of water by complexometric titration.
7. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1,10-phenanthroline complex in solution by Job's method
8. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1,10-phenanthroline complex in solution by mole ratio method

9. Preparation of the following inorganic compounds:
 - a). Tetraamminecopper(II) sulphate
 - b). Potassium trioxalatoferrate(III) trihydrate
 - c). Chrome alum
10. Any suitable experiment (other than the listed ones) based upon complexation reactions.

References:

Theory:

9. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
10. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
11. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
12. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition, Wiley India.
13. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
14. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier.
15. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
16. Sodhi G.S., Principles of Inorganic Chemistry, Third Edition, Viva Books, India.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Marr, G.; Rockett, B.W. (1972), **Practical Inorganic Chemistry**, Van Nostrand Reinhold.
3. Dua A, Manav N, **Practical Inorganic Chemistry**, (2017), Manakin Press.

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BSC. (LIFE SCIENCE)- CHEMISTRY COMPONENT SEMESTER-VI

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSC 16: Chemistry- VI: Conductance, Electrochemistry and Chemical Kinetics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Conductance, Electrochemistry and Chemical Kinetics DSC-16: Chemistry- 6	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of electrolytic and galvanic cells.
- Measurement of conductance and its applications, measurement of emf and its applications.
- To understand reaction rate, order, activation energy and theories of reaction rates.

Learning outcomes

By studying this course, students will be able to:

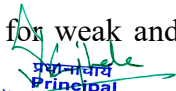
- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Understand the importance of Nernst equation, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.
- Understand rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.

Syllabus

Unit 1: Conductance

(Hours: 8)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and


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 धौला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

strong electrolytes, Kohlrausch Law of independent migration of ions, Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, Conductometric titrations (only acid-base).

Unit 2: Electrochemistry

(Hours: 12)

Concept of reversible and irreversible electrochemical cells, Standard hydrogen electrode, standard electrode potential, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes (Reference and inert electrodes), electrochemical series.

Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. pH determination using glass electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Unit 3: Chemical Kinetics and Catalysis

(Hours: 10)

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, integrated rate equations for zero, first and second order reactions (derivation not required), half-life of a reaction, Concept of activation energy and its calculation from Arrhenius equation.

Catalysis: Types of catalyst, specificity and selectivity, generalized treatment of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Practical Component:

Credits:02

Laboratory periods: 60

1. Determination of molar conductance, degree of dissociation and dissociation constant of a weak acid.
2. Perform the following conductometric titrations: Strong acid vs strong base.
3. Perform the following conductometric titrations: Weak acid vs strong base.
4. Determination of TDS of water from different sources.
5. Determination of Soil pH of soil collected from various locations.
6. Perform the potentiometric titrations of strong acid vs strong base
7. Perform the potentiometric titrations of Weak acid vs strong base.
8. Perform the potentiometric titrations of Potassium dichromate vs. Mohr's salt.
9. Perform the potentiometric titrations of KMnO_4 vs. Mohr's salt.
10. Study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid.

References:

Theory:

1. Castellan, G. W. (2004), **Physical Chemistry**, Narosa Publications.
2. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.5, 3rd Edition, McGraw Hill Education.
4. Puri, B.R., Sharma, L.R. and Pathania M.S. (2020), **Principles of Physical Chemistry**, Vishal Publishing Co.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGraw Hill Education.
3. Batra, S.K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry**, Book Age series.

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POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSEs)

SEMESTER III

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -1: Chemistry of Major and Minor Biogenic Elements

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-1: Chemistry of Major and Minor Biogenic Elements	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce learners to review periodic properties of main group elements and their role in the biological systems. It further discusses the patterns and trends exhibited by main group elements and their compounds with emphasis on synthesis, structure, bonding and their diverse applications in the environment, industry and in the biological system.
- To develop the interest of students in the frontier areas of inorganic and material chemistry, it gives an insight into how these compounds such as oxides of N and S affect our day-to-day life. Students learn about inorganic polymeric compounds borazine, silicates, silicones, phosphonitrilic compounds and their applications.

Learning outcomes

By studying this course, students will be able to:

- Understand the periodicity in atomic and ionic radii, electronegativity, ionization enthalpy, electron gain enthalpy of elements of the periodic table.
- Understand oxidation states with reference to the existence of elements in unusual and rare oxidation states in alkalides, carbides and nitrides.

- Understand vital role of sodium, potassium, calcium and magnesium ions etc. in biological systems and the role of oxides of N and S in our environment.
- Distribution of major and minor biogenic elements in human beings

Syllabus

Unit 1: Periodic Properties

(Hours: 6)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, the concept of exchange energy, inert pair effect.

General group trends of main group elements with special reference to size (atomic and ionic), Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, oxidation states (including rare oxidation states of alkali metals, carbides and nitrides), melting and boiling points, flame colour, metallic character and complex formation tendency (crown ethers and cryptates), Alkali metal solutions in liquid ammonia
Distribution of major and minor biogenic elements in human beings

Unit 2: Structure, Bonding and Properties

(Hours: 16)

Structure, bonding and properties: Acidic/Basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, thermal stability of the following:

Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.

Oxides: Oxides of nitrogen, phosphorus and sulphur

Oxoacids: oxoacids of phosphorus, sulphur and chlorine

Halides of phosphorus

Relevance of above compounds in industrial/environmental/biological systems wherever applicable

Unit 3: Preparation, Properties, Structure and Uses

(Hours: 8)

Preparation, properties, structure and uses of the following compounds: Borazine, Silicates, silicones, Phosphonitric halides $\{(\text{PNCl}_2)_n \text{ where } n = 3 \text{ and } 4\}$

Practicals

Credits:02

(Laboratory periods: 60)

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations (preferably 7-8 mixtures). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-} , NO_2^- , S^{2-} , SO_3^{2-} , SO_4^{2-} , $\text{S}_2\text{O}_3^{2-}$, CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$, PO_4^{3-} ,

NH_4^+ , K^+ , Pb^{2+} , Cu^{2+} , Cd^{2+} , Bi^{3+} , Sn^{2+} , Sb^{3+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+}

The mixtures may contain combination of anions/one interfering anion.

Spot tests should be preferred wherever applicable.

References:

Theory:

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Housecraft, E. H.; Sharpe, A.G. (2018), **Inorganic Chemistry**, 5th Edition, Pearson.

Practicals:

4. Vogel, A.I. (1972), **Qualitative Inorganic Analysis**, Longman.
5. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
6. Dua A, Manav N, **Practical Inorganic Chemistry**, (2017), Manakin Press.

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**DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -2: Polynuclear Hydrocarbons,
Pharmaceutical Compounds,**

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-2: Polynuclear Hydrocarbons, Pharmaceutical Compounds, UV- Visible & IR Spectroscopy	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the chemistry and applications of polynuclear hydrocarbons and heterocyclic compounds.
- Introduction to spectroscopy, an important analytical tool which allows identification of organic compounds by correlating their spectra to structure.

Learning outcomes

By studying this course, students will be able to:

- Understand the fundamentals of polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
- Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
- Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules.

Syllabus

UNIT-1: Polynuclear Hydrocarbons

(Hours: 6)

Introduction, classification, uses, aromaticity of polynuclear compounds, Structure elucidation of naphthalene, preparation and properties of naphthalene and anthracene.

UNIT-2: Pharmaceutical Compounds

(Hours: 12)

Introduction, classification, general mode of action of antipyretics and analgesics, aspirin; Synthesis, uses and side effects of the following drugs:

Antipyretics - Paracetamol (with synthesis and mode of action); Analgesics- Ibuprofen (with synthesis and overview of the mode of action); Antimalarials - Chloroquine (synthesis and mode of action).

An elementary treatment of Antibiotics and detailed study of chloramphenicol including mode of action. Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

UNIT-3: UV-Vis and IR Spectroscopy

(Hours: 12)

UV-Vis and IR Spectroscopy and their application to simple organic molecules. Electromagnetic radiations and their properties; double bond equivalence and hydrogen deficiency. UV-Vis spectroscopy (electronic spectroscopy): General electronic transitions, λ_{max} & ϵ_{max} , chromophores & auxochromes, bathochromic & hypsochromic shifts. Application of Woodward rules for the calculation of λ_{max} for the following systems: conjugated dienes - alicyclic, homoannular and heteroannular; α , β -unsaturated aldehydes and ketones, charge transfer complex.

Infrared (IR) Spectroscopy: Infrared radiation and types of molecular vibrations, the significance of functional group & fingerprint region. IR spectra of alkanes, alkenes, aromatic hydrocarbons (effect of conjugation and resonance on IR absorptions), simple alcohols (inter and intramolecular hydrogen bonding and IR absorptions), phenol, carbonyl compounds, carboxylic acids and their derivatives (effect of substitution on $>\text{C}=\text{O}$ stretching absorptions).

Practical component

Credit:02

(Laboratory periods: 15 classes of 4 hours each)

1. Isolation and estimation of the amount of aspirin in a commercial tablet.
2. Preparation of Aspirin.
3. Synthesis of ibuprofen.
4. Systematic qualitative identification and derivative preparation of organic compounds (Aromatic hydrocarbons, Aryl halides)
5. Detection of simple functional groups through examination of IR spectra (spectra to be provided). IR spectra of simple compounds like phenols, aldehydes, ketones, carboxylic acids may be given.
6. Differentiation between o-/p-hydroxybenzaldehyde by IR spectroscopy (Spectra to be provided).
7. Differentiation between benzoic acid and cinnamic acid by UV spectroscopy.
8. Diel's Alder reaction using Anthracene and Maleic anhydride.
9. Partial Reduction of m-dinitrobenzene to m-nitroaniline and then analysing the IR spectra of reactant and Product.
10. Laboratory preparation of Paraacetamol.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.

4. Pavia, D.L. **Introduction to Spectroscopy**, Cengage learning (India) Pvt. Ltd.
2. Kemp, W. (1991), **Organic Spectroscopy**, Palgrave Macmillan.

Practicals:

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry**, University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 3: Chemistry of Colloids and Adsorption

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 3: Chemistry of Colloids and Adsorption	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic concepts of colloids and colloidal phenomenon.
- Preparation and characterization of sols, understanding about applications of colloid in food, petroleum and cosmetic industry.
- Basic understanding of adsorption, types of adsorption, chemistry of adsorption and its applications.

Learning outcomes

By studying this course, students will be able to:

- Understand colloid solutions, preparation of sols.
- Understand the concept of Electrical double layer, charge on colloidal particles.
- Characterize the colloids sols, learn colloid phenomenon like Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation.
- Understand adsorption, types of adsorption. Characteristics, factors affecting adsorption and its applications

Syllabus

Unit 1: Colloidal State

(Hours: 8)

Distinction among true solutions, colloids and suspensions, components of Colloids, classification of colloids - lyophilic, lyophobic; Preparation methods and properties of lyophobic solutions, Hydrophile-lyophile balance (HLB), multi molecular, macromolecular and associated colloids (micelles formation), Schulze -Hardy law.

Unit 2: Preparation and properties of colloids

(Hours: 14)

of preparation of colloids, Tyndall effect, Brownian movement, coagulation and flocculation; electrophoresis, dialysis.

Emulsification by surfactants, selection of surfactants as emulsifying agent, colloidal phenomenon in food chemistry, Protein based functional colloids.

UNIT 3: Surface Chemistry

(Hours: 8)

Adsorption, Distinction between adsorption and absorption, Types of Adsorption, Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, Adsorption from solutions. Applications of Adsorption phenomenon in living systems.

Practical component

Credits: 02

(Laboratory periods: 60)

7. Preparation of Colloidal Sols of following
 - a. Egg Albumin
 - b. Starch /Gum
 - c. Ferric chloride
 - d. Aluminum hydroxide
 - e. Antimony Sulphide
8. To find out the precipitation values of Antimony Sulphide sol by using monovalent, bivalent and trivalent cations.
9. To verify the Schulze -Hardy law.
10. To verify the Freundlich's Adsorption isotherms.
11. Study of adsorption of HAc on charcoal and prove the validity of Langmuir's adsorption isotherms
12. Study of adsorption of Oxalic acid on charcoal and prove the validity of Langmuir's adsorption isotherms.

References:

Theory:

7. Puri B. R., Sharma L. R. and Pathania M.S., (2020) Principles of Physical Chemistry, Vishal Publishing Co.Jalandhar, Punjab, India.
8. Kapoor K L, **Text Book of Physical Chemistry, Vol. 4**, McGraw Hill Education (India) Private Limited, Chennai, India.
9. Evans D F and Wennerström's, **The Colloidal Domain**, Second Edition, John Wiley & Sons Inc.
10. Adamson A. W. and Gast A., **Physical Chemistry of Surfaces** (Main text) Sixth Edition, John Wiley & Sons Inc.
11. Berg J. C., **An Introduction to Interfaces and Colloids**, World Scientific Publishing Co., Inc. New Jersey.
12. Israelachvili J. N., **Intermolecular and Surface Forces**, Elsevier Inc.

Practical:

3. Giri, S; Bajpai, D.N.; Pandey, O.P. **Practical Chemistry**, S. Chand Limited.
4. Khosla, B.D.; Garg, V.C.; Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -4: Acids & Bases and Aqueous Chemistry of Metal Ions

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-4: Acids & Bases and Aqueous Chemistry of Metal Ions	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide basic understanding of the various concepts of acids and bases and Buffers to students and the factors responsible for variable acid and bases strength. This will help the learner to understand the importance of pH maintenance for a large number of biological processes especially enzyme systems.
- The unit of Aqueous Chemistry of metal ions provides an insight into the types of reactions a metal ion undergoes in aqueous medium- hydration, hydrolysis, redox, complexation, precipitation. The knowledge of these let a learner ascertain the feasibility of a proposed reaction and also to predict the possible outcomes of a new reaction. This additionally equips a biology student to understand different biological processes involving metal ions in a better way.

Learning outcomes

By studying this course, students will be able to:

- Define the Arrhenius, Bronsted Lowry, Lewis and Hard & soft acids and bases.
- Distinguish one class of acids and bases from the other and will be able to classify different types of available acids (synthetic and natural) under these classes.
- Understand the parameters affecting the relative strength of acids and bases and the effect of solvent on them.
- Explain the effect of mixing a strong/weak acid with a weak/strong base and will be able to calculate the pH of buffers.
- Correlate the concepts of acids and bases to the biological processes, the importance of pH and the buffers in sustaining specific metabolic activities.
- Explain the behavior of metal ions in aqueous solutions in presence of other reagents

- Differentiate between solvation and solvolysis and explain the formation of oxo ions as a result of hydrolysis.
- Write the redox reactions involving metal ions, use the Nernst equation to calculate redox potentials and correlate them with the relative oxidizing/reducing strength of metal ions
- Explain the successive reduction or oxidation of a metal ion capable of displaying more than two oxidation states and hence predict the spontaneity of a redox reaction
- Explain the disproportionation of an oxidation state and the stability of an oxidation state in aqueous medium by comparing the redox potentials with that of water at different pH.
- Explain the chemistry involved in the quantitative chemical analysis involving redox reactions like redox titrations.
- Explain the formation of metal complexes based on two different modes of ligand metal interaction.
- Understand the importance of complexation process in stabilizing some oxidation states more than the other.
- Write the reactions involving the precipitation of metal ions, and predict the relative precipitations based on solubility products.
- Explain the identification and separation of metal ions in a mixture based on difference in precipitation behavior of metal ions.
- Correlate the redox, complexation and precipitation behavior of metal ions in aqueous medium to the role of metal ions and metalloproteins in biological systems.

Syllabus

Unit 1: Acids & Bases

(Hours: 10)

Concepts: Arrhenius, Bronsted-Lowry (aqua, hydroxo, oxo), Lewis acids and bases, Hard and Soft acids and bases.

Strength of Acids and Bases: factors affecting relative strength of acids and bases, solvent levelling, superacids and superbases.

Buffers ($\text{NH}_4\text{OH}/\text{NH}_4\text{Cl}$, NaOAc/HOAc , boric acid and borate, Phosphate buffers, Universal Buffer), buffer capacity, calculation of pH of buffer solutions, pH calculation using Handerson-Hasselbalch equation, Applications of Acids & Bases and buffers in biological processes

Unit 2: Aqueous Chemistry of Metal ions

(Hours: 20)

Solvation effects on metal ions, oxocations and oxoanions

Redox reactions: Half reactions, balancing of redox reactions, Nernst equation, standard potentials and spontaneity, trends in standard potentials, electrochemical series

Redox stability of species in aqueous solutions (influence of pH, effect of solvation, redox reaction with water, disproportionation)

Diagrammatic presentation of potential data: Latimer diagrams, Frost diagrams and Pourbaix diagrams their significance

Applications of redox reactions in quantitative analysis: permanganate, dichromate & iodine titrations

Examples of Redox reactions in biological processes

Complexation behaviour of metal ions: Lewis acid – base type (d block), electrostatic interactions based (s block elements with crown ethers and cryptates), stabilisation of oxidation states by complexation (Cu(I) , Mn(III)),

Applications of complexes in biological systems with special mention of metalloenzymes.

Precipitation: Insoluble salts with anions like S^{2-} , SO_4^{2-} , PO_4^{3-} , halides, OH^- , $C_2O_4^{2-}$, CO_3^{2-} and their application in metal ions analysis.

Practical Component:

Credits:02

(Laboratory periods: 60)

1. Preparation of Potassium trioxalatochromate(III).
2. Preparation of Potassium trisoxalatomanganate(III).
3. Preparation of acetylacetonato complexes of
 - a). Cu(II)
 - b). Fe(III)
4. Determination of strength of oxalate ions and oxalic acid in a mixture titrimetrically.
5. Determination of available chlorine in bleaching powder iodometrically.
6. Preparation of a phosphate buffer solution and measurement of its pH using pHmeter.
7. Determination of buffer capacity of phosphate buffer.
8. Determination of strength of chloride ions argentometrically
 - a). Volhard's Method
 - b). Fajan's Method
 - c). Mohr's Method
9. pHmetric titration of a strong acid with a strong base.
10. Any suitable experiment other than the listed ones.

References:

Theory:

1. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
3. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
4. Miessler, G. L. (2008). **Inorganic chemistry**. Pearson Education India.
5. Sharpe, A. G. (1992). **Inorganic chemistry**. Longman Publishing Group.
6. Lehninger, A. L., Nelson, D. L., Cox, M. M., & Cox, M. M. (2005). **Lehninger principles of biochemistry**. Macmillan India.
7. Svehla, G. (2008). **Vogel's qualitative inorganic analysis**, 7/e. Pearson Education India.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 5 Biomolecule-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 5: Biomolecules-I	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the process of converting knowledge of chemistry into marketable products for commercial gain.
- To teach students about important biomolecules essential to life processes.
- 2. To discuss aspects of the principles of organic chemistry in the structure and function of important biomolecules.

Learning outcomes

By studying this course, students will be able to:

- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Comprehend the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.
- Understand the chemistry and applications of natural products like terpenoids and alkaloids.

Syllabus

Unit 1: Chemistry of Carbohydrates

(Hours:10)

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties

and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of the configuration of glucose (Fischer proof), the cyclic structure of glucose. Haworth projections. The cyclic structure of fructose. The linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2: Nucleosides, Nucleotides and Nucleic Acids

(Hours:10)

Components of Nucleic acids: Adenine, guanine, thymine, cytosine and uracil (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides; structure of DNA (Watson-Crick model) and RNA (types of RNA), difference between DNA and RNA, genetic code, biological roles of DNA and RNA: replication, transcription and translation.

Unit-3: Lipids

(Hours:10)

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins.

Properties, functions and biochemical functions of steroid hormones.

PRACTICALS:

Credits: 02

(Laboratory periods: 60)

1. Preparation of osazone of glucose, fructose and Maltose (Comparing the time of formation of the two and the shape of crystals using microscope).
2. Identification of given carbohydrates as
 - a. Reducing and Non-reducing
 - b. Monosaccharide and Disaccharide
 - c. Aldose and Ketose
3. Estimation of glucose by Fehling's solution.
4. Determination of the iodine number of oil.
5. Determination of the saponification number of oil.
6. Identification and separation of mixture of sugars by paper chromatography.
7. Isolation of DNA from cauliflower/ onion.
8. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).

References:

Theory

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2002), **Biochemistry**, W. H. Freeman.
4. Devlin, T.M. (2010), **Textbook of Biochemistry with Clinical Correlation**, Wiley.
5. Satyanarayana, U.; Chakrapani, U. (2017), **Fundamentals of Biochemistry**, Books and Allied (P) Ltd.
6. Lehninger, A.L; Nelson, D.L; Cox, M.M. (2009), **Principles of Biochemistry**, W. H. Freeman.

Practical:

1. Dean, J.R.; Jones, A.M.; Holmes, D.; Reed, R.; Jones, A.Weyers, J. (2011), **Practical skills in chemistry**, Prentice-Hall.
2. Wilson, K.; Walker, J. (2000), **Principles and techniques of practical biochemistry**, Cambridge University Press.
3. Gowenlock. A.H. (1988), **Varley's Practical Clinical Biochemistry**, CRC Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume II**, I K International Publishing House Pvt. Ltd., New Delhi.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -6 Quantum Chemistry and Spectroscopy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 6: Quantum Chemistry and Spectroscopy	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the concepts and methodology of quantum mechanics
- Application of Quantum chemistry to spectroscopy
- To establish the relation between structure determination and spectra.

Learning outcomes

By studying this course, students will be able to:

- Understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions.
- Understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra.

Syllabus

Unit 1: Quantum Chemistry

(Hours: 16)

Postulates of quantum mechanics, quantum mechanical operators.

Schrodinger equation and its application to free particle and particle in a 1-D box (complete solution), quantization, normalization of wave functions, concept of zero-point energy.

Qualitative treatment of H and H like atoms. Setting up of Schrodinger equation for many electron atoms.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels.

Unit 2: Spectroscopy

(Hours: 14)

Electromagnetic radiation and its interaction with matter. Lambert-Beer's law, Jablonski's diagram. Fluorescence and Phosphorescence.

Difference between atomic and molecular spectra. Born- Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.

Microwave Spectroscopy: Microwave (pure rotational) spectra of diatomic molecules. Selection rules.

Structural information derived from rotational spectroscopy.

IR Spectroscopy: Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free electron model and its application to electronic spectra of polyenes. chromophores, auxochromes, bathochromic and hypsochromic shifts.

Practical component

Credits:02

(Laboratory periods: 60)

UV/Visible spectroscopy

10. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
11. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$
12. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colorimetry

13. Verify Lambert-Beer's law and determine the concentration of CuSO_4 / KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$ / CoCl_2 in a solution of unknown concentration
14. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.
15. Study the kinetics of iodination of propanone in acidic medium.
16. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
17. Determine the dissociation constant of an indicator (phenolphthalein).
18. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

References:

Theory:

1. Banwell, C.N.; McCash, E.M.(2006), **Fundamentals of Molecular Spectroscopy**, Tata McGraw- Hill.
2. Kapoor, K.L.(2015), **A Textbook of Physical Chemistry**, McGraw Hill Education, Vol 4, 5th Edition, McGraw Hill Education.
3. McQuarrie, D.A.(2016), **Quantum Chemistry**, Viva Books.
4. Chandra, A. K.(2001), **Introductory Quantum Chemistry**, Tata McGraw-Hill.
5. Dua A and Tyagi P, **Molecular Spectroscopy: Quantum to Spectrum**, (2022) Atlantic Publishers & Distributors Pvt Ltd.
6. Dua A, Singh C, **Quantum Chemistry: Classical to Computational** (2015) ManakinPress.

Practical:

4. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
5. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
6. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Additional Resources:

3. Castellan, G. W. (2004), **Physical Chemistry**, Narosa.
4. Petrucci, R. H.(1989), **General Chemistry: Principles and Applications**, Macmillan Publishing

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -7: Analytical Methods in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-7: Analytical Methods in Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with the concepts of sampling, errors in analysis, accuracy, precision and introduce basics of statistical analysis. The course introduces students to important instrumentation and separation techniques routinely used in the laboratory analysis of biological samples.
- To expose students to instrumentation in the practical and they learn to detect and separate analytes in a mixture.

Learning outcomes

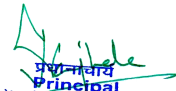
By studying this course, students will be able to:

- Understand various sources of errors in chemical analysis.
- Learn about methods to minimize error.
- Understand basic principle of instrumentation (Flame Photometer, UV-vis spectrophotometer, Atomic Absorption spectrophotometer).
- Apply the principles of analysis and instrumentation to analyse soil samples, soft drinks and synthetic mixtures provided in the laboratory.
- Learn basic principles of separation techniques (chromatography and solvent extraction) and apply them to separate mixtures.
- Understand principles of Gravimetric analysis and apply them in determination of Ni^{2+} and Al^{3+}
- Analyse samples independently in the laboratory.

Syllabus

Unit I: Errors in Chemical Analysis

(Hours: 8)


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Types of errors, Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. The Gaussian distribution, mean and standard deviation, confidence intervals.

Unit 2: Optical Methods of Analysis

(Hours: 10)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, Beer's-Lambert Law.

UV-Visible Spectrophotometry: Basic principles of instrumentation for single and double beam instruments. Determination of concentration of unknown compounds, composition of metal complexes using Job's method of continuous variation and mole ratio method.

Flame Atomic Absorption and Emission Spectroscopy: Basic principles of instrumentation. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal.

Application of these techniques in analysis of biological samples.

Unit 3: Separation Techniques

(12 Hours)

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.

Chromatography: Principles of Chromatographic separations, Classification of Chromatographic techniques, Thin Layer Chromatography, Column Chromatography, efficiency of separation (Resolution, Efficiency of Resolution, Plate Height)

Application of these techniques in analysis of biological samples.

Practical Component

Credits: 02

(Laboratory periods: 60)

1. Analysis of soil.
 - (a) Determination of pH of soil, Total soluble salts, carbonate and bicarbonate, calcium and magnesium by titration.
 - (b) Estimation of Potassium, calcium and magnesium by flame photometry.
2. Separation of constituents of leaf pigments by thin layer chromatography.
3. Determination of the ion exchange capacity of an anion exchange resin.
4. Determination of the ion exchange capacity of a cation exchange resin.
5. Separation of amino acids by ion exchange chromatography.
6. Spectrophotometric analysis of Co^{2+} and Ni^{2+} ions in a mixture.
7. Spectrophotometric analysis of Caffeine and Benzoic acid in a soft drink
8. Gravimetric estimation of Ni^{2+} using Dimethylglyoxime.
9. Gravimetric estimation of Al^{3+} using oxine.
10. Any suitable experiment (other than the listed ones) based upon analytical techniques discussed in theory section.

References:

Theory:

1. Willard, H.H. (1988), **Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D. (2004), **Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C. (2007), **Quantitative Chemical Analysis**, 6th Edition, Freeman.
4. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.
5. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Marr, G.; Rockett, B. W. (1972), **Practical Inorganic Chemistry**, Van Nostrand Reinhold.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 8: Biomolecule-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 8: Biomolecules-II	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the process of converting knowledge of chemistry into marketable products for commercial gain.
- To teach students about important biomolecules essential to life processes.
- 2. To discuss aspects of the principles of organic chemistry in the structure and function of important biomolecules.

Learning outcomes

By studying this course, students will be able to:

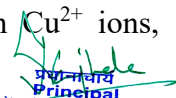
- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Comprehend the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.
- Understand the chemistry and applications of natural products like terpenoids and alkaloids.

Syllabus

Unit 1: Amino acids, Peptides & Proteins

(Lecture : 12)

Amino Acids and Peptides -Zwitterion, isoelectric point and electrophoresis. Preparation of amino acids: Strecker synthesis and using Gabriel's phthalimide synthesis. Reactions of amino acids: ester of -COOH group, acetylation of -NH_2 group, complexation with Cu^{2+} ions, ninhydrin test.


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Determination of the primary structure of peptides by degradation Edman degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (up to dipeptides) by N-protection (*t*-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis. An Overview of primary, secondary, tertiary and quaternary structure of proteins.

UNIT 2 : Enzymes

(Hours: 08)

Classification of enzymes and their uses (mention ribozymes). Mechanism of enzyme action, factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo-specificity), enzyme inhibitors and their importance, and the phenomenon of inhibition (competitive and non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, –NH₂ group, double bond and aromatic ring.

Unit 3: Concept of Energy in Biosystems

(Hours: 10)

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD⁺, FAD. Conversion of food to energy: Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle. The caloric value of food, the standard caloric content of food types.

PRACTICALS:

Credits: 02

(Laboratory periods: 60)

1. Qualitative tests for amino acids and proteins.
2. Separation and identification of mixture of amino acids by paper chromatography.
3. Study of the action of salivary amylase on starch under optimum conditions and determine the enzyme activity.
4. Study the effect of temperature on activity of salivary amylase.
5. Isolation of casein from milk.
6. Estimation of proteins by Lowry's method.
7. Estimation of glucose by Fehling's solution.
8. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).
9. Study of the titration curve of glycine and determine the isoelectric point of glycine.
10. Estimation of proteins by Lowry's method.
11. Estimation of Glycine by Sorensen's method.

References:

Theory:

1. Devlin, T.M. (2010), **Textbook of Biochemistry with Clinical Correlation**, Wiley.
2. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry**, 9th Ed., W. H. Freeman Co Ltd.
3. Lehninger, A.L; Nelson, D.L; Cox, M.M. (2009), **Principles of Biochemistry**, W. H. Freeman.
5. Finar, I.L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Practical:

1. Dean, J.R.; Jones, A.M.; Holmes, D., Reed, R.; Jones, A. Weyers, J. (2011), **Practical skills in chemistry**, Prentice-Hall.
2. Wilson, K.; Walker, J. (2000), **Principles and techniques of practical biochemistry**, Cambridge University Press.
3. Gowenlock. A.H. (1988), **Varley's Practical Clinical Biochemistry**, CRC Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume II**, I K International Publishing House Pvt. Ltd., New Delhi.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 9: Computer Applications in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 9: Computer Applications in Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

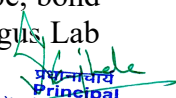
The Learning Objectives of this course are as follows:

- To introduce the students to basic computer skills that will help them in solving chemistry problems using spreadsheets and BASIC language.
- To acquaint the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.
- To expose the students to the concept of molecular modelling, its applications to various molecular systems, energy minimization techniques, analysis of Mulliken Charge and ESP Plots.

Learning outcomes

By studying this course, students will be able to:

- Become familiar with the simple use of BASIC Language.
- Use software for tabulating data, plotting graphs and charts, carry out statistical analysis of the data.
- Solve chemistry problems and simulate graphs.
- Prepare documents that will incorporate chemical structure, chemical equations, mathematical expressions from chemistry.
- Understand theoretical background of computational techniques and selective application to various molecular systems.
- Learn Energy minimization methods through use of different force fields.
- Learn ESP Plots by suitable soft wares, electron rich and electron deficient sites.
- Compare computational and experimental results and explain deviations.
- Perform Optimization of geometry parameters of a molecule (such as shape, bond length and bond angle) through use of software like Chem Sketch and Argus Lab in interesting hands-on exercises.


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Syllabus

Unit 1: Programming using BASIC

(Hours: 20)

Programming Language – Elements of BASIC language, Numeric and string Constants and Variables, arithmetic expressions, hierarchy of operations, inbuilt functions. Syntax and use of the various QBASIC commands: REM, CLS, INPUT, PRINT, GOTO, IF, IF...THEN, IF...THEN..ELSE, IF and END IF, FOR and NEXT etc., DIM, READ, DATA, GOSUB, RETURN, RESTORE, DEF FNR and Library Functions, Simple programs based on usage of the commands mentioned above.

Statistical analysis using BASIC: Mean, Least square fit - Linear regression, variance, standard deviation.

Unit 2 : Handling of Numerical Data

(Hours: 4)

Spreadsheet software: MS Excel. Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R^2 value, incorporating tables and graphs in Word files, graphical solution of equations, plotting pressure-volume curves of van der Waals gases, Maxwell-Boltzmann distribution, concentration versus time graphs, spectral data, titration curves, etc.

Unit 3: Molecular Modelling

(Hours: 6)

Introduction to molecular modelling, overview of classical and quantum mechanical methods (molecular mechanics, semi empirical, ab initio and DFT), general considerations and comparison of these methods.

Practical component

Credit:02

(Laboratory periods: 15 classes of 4 hours each)

Exercises of Programing

7. Calculate pressure of a real gas using Van der Waal's Equation.
8. Calculate the most probable speed, average speed and root mean square velocity of an ideal gas.
9. Roots of quadratic equations
10. Binomial coefficient using GOSUB statement.
11. Mean, standard deviation
12. Least square curve fitting method for linear equation.

Plotting graphs using a spreadsheet

4. Van der Waals isotherms
5. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight

6. Plot the conductometric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base
5. Plot the pH metric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base and determine the pK_a of the weak acid
7. Plot the graphs for the kinetics of first order reaction and determine the rate constant
8. Plot the UV-vis absorbance spectra and determine the molar absorption coefficient.

Molecular Modelling

6. Optimize and compare the geometry parameters of H_2O and H_2S using ArgusLab.
7. Compare the basicities of N atom in ammonia, methylamine, dimethylamine and trimethylamine using ArgusLab by comparing Mulliken charges and ESP map in ArgusLab.
8. Compare C-C bond lengths and bond order in ethane, ethene and ethyne using ArgusLab.
9. Determine enthalpy of isomerization of cis and trans-2-butene using ArgusLab.
10. Compare the HAH bond angles for the second row hydrides (BeH_2 , CH_4 , NH_3 , H_2O) and compare with the results from qualitative MO theory.

References:

Theory:

7. Levie, R. de. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press.
8. Venit, S.M. (1996), **Programming in BASIC: Problem solving with structure and style**. Jaico Publishing House.
9. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
10. Cramer, C.J.(2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
11. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.
12. Leach, A.R.(2001), **Molecular Modelling**, Prentice-Hall.

Practicals

4. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
5. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
6. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -10: Applied Inorganic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 10: Applied Inorganic Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the principles of catalysis. It further discusses the types of catalysts and their industrial applications. It gives an insight into different types of fertilizers and chemistry involved in their manufacturing.
- To learn about applications of metals and inorganic compounds as diagnostic agents and medicines. The course helps develop the interest of students in the frontier areas of applied inorganic and medicinal chemistry.

Learning outcomes

By studying this course, students will be able to:

- Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process and applications of zeolites and biocatalysis.
- Explain the suitability of fertilizers for different kinds of crops and soil.
- Explain the inorganic compounds and metals in medicine and, specifically, the role of cisplatin in cancer therapy

Syllabus

Unit 1: Catalysis

(Hours: 10)

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis (catalytic steps, examples) and their industrial applications, deactivation and regeneration of catalysts, catalytic poison, promoter. Study of the following processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer-Tropsch reaction)

3. Polymerisation of ethene and propene using Ziegler-Natta catalyst
 4. Application of zeolites as catalysts.
- Introduction and importance of biocatalysis

Unit 2: Fertilizers

(Hours: 8)

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime and potassium chloride, Environmental aspects of fertilizers.

Unit 3: Medical Applications of Inorganic Compounds

(Hours: 12)

Introduction, Use of Chelating agents, metal complexes as diagnostic agents, Lithium in mental health, Gold containing drugs, role of metals in Neurodegenerative Diseases, Inorganic compounds in Chemotherapy: Cisplatin; mode of action, basic idea of second and third generation drugs.

Practical Component (Laboratory Periods: 60)

Credits:02

1. Preparation of magnesium pyrosilicate (Antacid).
2. Determination of ascorbic acid in vitamin C tablets by iodometric titrations.
3. Preparation of borax.
4. Preparation of boric acid.
5. Catalytic oxidation of potassium sodium tartrate by cobalt(II) chloride.
6. Estimation of boric acid and borax in a mixture by titrimetric analysis
7. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.
8. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) and estimation of phosphoric acid content.
9. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) and determination of composition of Dolomite (Complexometric titration)

References:

Theory:

1. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins **Inorganic Chemistry**, 5th Edition, Oxford University Press.
3. Housecraft, E. H.; Sharpe, A.G. (2018), **Inorganic Chemistry**, 5th Edition, Pearson.
4. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
5. Lippard, S.J.; Berg, J.M. (1994), **Principles of Bioinorganic Chemistry**, Panima Publishing Company.
6. Spessard, Gary O.; Miessler, Gary L. (1996), **Organometallic Chemistry**, Prentice-Hall.

7. Fertilizers and Their Composition, Characteristics, Quality, Transformations and Applications, Tandon, H.L.S., 2008., **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
8. Patrick, G. (2017), **Introduction to Medicinal Chemistry**, Oxford University Press.
9. Wolfgang Kaim, Brigitte Schwederski, Axel Klein, **Bioinorganic chemistry: Inorganic elements in the chemistry of life**, John Wiley & Sons Inc.

Practicals:

1. Vogel, A.I. (1972), **Qualitative Inorganic Analysis**, Longman.
2. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
3. Marsh, D.G.; Jacobs, D.L.; Veening, H., J. Chem. Educ., Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry. 1973, 50 (9), p 626. DOI: 10.1021/ed050p626
4. <https://edu.rsc.org/experiments/catalytic-oxidation-of-potassium-sodiumtartrate/1736.article>

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 11: Chemistry of Polymers, Dyes and Natural Products

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 11: Chemistry of Polymers, Dyes and Natural Products	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the process of converting knowledge of chemistry into marketable products for commercial gain.
- To familiarize the basic nomenclature of polymers, dyes and natural products, classification and important terms.

Learning outcomes

By studying this course, students will be able to:

- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Comprehend the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.
- Understand the chemistry and applications of natural products like terpenoids and alkaloids.

Syllabus

UNIT-1: Polymers

(Hours: 12)

Introduction and classification based on origin, monomer units, thermal response, mode of formation, structure, application and tacticity; di-block, tri-block and amphiphilic polymers; Weight average molecular weight, number average molecular weight, glass transition

temperature (T_g) of polymers; Polymerisation Reactions-Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes.

Preparation and applications of: Plastics -thermosetting (phenol-formaldehyde, polyurethanes) and thermosoftening(PVC, polythene); Fabrics -natural (cellulose and synthetic derivatives of cellulose like rayon and viscose); synthetic (acrylic, polyamide, polyester); Rubbers-natural and synthetic: Buna-N, Buna-S, Neoprene, silicon rubber; Vulcanization; Polymer additives; Introduction to Specialty Polymers: electroluminescent (Organic light emitting diodes), conducting, biodegradable polymers and liquid crystals.

UNIT 2: Dyes

(Hours: 08)

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing. Synthesis and applications of Azo dyes – Methyl orange, Congo red; Triphenyl methane dyes- Crystal violet; Phthalein Dyes – Phenolphthalein; Natural dyes –Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

Unit 3: Natural Product Chemistry- An Introduction to Terpenoids and Alkaloids

(Hours: 10)

Terpenes: Introduction, occurrence, classification, uses, isoprene and special isoprene rule; structure elucidation, synthesis and industrial application of citral.

Alkaloids: Introduction, occurrence, classification, uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.

Practicals:

-

Credits: 02

(Laboratory periods: 60)

1. Preparation of Starch-PVA Film.
2. Recycling of Plastic: Moulding of plastic or Cracking of plastic.
3. Preparation of Urea-formaldehyde resin.
4. Preparation of Methyl Orange.
 - (a) Dyeing of different fabrics (cotton, wool, silk) using Alizarin or any other dye.
 - (b) Preparation of azo dye on the surface of the fabric.
5. Qualitative test for identification of alkaloids (Dragendorff Reagent and Mayer's reagent test) and terpenoids (Salkowski test).
6. Preparation of Malachite Green.
7. Preparation of perichromic dye using p-amino Phenol and p-nitro benzaldehyde.

References:

Theory

1. Finar, I.L. (2008), **Organic Chemistry**, Volume 2, 5th Edition, Pearson Education
2. Saunders, K. J. (1988), **Organic Polymer Chemistry**, 2nd Edition Chapman & Hall, London
3. Campbell, Ian M., (2000), **Introduction to Synthetic Polymers**, 2nd Edition Oxford University Press, USA.
4. Bahadur, P. and Sastry, N.V. (2002) **Principles of Polymer Science** Narosa Publications, New Delhi
5. Patrick, G. **An Introduction to Medicinal Chemistry** (2013), 4th Edition, Oxford University Press.

6. Priscilla Abarca, Patricia Silva, Iriux Almodovar and Marcos Caroli Rezende* Quim. Nova, Vol. 37, No. 4, 745-747, 2014. <http://dx.doi.org/10.5935/0100-4042.20140120>

Practical:

1. Ashraf S.M., Ahmad S., Riaz U., **A Laboratory Manual of Polymers**, I. K. International Publishing House Pvt. Ltd., New Delh.
2. Hannaford FA J., Smith P. W. G. & Tatchell A. R.; **Vogel's Textbook of Practical Organic Chemistry** Fifth Edition, Longman Scientific and Technical.
3. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 12: Biophysical Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 12: Biophysical Chemistry	04	02	-	02	Class XII with Science	

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide students with a sound background of latest techniques used in biophysical research
- To provide them with an understanding of the principles underlying these techniques.

Learning outcomes

By studying this course, students will be able to:

- The students will acquire knowledge of structure and biological functions of proteins and enzyme.
- Students will acquire knowledge about the principles and applications of latest methods used to analyse amino acid and proteins.
- The course will also provide students an opportunity for hands-on-experience to develop their laboratory skills expected for working in a biophysical research lab.

Syllabus

Unit I: Fundamentals of Biological Macromolecules (Hours: 10)

Structure and physical properties of amino acids, structure, function, and folding of proteins, internal rotational angle, conformations of proteins (Ramachandran plot, secondary, tertiary and quaternary structure). Structures of nucleic acids, Properties of nucleosides and nucleotides; composition of nucleic acids, Stabilizing interactions in biomolecules.

Unit II: Biophysical techniques for the Structural and Conformational Analysis (Hours: 20)

Overview : General principle and qualitative treatment of the techniques to understand the structure and characteristics of enzymes, protein and nucleic acid: X-ray crystallography – protein crystals, myoglobin, nitrogenase, pepsinogen; NMR spectroscopy-NMR spectra of

amino acids, UV-vis absorption spectroscopy, Fluorescence spectroscopy and Vibrational spectroscopy. Determination of protein structures by spectroscopic methods (FTIR, NMR), thermodynamics of protein folding by spectroscopic methods, protein conformational study by NMR and fluorescence spectroscopy. Methods for the separation of biomolecules: General principles, including Chromatography; Sedimentation, Moving Boundary Sedimentation, Electrophoresis, Isoelectric focusing.

Practical Component

Credits: 02

(Laboratory periods: 60)

1. Separate and identify amino acids by paper chromatography.
2. Determine the isoelectric point of the given proteins.
3. Estimation of Proteins by Biuret, Lowry and Bradford.
4. Estimation of Urea.
5. Separation and identification of Sugars/lipids by TLC.
6. To check the purity of the proteins by calculating A260/ A280 ratio spectrophotometrically.
7. Agarose gel electrophoresis to check the size of DNA (For example- Calf ThymusDNA).
8. Characterization of the DNA (genomic/ designed oligonucleotide) as a function of pH, salt-concentration spectrophotometrically.
9. Determination of the isobestic point by titrating DNA sample with any ligand using UV- Visible spectrophotometer.
10. SDS-PAGE analysis of proteins.

References:

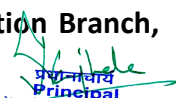
Theory:

1. Lesk, A.M., **Introduction to Protein Science: Architecture, Function, and Genomics**, 2nd edition, 2010, Oxford University Press.
2. Cantor, C.R. and Schimmel, P.R., **Biophysical Chemistry**, 1980, Freeman.
3. Van Holde, K.E., Johnson, W.C. and Ho, P.S., **Principles of Physical Biochemistry**, 2nded, 2006, Pearson Education.
4. Harding, S.E. and Chowdhry, B. Z. **Protein-Ligand Interactions**, Oxford University Press.

Practical:

1. Hofmann, A., Clokie, S., Wilson and Walker's Principles & Techniques of Practical Biochemistry, 2018, Cambridge University Press.
2. Friefelder D. **Physical Biochemistry- Application to Biochemistry and Molecular Biology**, 1983, WH Freeman and Company.
3. R. N. Roy, **Viva and Practical Physiology, Biochemistry and Biophysics**, 1998, Books and allied Pvt. Ltd.
4. Sawhney, S.K. and Singh, R., **Introductory Practical Biochemistry**, 2nd Edition, 2005, Alpha Science International.
5. Keith Wilson, John Walker, John M. Walker **Principles and Techniques of Practical Biochemistry**, 5th Edition, 2000, Cambridge University Press.

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CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Research Methodology for Chemists (DSE-13)	04	03	--	01	Class 12 th with Physics, Chemistry	

Learning objectives

The objectives of this course are as follows:

- To make the students aware of fundamental but mandatory ethical practices in chemistry.
- To introduce the concept of data analysis.
- To learn to perform literature survey in different modes.
- To make the students aware of safety handling and safe storage of chemicals.
- To make students aware about plagiarism and how to avoid it.
- To teach the use of different e-resources.

Learning outcomes

By studying this course, students will be able to:

- Follow ethical practices in chemistry
- Do Data analysis
- Literature survey in different modes
- Use e-resources.
- Avoid plagiarism, understand the consequences and how to avoid

SYLLABUS OF DSE-13

UNIT – 1: Scope of Research

(Hours: 3)

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.

UNIT – 2: Literature Survey, Databases and Research metrics

(Hours: 15)

Print: Sources of information: Primary, secondary, tertiary sources; Journals; Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of Science.

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Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN

UNIT – 3: Communication in Science

(Hours: 12)

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis.

Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chems sketch etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

UNIT – 4: Research and Publication ethics

(Hours: 9)

Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkund etc), redundant duplications

Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals

IPR - Intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS)

UNIT – 5: Statistical analysis for chemists

(Hours:

6)

Types of data, data collection-Methods and tools, data processing, hypothesis testing, Normal and Binomial distribution, tests of significance: t-test, F-test, chi- square test, ANOVA, multiple range test, regression and correlation.

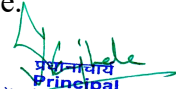
Features of data analysis with computers and softwares -Microsoft Excel, Origin, SPSS

Practical component

Credits: 01

(Laboratory periods:15 classes of 2 hours each)

12. Collection of journal articles on a particular topic using Google Scholar and creating a database.
13. Collection of journal articles on a particular topic using Science Direct and creating a database.
14. Collection of journal articles on a particular topic using Scopus and creating a database.
15. Drawing chemical structure, reactions and mechanisms using Chems sketch or ISIS draw or any other software.
16. Collection of chemical structure using ChemSpider and creating a database.
17. Curve fitting using freely available softwares/apps (any one)


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18. Making of power point presentation
19. Experimental learning of safe storage hazardous chemicals
20. Experimental learning of handling of hazardous chemicals
21. Technical writing on topics assigned.
22. Demonstration for checking of plagiarism using recommended software

Essential/recommended readings:

7. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
8. Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
9. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
10. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
11. Levie, R. de, how to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
12. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
OSU safety manual 1.01

Bachelor of Sciences in Industrial Chemistry

Category II

Industrial Chemistry Course for Undergraduate Programme of study with
Industrial Chemistry as one of the Core Disciplines

SEMESTER IV

DISCIPLINE SPECIFIC CORE COURSE – 10: (DSC-10) PHARMACEUTICALS, COSMETICS AND PESTICIDES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pharmaceuticals, Cosmetics and Pesticides (DSC-10: Industrial Chemistry -IV)	04	02	--	02	Physics, Chemistry, Mathematics, in Class XII	NIL

Learning Objectives

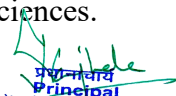
The Learning Objectives of this course are as follows:

- To impart basic knowledge of chemistry of inorganic materials such as silicates, non-silicates, ceramics, and cement.
- To enrich students with the knowledge of various types of batteries like Pb acid Battery, Li-ion Battery, Fuel Cells, Solar cell and Polymer cell.
- To impart the theoretical and practical knowledge of estimation and determination of various industrially important chemicals.

Learning outcomes

By the end of this course, students will be able to:

- Establish an appreciation of the role of inorganic chemistry in the chemical sciences.
- Analyse inorganic materials like silicates, ceramics and cement.


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- Familiarized with scientific method of planning, developing, conducting, reviewing and reporting experiments.
- Draw various concepts of industrial metallurgy which will help them to explore new innovative areas of research.
- Explain scientific methods employed in inorganic chemistry.

SYLLABUS OF DSC-10

Unit 1: Drugs and Pharmaceuticals

Hours: 12

Drug discovery, design and development. Synthesis of the representative drugs of the following classes: analgesics, antipyretics, antiinflammatory agents (Aspirin, Paracetamol.), antibiotics (Penicillin, Cephalosporin, Chloromycetin, Streptomycin and Chloramphenicol), antibacterial and antifungal agents (Sulphonamides, Sulfamethoxazole), antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular drugs (Glyceryl trinitrate), antileprosy drug (Dapsone).

Unit 2: Cosmetics

Hours: 08

Introduction to cosmetics and perfumes, preparation and uses of the following: Hair dye, hair spray. Shampoo. Sun-tan lotions, face powder, lipsticks. talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants.

Unit 3: Pesticides

Hours: 10

Introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides. Synthesis and technical manufacture, uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene), Organophosphates (Malathion, Parathion), Carbamates (Carbofuran and carbaryl), Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Practical

(Credits: 2, Laboratory periods: 60)

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of nail enamel
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of Aspirin and its analysis.
7. Preparation of nail polish and nail polish remover.
8. To calculate acidity in a given sample of pesticide formulations as per BIS specifications.
9. To calculate alkalinity in a given sample of pesticide formulations as per BIS specifications.
10. Preparation of Antacid.
11. Preparation of paracetamol.

References (Theory and practical):

1. Vermani, O. P.; Narula, A. K. (2004), **Industrial Chemistry**, Galgotia Publications Pvt. Ltd., New Delhi.
2. Bhatia, S. C. (2004), **Chemical Process Industries**, Vol. I & II, CBS Publishers, New Delhi.
3. Barel, A.O.; Paye, M.; Maibach, H.I.(2014), **Handbook of Cosmetic Science and Technology**, CRC Press.
4. Gupta, P.K.; Gupta, S.K.(2011), **Pharmaceutics and Cosmetics**, Pragati Prakashan
5. Butler, H. (2000), **Poucher's Perfumes, Cosmetic and Soap**, Springer.
6. Kumari, R.(2018), **Chemistry of Cosmetics**, Prestige Publisher.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 11: Chemistry of Carboxylic acids & derivatives, Amines and Heterocycles

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Carboxylic Acids & their Derivatives, Amines and Heterocycles DSC-10: Chemistry-IV	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students learn about the chemistry of carboxylic acids and their derivatives (aliphatic and aromatic)
- To give basic understanding of amines (aliphatic & aromatic), diazonium salts
- To provide basic understanding of heterocyclic systems.

Learning outcomes

By studying this course, students will be able to:

- Understand reactions of carboxylic acids, esters, amides, amines and diazonium salts
- Understand the concept of protection and deprotection.
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Gain theoretical understanding of chemistry of heterocyclic compounds.

Syllabus

Unit 1: Carboxylic Acids and their Derivatives (aliphatic and aromatic)

(Hours: 13)

Preparation: Oxidation reactions of alcohols, aldehydes and ketones, Acidic and alkaline hydrolysis of esters; Reactions: Hell-Volhard Zelinsky reaction,

Carboxylic acid derivatives (aliphatic): Preparation: Acid chlorides, anhydrides, esters and amides from acids and their interconversion, Claisen condensation. Reactions: Relative reactivities of acid derivatives towards nucleophiles, Reformatsky reaction, Perkin condensation.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of ethyl acetoacetate

Unit 2: Amines (aliphatic & aromatic) and Diazonium Salts (Hours:10)

Amines

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hoffmann bromamide reaction. Reactions: Hoffmann vs Saytzeff elimination, carbylamine test, Hinsberg test, reaction with HNO_2 , Schotten-Baumann reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation; basicity of amines.

Diazonium salt

Preparation: from aromatic amines; Reactions: conversion to benzene, phenol and dyes.

Unit 3: Heterocyclic Compounds

(Hours: 7)

Introduction, classification, structure, nomenclature and uses. Preparation and properties of the following heterocyclic compounds with reference to electrophilic and nucleophilic substitution: furan, pyrrole, thiophene, and pyridine.

Practical Component:**Credits: 02****(Laboratory periods: 60)**

3. Systematic qualitative analysis and preparation of suitable crystalline derivative (carboxylic acids, carbonyl, alcohols, phenols, amines (1° , 2° , 3°) and amides).
4. Preparation:
 - a. Acetylation of Aniline and Phenols.
 - b. Benzoylation of Aniline and phenols

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References:**Theory:**

5. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. **Organic Chemistry** (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), **Intermediate for Organic Synthesis**, I.K. International.
8. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016), **Organic Chemistry**, 12th Ed., Wiley.

Practical:

7. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry**, University Press (India) Ltd.
8. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
9. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
10. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume II**, I K International Publishing House Pvt. Ltd., New Delhi.
11. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
12. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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Bachelor of Sciences in Industrial Chemistry

SEMESTER V

DISCIPLINE SPECIFIC CORE COURSE – 13: (DSC-13) INDUSTRIAL CATALYSTS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Industrial Catalysts (DSC-13: Industrial Chemistry -V)	04	02	--	02	Physics, Chemistry, Mathematics, in Class XII	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To impart basic knowledge of catalysis, properties of catalysts and mode of action of catalyst.
- To enrich students with the knowledge of various types of catalysts such as organometallic catalyst, biocatalyst, shape selective catalyst and photocatalysts.
- To impart the theoretical and practical knowledge of catalysts with the view of their industrial applications.

Learning Outcomes:

By the end of this course, students will be able to:

- Establish an appreciation of the role of catalyst in industrial applications.
- Gain sound knowledge of various types of catalyst.
- Get skilled in the scientific method of planning, developing, conducting, reviewing and reporting experiments.
- Get skilled concepts of industrial catalysis which will help them to explore new innovative areas of research.

Unit 1: Introduction of Catalyst

Hours: 8

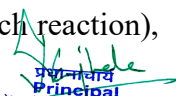
General principles of catalysis, properties of catalysts, Mode of action of catalyst, Types of catalyst (homogeneous and heterogeneous catalysis), Deactivation and regeneration of catalysts, catalytic poison, Promoter, Turnover frequency, Turnover number, Specificity and selectivity

Unit 2: Catalysis by Organometallic Compounds

Hours: 6

Study of the following industrial processes, catalytic cycle and their mechanism:

Alkene hydrogenation (Wilkinson's Catalyst), Synthetic gasoline (Fischer Tropsch reaction), Polymerisation of ethene using Ziegler-Natta catalyst


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Unit 3: Biocatalysis

Hours: 5

Introduction, Kinetics of enzyme-catalysed reactions, Industrial process with biocatalyst, Aspartame through enzymatic peptide synthesis, 4-Hydroxyphenoxypionic acid as herbicide intermediate

Unit 4: Shape selective catalysis: Zeolites

Hours: 6

Composition and structure of Zeolites, Catalytic properties of Zeolites, Shape selectivity, Isomorphic substitution of Zeolites, Metal doped Zeolites, Applications of Zeolites

Unit 5: Photocatalysis

Hours: 5

Basic principle, Photoreduction and oxidation of water, Water reduction, Water oxidation, Photocleavage of water

Practical

(Credits: 2, Laboratory periods: 60)

1. Catalytic bromination of benzene. Catalyst: $\text{FeCl}_3/\text{AlCl}_3$
2. Catalytic chlorination of benzene. Catalyst: $\text{FeCl}_3/\text{AlCl}_3$
3. Catalytic Removal of Bromates from polluted Water: Synthesis of catalyst one lab, Removal of Bromates one lab.
4. Phase-Transfer Catalytic Reactions
5. Catalytic oxidation of ammonia using chromium(III) oxide as a catalyst. Catalytic Friedel-Craft reaction using AlCl_3 and Lewis acid catalyst. Synthesis of toluene.
6. Synthesis of "Zeolite A" catalyst.
7. Zeolite Hydrogen-Y or $\text{dil.HCl}/\text{dil.H}_2\text{SO}_4$ as a Catalyst for the Preparation of an Ester.
8. Synthesis of biaryl using palladium catalyst.
9. Catalytic Transfer Hydrogenation of Castor Oil
10. Reduction of Nitrobenzene

References (Theory):

1. Huheey, J. E.; Keiter, E.A.; Keiter, R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
2. Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry**, Wiley-VCH.
3. Jens Hagen (2015) **Industrial Catalysis: A Practical Approach** Wiley-VCH Verlag GmbH & Co

References (Practical):

1. Cerrillo, J. L.; López-Hernández, I.; Palomares, A. E. **Catalytic Removal of Bromates from Water: A Hands-On Laboratory Experiment to Solve a Water Pollution Problem through Catalysis** J. Chem. Educ. 2021, 98, 1726–1731.
2. Shabestary, N.; Khazaeli, S.; Hickman, R.; **Phase-Transfer Catalytic Reactions** Journal of Chemical Education, 1998, 75, 1470-1472.
3. Volkovich, V. A.; Griffiths, T. R.; **Catalytic Oxidation of Ammonia: A Sparkling Experiment** J. Chem. Educ. 2000, 77, 2, 177.

- Williams, D. J.; Huck, B. E.; Wilkinson, A. P. **First-Year Undergraduate Laboratory Experiments with Zeolites** *Chem. Educator* 2002, 7, 33–36.
- Coker, E. N.; Davis, P. J.; **Experiments with Zeolites at the Secondary-School Level: Experience from The Netherlands** *Journal of Chemical Education* 1999, 76, 10, 1417.
- Hanson RW. **Catalytic transfer hydrogenation reactions for undergraduate practical programs.** *J Chem Educ.* 2009, 74, 430.
- Alwaseem H, Donahue CJ, Marincean S. **Catalytic transfer hydrogenation of castor oil.** *J Chem Educ.* 2014; 91, 575–8.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 14: COORDINATION CHEMISTRY AND ORGANOMETALLICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Coordination Chemistry and Organometallics DSC-13: Chemistry- V	04	02	-	02	Class 12th with Physics, Chemistry, Mathematics	

Learning Objectives

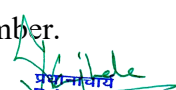
The Learning Objectives of this course are as follows:

- To develop basic understanding of coordination chemistry and organometallics which are of immense importance to biological systems, qualitative quantitative analysis, catalysis, medicines, paints and pigments etc.
- The students learn nomenclature, isomerism and bonding in coordination compounds with special emphasis on important coordination compounds in the biological system.
- To understand classification of organometallic compounds, the concept of hapticity and the 18-electron rule governing the stability of a wide variety of organometallic species with special emphasis on metal carbonyls.

Learning outcomes

By studying this course, students will be able to:

- Understand terms: ligand, denticity of ligands, chelate, coordination number.
- Systematically name coordination compounds.


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- Discuss the various types of isomerism possible in Octahedral and Tetrahedral coordination compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
- Learn how IR data can be used to understand extent of back bonding in metal carbonyls.

Syllabus

Unit 1: Introduction to Coordination compounds (Hours: 6)

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands. Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Unit 2: Bonding in Coordination Compounds (Hours: 14)

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes, Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields, Crystal field stabilization energy (CFSE), concept of pairing energy, Factors affecting the magnitude of Δ , Spectrochemical series, Splitting of d orbitals in tetrahedral symmetry, Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry, Jahn-Teller distortion

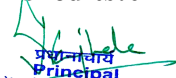
Unit 3: Organometallic Chemistry (Hours: 10)

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, sigma, pi and multicentre bonds), Structure and bonding of methyl lithium and Zeise's salt, Structure and bonding of ferrocene, mononuclear and polynuclear carbonyls of 3d metals, 18-electron rule as applied to carbonyls, π -acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Practical Component

(Laboratory periods:60)

Credits:02


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8. Estimation of Mg^{2+} by direct complexometric titrations using EDTA.
9. Estimation of Zn^{2+} by direct complexometric titrations using EDTA.
10. Estimation of Ca^{2+} by direct complexometric titrations using EDTA.
11. Estimation of total hardness of a given sample of water by complexometric titration.
12. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1, 10- phenanthroline complex in solution by Job's method.
13. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} -1,10- phenanthroline complex in solution by mole ratio method
14. Preparation of the following inorganic compounds:
 - a). Tetraamminecopper(II) sulphate
 - b). Potassium trioxalatoferrate(III) trihydrate
 - c). Chrome alum
 - d). *Cis*- and *trans*-Potassium diaquadioxalatochromate(III)
8. Any suitable experiment (other than the listed ones) based upon complexation reactions.

References:

Theory:

17. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
18. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
19. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
20. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition, Wiley India.
21. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
22. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier.
23. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.

Practicals:

4. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
5. Marr, G.; Rockett, B.W. (1972), Practical Inorganic Chemistry, Van Nostrand Reinhold.
6. Dua A, Manav N, **Practical Inorganic Chemistry**, (2017), Manakin Press.

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Bachelor of Sciences in Industrial Chemistry

SEMESTER VI

DISCIPLINE SPECIFIC CORE COURSE – 16: (DSC-16) FOOD ADDITIVES, CONTAMINATION AND SAFETY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Additives, Contamination and Safety (DSC-16: Industrial Chemistry - VI)	04	02	--	02	Physics, Chemistry, Mathematics, in Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the chemistry of food additives and their applications.
- To impart theoretical and practical knowledge on common food additives, contaminants and adulterants.
- To enhance the understanding of safety measures of food and evaluation techniques to determine toxicity of additives.
- To enhance knowledge about regulations and monitoring agencies of food.

Learning Outcomes:

By the end of this course, students will be able to:

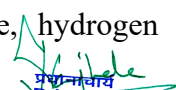
- Understand and describe applications of various food additives in food processing and preservation.
- Know the merits and demerits of synthetic and natural colouring, flavouring and sweetening agents as food additives.
- Identify and prevent potential sources of food contamination
- Know Safety measures of food additives, regulations and monitoring agencies and toxicological evaluation of additives.

Unit 1: Food Additives

Hours: 12

Introduction, need of food additives in food processing and preservation. Characteristics and classification of food additives.

Antimicrobial agents. -Nitrites, sulphides, sulphur dioxide, sodium chloride, hydrogen peroxide.


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Antioxidants - Introduction, mechanism of action, natural and synthetic antioxidants, technological aspect of antioxidants.

Sweeteners- Introduction, importance, classification- natural and artificial, chemistry, technology and toxicology, consideration for choosing sweetening agents.

Colors- Introduction, importance, classification- natural, artificial, and natural identical, FD&C Dyes and Lakes. polymeric colors.

Unit 2: Food Contamination & adulterants

Hours: 12

Contamination in Food: Physical, chemical contaminants- heavy metals, pesticide residues, agrochemicals, Antibiotics and Veterinary Drug residues, environmental pollutants, radionuclides, solvent residues, NOTS (Naturally Occurring Toxic Substances)

Contaminants formed during processing & packaging – nitrosamines, acrylamide, alloys, benzene, dioxins, furans, persistent organic pollutants, polymers, PAH (Polycyclic Aromatic Hydrocarbons) in smoked foods, food. fumigants, autooxidation products.

Food adulteration - Common adulterants in foods and tests to detect common adulterants.

Unit 3: Food Safety, Risks and hazards

Hours: 6

Food related hazards, regulations and monitoring agencies, interaction of additives with food ingredients and their toxicological aspects, quality evaluation of additives and contaminants, Acute and chronic studies, NOEL, ADI, LD50

Practical

Credits: 02, Laboratory periods: 60)

1. Determination of moisture content of foods by oven drying.
2. Determination of reducing and total sugar content in foods.
3. Chromatographic Separation and identification of sugars and amino acids.
4. Testing of turmeric powder, milk and mustard oil for adulterants.
5. Extraction of natural coloring and flavoring agent from flowers and fruits
6. Inspection of various food grains- cereals and coarse cereals
7. Determination of quality standards and inspection of spices and condiments.
8. Qualitative tests for hydrogenated fats, butter, and ghee.
9. Estimation of sulphur dioxide in beverages.
10. Qualitative estimation of benzoic acid in ketchup and sauces.
11. Chromatographic estimation of colour.
12. Study the effect of aerial oxidation of food.

References (Theory):

1. DeMan. (2007). **Principles of Food Chemistry**. Springer, 3rd edition
2. Emerton, V, (2008). **Food Colours**. Blackwell Publishing.
3. Wilson, R. (2007). **Sweeteners**. Blackwell Publishing.
4. Fennema OR. (1996). **Food Chemistry**. Marcel Dekker.
5. Pieternel A, Luning. & Willem, J. Marcelis. (2009). **Food Quality Management Technological and Managerial principles and practices**. Wageningen.

References (Practical):

1. Ranganna, S., & Ranganna, S. (2003). **Handbook of analysis and quality control for fruit and vegetable products**. New Delhi: Tata McGraw-Hill
2. Nielsen, S. S. (2017). **Food analysis**.
3. Vogel, Arthur I. (Arthur Israel). (1989). **Vogel's textbook of quantitative chemical analysis**. Harlow, Essex, England : New York :Longman Scientific & Technical ; Wiley,

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Quantum Chemistry and Spectroscopy DSC-16: Chemistry- VI	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the concepts and methodology of quantum mechanics
- Application of Quantum chemistry to spectroscopy
- To establish the relation between structure determination and spectra.

Learning outcomes

By studying this course, students will be able to:

- Understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions.
- Understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra.

Syllabus

Unit 1: Quantum Chemistry

(Hours: 16)

Postulates of quantum mechanics, quantum mechanical operators.

Schrodinger equation and its application to free particle and particle in a 1-D box (complete solution), quantization, normalization of wave functions, concept of zero-point energy.

Qualitative treatment of H and H like atoms. Setting up of Schrodinger equation for many electron atoms.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels.

Unit 2: Spectroscopy

(Hours: 14)

Electromagnetic radiation and its interaction with matter. Lambert-Beer's law, Jablonski's diagram. Florescence and Phosphorescence.

Difference between atomic and molecular spectra. Born- Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.

Microwave Spectroscopy: Microwave (pure rotational) spectra of diatomic molecules. Selection rules.

Structural information derived from rotational spectroscopy.

IR Spectroscopy: Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free electron model and its application to electronic spectra of polyenes. chromophores, auxochromes, bathochromic and hypsochromic shifts.

Practical component

Credits:02

(Laboratory Periods: 60)UV/Visible spectroscopy

19. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
20. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$
21. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2- propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colorimetry

22. Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4/$ $\text{KMnO}_4/ \text{K}_2\text{Cr}_2\text{O}_7/\text{CoCl}_2$ in a solution of unknown concentration
23. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.
24. Study the kinetics of iodination of propanone in acidic medium.
25. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
26. Determine the dissociation constant of an indicator (phenolphthalein).

27. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

References:

Theory:

1. Banwell, C.N.; McCash, E.M.(2006), **Fundamentals of Molecular Spectroscopy**, Tata McGraw- Hill.
2. Kapoor, K.L.(2015), **A Textbook of Physical Chemistry**, McGraw Hill Education, Vol 4, 5th Edition, McGraw Hill Education.
3. McQuarrie, D.A.(2016), **Quantum Chemistry**, Viva Books.
4. Chandra, A. K.(2001), **Introductory Quantum Chemistry**, Tata McGraw-Hill.
5. Dua A and Tyagi P, **Molecular Spectroscopy: Quantum to Spectrum**, (2022) Atlantic Publishers & Distributors Pvt Ltd.
6. Dua A, Singh C, **Quantum Chemistry: Classical to Computational** (2015) Manakin Press.

Practical:

7. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
8. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
9. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Additional Resources:

5. Castellan, G. W .(2004), **Physical Chemistry**, Narosa.
6. Petrucci, R. H.(1989), **General Chemistry: Principles and Applications**, Macmillan Publishing

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Pool of Discipline Specific Elective Courses (DSE)

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Green Chemistry	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the society to become more and more environmentally conscious by knowing huge rise in environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up has forced.
- To improve the creative and innovative thinking in undergraduate students towards sustainable practices of Green Chemistry. has arisen from these concerns.
- To know the Green chemistry in a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. To trained them to practice chemistry in the safest way in the laboratories as well as the chemical industry and extends to society in a sustainable future for the planet.

Learning Outcomes:

By the end of this course, students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- Appreciate the use of catalyst over stoichiometric reagents
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.
- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD)
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry

Unit 1: Introduction

Hours :08

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

- Need of green chemistry
- Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).
- A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit 2: Twelve Principles of Green Chemistry

Hours : 12

The twelve principles of the Green Chemistry with their explanations, Special emphasis on the following:

- Prevention of waste / byproducts, pollution prevention hierarchy.
- Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.
- Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.
- Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
- Green energy and sustainability.
- Real-time analysis for pollution prevention.
- Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carbaryl) and Flixborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation

Unit 3:

Hours : 10

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical

(Credits: 02, Laboratory periods: 60)

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
4. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
5. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
6. Mechanochemical solvent free, solid-solid synthesis of azomethine using *p*-toluidine and *o*-vanillin/*p*-vanillin.
8. Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (*cis-trans* isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

References (Theory):

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry**, American Chemical Society, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

References (Practical):

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
4. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
5. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.
6. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analytical Methods in Chemistry	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the students aware of the concept of sampling, accuracy, precision, statistical test data-F, Q and t test.
- To learn the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectrum, Thermal and electroanalytical methods of analysis.
- To learn important separation methods like solvent extraction and chromatography. The practical exposure to the latest instrumentation and to detect analytes in a mixture.

Learning Outcomes:

By the end of this course, students will be able to:

- Perform experiments with accuracy and precision.
- Develop methods of analysis for different samples independently.
- Test contaminated water samples.
- Understand basic principles of instruments like Flame Photometer, UV-vis spectrophotometer.
- Learn separation of analytes by chromatography.
- Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.
- Determine composition of soil.
- Estimate macronutrients using Flame photometry.

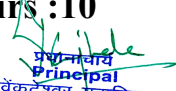
Unit 1: Qualitative and quantitative aspects of analysis

Hours : 04

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression. Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit 2: Optical methods of analysis

Hours :10


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Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Transmittance. Absorbance and Beer-Lambert law. Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs).

Unit 3: Thermal methods of analysis

Hours :04

Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser. Techniques for quantitative estimation of Ca and Mg from their mixture.

Unit 4: Electroanalytical methods

Hours :04

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit 5: Separation techniques

Hours :08

Solvent extraction: Classification, principle and efficiency of the technique. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion-exchange, Development of chromatograms: frontal, elution and displacement methods.

Practical

(Credits: 02, Laboratory periods: 60)

1. Separation of mixtures by paper chromatography and reporting the R_f values:

- (i) Co²⁺ and Ni²⁺.
- (ii) Amino acids present in the given mixture.

2. Solvent Extractions

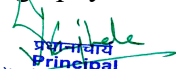
To separate a mixture of Ni²⁺ & Fe²⁺ by complexation with DMG and extracting the Ni²⁺ DMG complex in chloroform, and determine its concentration by spectrophotometry.

3. Analysis of soil:

- (i) Determination of pH of soil.
- (ii) Total soluble salt
- (iii) Estimation of calcium and magnesium
- (iv) Qualitative detection of nitrate and phosphate

4. Ion exchange:

- (i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
- (ii) Separation of amino acids from organic acids by ion exchange chromatography.


Principal
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Sri Venkateswara College
दिल्ली विश्वविद्यालय / University of Delhi
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5. Spectrophotometry

- (i) Verification of Lambert-Beer's law and determination of concentration of a coloured species (CuSO_4 , KMnO_4 , CoCl_2 , CoSO_4)
- (ii) Determination of concentration of coloured species via following methods;
 - (a) Graphical method
 - (b) Epsilon method
 - (c) Ratio method
 - (d) Standard addition method

References (Theory):

1. Willard, H.H.(1988), **Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D.(2004), **Analytical Chemistry**, 7th Edition, John Wiley & Sons, New York.
3. Harris, D. C.(2007), **Quantitative Chemical Analysis**, 7th Edition, Freeman.
4. Khopkar, S.M. (2008), **Basic Concepts of Analytical Chemistry**, New Age International Publisher.
5. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2017), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.

References (Practical):

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basics of Polymer Chemistry	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To help the student to know about the synthesis, properties and applications of polymers.
- To give glimpse of polymer industry to the student and help them to choose their career in the field of polymer chemistry.

Learning Outcomes:

By the end of this course, students will be able to:

- Know about history of polymeric materials and their classification
- Learn about different mechanisms of polymerization and polymerization techniques
- Learn about different methods of finding out average molecular weight of polymers
- Differentiate between glass transition temperature (T_g) and crystalline melting point (T_m)
- Determine T_g and T_m
- Learn properties and applications of various useful polymers in our daily life.

Unit 1: Introduction to Polymeric Materials

Hours:10

History of polymeric materials, Different schemes of classification of polymers, Polymer nomenclature

Molecular forces and chemical bonding in polymers, Physical and chemical properties of polymers

Solubility and Criteria for polymer solubility, Texture of Polymers, modification of polymers, Structure and property relationships, Introduction to conducting and biodegradable polymers.

Unit 2: Characterization of Polymers:

Hours:10

Thermal characterisation of polymer: Glass transition temperature (T_g), thermal stability and decomposition of polymers, Molecular weight of polymers (M_n , M_w , etc.) by end group analysis, viscometry, light scattering technique and osmotic pressure methods.

Structural characterisation of polymers by IR and NMR spectroscopy.

Unit 3: Preparation, Properties and Uses of Polymers:

Hours:10

Brief introduction to polymerisation, mechanism, properties and application of the following polymers: polyolefins, polystyrene, poly(vinyl chloride), poly(vinyl acetate), polyurethanes, acrylic polymers and polyamides. Phenol formaldehyde and urea formaldehyde, Silicone polymers, Conducting Polymers: polyacetylene, polyaniline, polypyrrole, polythiophene., Biopolymer: Cellulose and Chitosan.

Practical:

(Credits: 2, Laboratory periods: 60)

1. Preparation of nylon 6,6.
2. Redox polymerization of acrylamide.
3. polymerization of acrylonitrile.
4. Preparation of urea-formaldehyde resin.
5. Preparations of phenol-formaldehyde resin.

6. Determination of molecular weight of different polymers in water by viscometry.
7. Estimation of the amount of HCHO in the given solution by sodium sulphite method.
8. Demonstration for chemical structure and functional group in polymers using IR spectroscopy.
9. Purification of monomer and polymerisation of Styrene and Polymethylmethacrylate using BPO (Benzoyl Peroxide).
10. Polymerization of aniline and pyrrole by chemical polymerisation method.
11. Preparation of poly methylacrylate by emulsion and bulk polymerisation and compare the results.
12. Characterisation of polymers by IR spectroscopy.

References (Theory):

1. Ahluwalia V.K. & Mishra A. **Polymer Science :A Textbook**(2009) Anne Books.
2. Odian, G. (2004), **Principles of Polymerization**, John Wiley.
3. Billmeyer, F.W. (1984),**Text Book of Polymer Science**,3rd Ed., John Wiley.
4. Ghosh, P. (2001),**Polymer Science & Technology**, Tata McGraw-Hill.
5. Lenz, R.W. (1967),**Organic Chemistry of Synthetic High Polymers**, Interscience (Wiley).

References (Practical):

1. Hundiware ,D.G.,Athawale V.D ,Kapadi, U.R.& Gite V.V, **Experiments in Polymer Science** ,New Age International Publishers .
2. Allcock, H.R.; Lampe, F. W.; Mark, J. E. (2003), **Contemporary Polymer Chemistry**, Prentice-Hall.
3. Fried, J.R. (2003), **Polymer Science and Technology**, 2nd Ed, Prentice-Hall.
4. Munk, P.; Aminabhavi , T. M. (2002), **Introduction to Macromolecular Science**, John Wiley & Sons.
6. Sperling, L.H. (2005), **Introduction to Physical Polymer Science**, John Wiley & Sons.

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecules of Life	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To deliver information about the chemistry of carbohydrates, proteins & enzymes and its relevance in the biological system using suitable examples.
- To understand the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural details.

Learning Outcomes:

By the end of the course, the students will be able to:

- Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.
- Gain an insight into the mechanism of enzyme action and inhibition.
- Understand the basic principles of drug-receptor interaction and SAR.

Unit 1: Carbohydrates

Hours: 12

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2: Amino Acids, Peptides and Proteins

Hours: 10

Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by Edman method) and C-terminal amino acid (with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl) & C-activating groups (only DCC) and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.

Unit 3: Enzymes

Hours: 04

Classification of enzymes and their uses (mention Ribozymes). Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in enzyme action, specificity of enzyme action (including stereospecificity).

Unit 4: Nucleosides, Nucleotides and Nucleic acids

Hours: 04

Components of Nucleic acids: Adenine, guanine, thymine, cytosine and uracil (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides; structure of DNA (Watson-Crick model) and RNA (types of RNA), difference between DNA and RNA

Practical

(Credits: 02, Laboratory periods: 60)

1. Estimation of glucose by Fehling's solution.
2. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).
3. Study of the titration curve of glycine and determine the isoelectric point of glycine.
4. Estimation of proteins by Lowry's method.
5. Qualitative tests for amino acids, proteins and carbohydrates.
6. Separation and identification of mixture of sugars by paper chromatography.
7. Separation and identification of mixture of Amino acids by paper chromatography.
8. Study of the action of salivary amylase on starch under optimum conditions and find the enzyme activity.
9. Study the effect of temperature on activity of salivary amylase.
10. Extraction of DNA from onion/cauliflower.

References (Theory):

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry**, 9th Ed., W. H. Freeman Co Ltd.

References (Practical):

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. **Manual of Biochemistry Workshop**, 2012, Department of Chemistry, University of Delhi.

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Main Group Chemistry	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide basic understanding of the fundamental principles of metallurgy through study of the different methods of extraction and refining of metals.
- To illustrate the diversity and fascination of inorganic chemistry through the study of structure, properties and utilities of s- and p-block elements and their compounds

Learning Outcomes:

By the end of the course, the students will be able to:

- Understand the basis of occurrence of metals in nature and the methods that can be applied on minerals to extract the metals from them.
- Explain the importance of free energy of formation of oxides with the choice of reducing agent for extracting the metals.
- Understand and explain the importance of refining of metals and the choice of a refining procedure
- Explain the group trends observed for different properties of s and p block elements
- Explain the structures and the bonding basis of compounds of s- and p- block elements
- Explain the uniqueness observed in alkali metals and some other main group elements
- Understand and explain the polymerization of inorganic ions to generate inorganic polymers and the difference between organic and inorganic polymers.

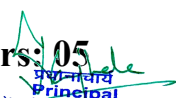
Unit 1: General Principles of Metallurgy

Hours: 06

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining.

Unit 2: General Properties

Hours: 05


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General group trends of s- and p-block elements with special reference to melting and boiling points, flame colour, metallic character and complex formation tendency, diagonal relationship and anomalous behaviour of first member of each group, Alkali metal solutions in liquid ammonia

Unit 3: Structure, Bonding, Properties and Applications Hours: 15

Structure, bonding, properties (Acidic/Basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, thermal stability) and applications of the following:

Crown Ethers and cryptates of Alkali metals

Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.

Oxides: Oxides of nitrogen, phosphorus and sulphur.

Oxoacids: oxoacids of phosphorus, sulphur and chlorine

Halides of phosphorus

Unit 4: Inorganic Polymers Hours: 04

Preparation, properties, structure and uses of the following:

Borazine, Silicates and Silicones

Practical

(Credits: 02, Laboratory periods: 60)

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations (preferably 7-8 mixtures). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-} , NO_2^- , S^{2-} , SO_3^{2-} , SO_4^{2-} , $\text{S}_2\text{O}_3^{2-}$, CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$, PO_4^{3-} , NH_4^+ , K^+ , Pb^{2+} , Cu^{2+} , Cd^{2+} , Bi^{3+} , Sn^{2+} , Sb^{3+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+}

The mixtures may contain combination of anions/one interfering anion.

Spot tests should be preferred wherever applicable.

References (Theory):

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.

3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Housecroft, E. H.; Sharpe, A.G. (2018), **Inorganic Chemistry**, 5th Edition, Pearson.
6. F.A. Cotton & G. Wilkinson (1999), **Advanced Inorganic Chemistry**, 6th Edition, John Wiley & Sons.

References (Practical):

1. Vogel, A.I. (1972), **Qualitative Inorganic Analysis**, Longman.
2. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nanoscale Materials and their applications	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide an introduction to nanoscale materials and their applications.
- To provides an insight into bottom-up and top-down-approach, the methods of synthesis of nanoparticles, simple characterization techniques and applications of nanomaterials.

Learning Outcomes:

By the end of the course, the students will be able to:

- Understand the concept of nano dimensions.
- Know the various methods of preparation of nanomaterials.
- Understand the principles of optical and electron microscopy techniques of characterizing nanomaterials.
- Understand the Appreciate the real life applications of nanomaterials.

Unit 1: Introduction to Nanodimensions

Hours: 12

0D, 1D, 2D nanomaterials, Quantum Dots, Nanoparticles, Nanostructures (nanowires, thin films, nanorods), carbon nanostructures (carbon nanotubes, carbon nanofibers, fullerenes), Size Effects in nano systems, Quantum confinement and its consequences, Semiconductors. Band structure and band gap. Optical Properties Surface plasmon resonance

Unit 2: Preparation of Nanomaterials

Hours: 10

Top down and Bottom up approach, Photolithography. Ball milling. Vacuum deposition. Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Thermal decomposition, Chemical reduction, Sol-Gel synthesis, Hydrothermal synthesis, Spray pyrolysis, Electrochemical deposition, Pulsed Laser deposition. Characterization of nanomaterials: Basic principle of optical methods and electron microscopy.

Unit 3: Applications of Nanomaterials

Hours: 8

Nanomaterials as Catalysts, semiconductor nanomaterials as photocatalysts, Nanocomposites as catalysts. Carbon nanostructures as catalytic nanoreactors, metal and metal oxides confined inside carbon nanostructures, Nanowires and thin films for photonic devices (LEDs, solar cells, transistors).

Practical

(Credits: 02, Laboratory periods: 60)

1. Synthesis of silver nanoparticles by chemical methods and characterization using UV-visible spectrophotometer.
 - a. Turkevich Method
 - b. Burst Method
2. Synthesis of silver nanoparticles by green approach methods (using soluble starch, glucose or cinnamon bark) and characterization using UV-visible spectrophotometer.
3. Synthesis of metal sulphide nanoparticles and characterization using UV-visible spectrophotometer and determination of Band gap.
 - a. MnS
 - b. ZnS
 - c. CuS
4. Intercalation of hydrogen in tungsten trioxide and its conductivity measurement using conductometer.
5. Synthesis of pure ZnO and Cu doped ZnO nanoparticles.
6. Phytochemicals mediated synthesis of gold nanoparticles (AuNPs) using tea leaves and to study the effect of size on color of gold/silver nanoparticles.
7. Preparation of magnetic nanoparticles (MNPs) of Fe₃O₄ using green tea leaf extract

8. Any suitable experiment (other than the listed ones) based upon complexation reactions.

References (Theory):

1. West, A. R. (2014), **Solid State Chemistry and Its Application**, Wiley.
2. Smart, L. E.; Moore, E. A., (2012), **Solid State Chemistry: An Introduction**, CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J. (1997), **New Direction in Solid State Chemistry**, Cambridge University Press.
4. Poole Jr.; Charles P.; Owens, Frank J. (2003), **Introduction to Nanotechnology**, John Wiley and Sons. Harris, D. C. (2007), **Quantitative Chemical Analysis**, 6th Edition, Freeman.
5. Chattopadhyay, K.K.; Banerjee, A. N. (2009), **Introduction to Nanoscience and Technology**, PHI.

References (Practicals):

1. Orbaek, W.; McHale, M.M.; Barron, A. R.; **Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory**, J. Chem. Educ. 2015, 92, 339–344.
2. MacDiarmid, G.; Chiang, J.C.; Richter, A.F.; Somasiri, N.L.D.(1987), **Polyaniline: Synthesis and Characterization of the Emeraldine Oxidation State by Elemental Analysis**, L. Alcaer (ed.), Conducting Polymers, 105-120, D. Reidel Publishing.
3. Cheng, K.H.; Jacobson, A.J.; Whittingham, M.S. (1981), **Hexagonal Tungsten Trioxide and Its Intercalation Chemistry**, **Solid State Ionics**, 5, 1981, 355-358.
4. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; **Synthesis of ZnO Nanoparticles by Precipitation Method**, **Orient J Chem** 2015, 31(2).

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Polymers, Dyes and Natural Products	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- Introducing the students to the process of converting knowledge of chemistry into marketable products for commercial gain.
- To learn the applications of chemistry in small industries.
- To give knowledge for business opportunities for small and medium enterprises through chemistry.

Learning Outcomes:

By the end of this course the students will be able to:

- Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
- Comprehend the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.
- Understand the chemistry and applications of natural products like terpenoids and alkaloids.

Unit-1: Polymers

Hours:12

Introduction and classification based on origin, monomer units, thermal response, mode of formation, structure, application and tacticity; di-block, tri-block and amphiphilic polymers; Weight average molecular weight, number average molecular weight, glass transition temperature (T_g) of polymers; Polymerisation Reactions-Addition and condensation. Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes.

Preparation and applications of: Plastics -thermosetting (phenol-formaldehyde, polyurethanes) and thermosoftening (PVC, polythene); Fabrics -natural (cellulose and synthetic derivatives of

cellulose like rayon and viscose); synthetic (acrylic, polyamide, polyester); Rubbers-natural and synthetic: Buna-N, Buna-S, Neoprene, silicon rubber; Vulcanization; Polymer additives; Introduction to Specialty Polymers: electroluminescent (Organic light emitting diodes), conducting, biodegradable polymers and liquid crystals.

Unit-2: Dyes

Hours: 08

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing. Synthesis and applications of Azo dyes – Methyl orange, Congo red; Triphenyl methane dyes- Crystal violet; Phthalein Dyes – Phenolphthalein; Natural dyes –Structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

Unit 3: Natural Product Chemistry- An Introduction to Terpenoids and Alkaloids

Hours: 10

Terpenes: Introduction, occurrence, classification, uses, isoprene and special isoprene rule; structure elucidation, synthesis and industrial application of citral.

Alkaloids: Introduction, occurrence, classification, uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.

Practical

(Credits: 02, Laboratory periods: 60)

1. Preparation of Methyl Orange.
2. Preparation of Malachite Green.
3. Recycling of Plastic: Moulding of plastic or Cracking of plastic.
4. Preparation of Urea-formaldehyde resin.
5. (a) Dyeing of different fabrics (cotton, wool, silk) using Alizarin or any other dye.
(b) Preparation of azo dye on the surface of the fabric.
6. Qualitative test for identification of alkaloids (Dragendorff Reagent and Mayer's reagent test) and terpenoids (Salkowski test).
7. Preparation of perichromic dye using p-amino Phenol and p-nitro benzaldehyde.

References (Theory):

1. Finar, I.L. (2008), **Organic Chemistry**, Volume 2, 5th Edition, Pearson Education
2. Saunders, K. J. (1988), **Organic Polymer Chemistry**, 2nd Edition Chapman & Hall, London
3. Campbell, Ian M., (2000), **Introduction to Synthetic Polymers**, 2nd Edition Oxford University Press, USA.
4. Bahadur, P. and Sastry, N.V. (2002) **Principles of Polymer Science** Narosa, New Delhi
5. Patrick, G. **An Introduction to Medicinal Chemistry** (2013), 4th Edition, Oxford University Press.
6. Priscilla Abarca, Patricia Silva, Iriux Almodovar and Marcos Caroli ezende*Quim. Nova, Vol. 37, No. 4, 745-747, 2014. <http://dx.doi.org/10.5935/0100-4042.20140120>

Credit Distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry : IT Skills and Molecular Modelling	04	02	--	02	Class 12th with Physics, Chemistry, Mathematics	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to basic computer skills that are a must for a new age chemist.
- To acquaints the students with data tabulation, calculation, graph plotting, data analysis and document. Preparation using various software (preferably open-source).
- To learn about molecular modelling, its applications to various molecular systems, energy minimization techniques, analysis of Mulliken Charge and ESP Plots.

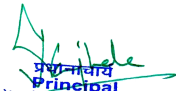
Learning Outcomes:

By the end of the course, the students will be able to:

- Become familiar with the use of computers
- Use software for tabulating data, plotting graphs and charts, carry out statistical analysis of the data.
- Solve chemistry problems and simulate graphs.
- Prepare documents that will incorporate chemical structure, chemical equations, mathematical expressions from chemistry.
- Understand theoretical background of computational techniques and selective application to various molecular systems.
- Learn ESP Plots by suitable software, electron rich and electron deficient sites.
- Compare computational and experimental results and explain deviations.
- Perform Optimization of geometry parameters of a molecule (such as shape, bond length and bond angle) through use of software like Chem Sketch and Argus Lab in interesting hands-on exercises.

Unit 1: Introduction to important software in chemistry

Hours:10


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Introduction to different software available for drawing chemical structures (Proprietary and Open-source) like ACD ChemsSketch and 3-D viewer, ChemDraw.

Carrying out simple calculations on anyone of the following software: ArgusLab, Pymol, Avogadro, Molview, MarvinSketch.

Draw structures of various compounds (aliphatic, aromatic, heterocyclic with different functional groups) using software. Save the structures in various file formats. Incorporate the structures in word document and powerpoint presentation. SMILES notation for the chemical structures. PDB Files.

Unit 2: Handling of Numerical Data

Hours:10

Using a spreadsheet software: applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R^2 value, incorporating tables and graphs in Word files, graphical solution of equations, plotting pressure-volume curves of van der Waals gases, Maxwell-Boltzmann distribution, concentration versus time graphs, spectral data, titration curves, etc.

Unit 3: Molecular Modelling

Hours: 10

Introduction to molecular modelling, overview of classical and quantum mechanical methods (semi empirical, ab initio and DFT) and molecular mechanics method

Intrinsic Reaction Coordinates, Stationary points, Equilibrium points – Local and Global minima, concept of transition state with examples.

Practical

(Credits: 02, Laboratory periods: 60)

Plotting graphs using a spreadsheet

1. van der Waals isotherms
2. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight
3. Plot the conductometric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base
4. Plot the pH metric titration curve for
 - a) strong acid vs strong base and b) weak acid vs strong base
5. Plot the graphs for the kinetics of first order reaction.

Molecular Modelling

6. Optimise and compare the geometry parameters of H_2O and H_2S using Argus Lab.

7. Compare the basicities of ammonia, methylamine, dimethylamine and trimethylamine using Argus Lab by comparing Mulliken charges and ESP maps.
8. Compare C-C bond lengths and bond order in ethane, ethene and ethyne using Argus Lab.
9. Determine enthalpy of isomerization of cis and trans-2-butene in Argus Lab.
10. Compare the HAH bond angles for the second row hydrides (BeH_2 , CH_4 , NH_3 , H_2O) and compare with the results from qualitative MO theory.

References (Theory):

1. Levie, R. de. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press.
2. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
3. Cramer, C.J.(2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
4. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.
5. Leach, A.R.(2001), **Molecular Modelling**, Prentice-Hall.

References (Practical):

1. Lewars, E. (2003), **Computational Chemistry**, Kluwer academic Publisher.
2. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
3. Hinchcliffe, A. (1996), **Modelling Molecular Structures**, John Wiley & Sons.

Note: Some of the papers are same as in B Sc (H) Chemistry and B Sc Physical Sciences.

**Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management
SEMESTER-IV**

BOTANY COMPONENT - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Phytopathology ALS BOT DSC 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

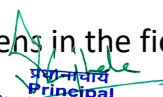
The learning objectives of this course are as follows:

- to introduce students with various fungi, fungus like organisms, bacteria and viruses.
- to give an understanding of their characteristics, reproduction and ecology.
- to introduce students with the principles and concepts of plant pathology.
- to acquaint with various plant diseases, symptomatology, causal organisms and their control measures.

Learning Outcomes:

By studying this course, students will be able to:

- understand the world of different types of pathogens of plants.
- identify the characteristic symptoms of different groups of plant pathogens in the fields.


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- understand the ecological and economical impact of plant diseases.
- identify common plant diseases and their control measures.
- understand the application and significance of integrated disease management.
- explicate the economic and pathological importance of fungi, bacteria and viruses.

Unit 1: Introduction

(3 Hours)

Definition, Concepts and Terminology; General symptoms; Classification of diseases.

Unit 2: Key events of Disease development

(6 Hours)

Disease cycle; Host pathogen relationships; Plant defence mechanism (Structural and biochemical); Epidemiology and Disease forecasting.

Unit 3: Fungal Diseases

(5 Hours)

General symptoms; Disease cycle and Control measures - Powdery mildew of Pea.

Black stem Rust of Wheat; Smut of Barley (Loose and Covered smut).

Unit 4: Diseases caused by Oomycota

(3 Hours)

General symptoms; Disease cycle and Control measures – White rust of Crucifers; Late blight of Potato.

Unit 5: Bacterial Diseases

(3 Hours)

General symptoms; Disease cycle and Control measures - Citrus canker; Angular leaf spot of Cotton.

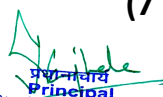
Unit 6: Viral Diseases

(3 Hours)

General symptoms; Mode of transmission and Control measures-- Tobacco mosaic disease; Vein clearing of Bhindi.

Unit 7: Plant Disease Control

(7 Hours)


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Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Predation, Induced Systemic Resistance).

PRACTICAL

(60 Hours)

1. Study of White rust of crucifers, Symptoms on leaves and hypertrophy with the help of live or preserved specimens. Study of causal organism (*Albugo candida*) with the help of temporary tease/section mount. Permanent section mount of somatic and reproductive phases.
2. Study of Late blight of Potato through specimens, temporary mounts (V.S. of leaf showing infection) and permanent slides.
3. Study of Powdery mildew of Pea, Symptoms on leaves and stem of Pea with the help of live or preserved specimens. Study of *Erysiphe* asexual stage with the help of temporary tease/ section mount and sexual stage through permanent slides.
4. Study of Black stem Rust of Wheat, Symptoms on both Wheat and Barberry with the help of live or preserved specimens/photographs. Study of *Puccinia graminis tritici* with the help of temporary tease/section mount of Wheat . Permanent slides of somatic and reproductive phases on both the hosts.
5. Study of Smut of Barley, Symptoms of Loose and Covered smut through live or preserved specimens. Study of teliospores through temporary mount.
6. Study of Bacterial Diseases through the specimens - Citrus canker; Angular leaf spot of Cotton.
7. Study of Viral Diseases through specimens - Tobacco mosaic Disease; Vein clearing of Bhindi.
8. Study of Phylloplane Mycoflora through cellotape method.

9. Study through digital images / photographs – Chlorosis, Tuber rot, Apple scab, Mycoparasite, Predaceous fungi.

Essential/ Recommended readings:

1. Oliver, R. (2023) *Agrios' Plant Pathology* 6th edition, Academic Press.
2. Agrios, G.N. (2005) *Plant Pathology* 5th edition, Elsevier Academic Press, Amsterdam.
3. Sharma, P.D. (2014) *Plant Pathology* Rastogi Publications, Meerut, U.P.
4. Singh, R.S. (2021) *Plant Diseases* 10th revised edition, Medtech, New Delhi.
5. Schumann, G.L. and D'Arcy C.J. (2009) *Essential Plant Pathology* 2nd edition, American Phytopathological Society, U.S.A.

Suggestive readings:

1. Singh, R.S. (2017) *Introduction to Principles of Plant Pathology*, 5th edition, Medtech, New Delhi.
2. Gupta, R. and Chugh, G. (2022) *Plant, Microbes and Diseases*. I.K. International Pvt. Ltd., Delhi.
3. Tronsmo A.M., Munk L., Anika D., Tronsmo A., Yuen J and Collinge D.B. (2020) *Plant Pathology and Plant Diseases*. CABI Publishing, U.S.A.
4. Ownley B.H. and Trigiano R.N. (2016) *Plant Pathology Concepts and Laboratory Exercises* 3rd edition, CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BOTANY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 02)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Crop Genetics and Plant Breeding ALS BOT DSE 02	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

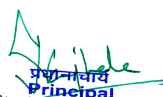
The Learning Objectives of this course are as follows:

- to develop an understanding of the concepts of plant breeding and its applications.
- to provide adequate knowledge on the natural breeding systems of different agriculturally important plant and strategies employed for crop improvement.
- to impart skills on plant genome analysis and gene mapping using DNA markers and their use in increasing efficiency of plant breeding.
- to understand the genetic basis of hybrid vigour and development of hybrid varieties.
- to make students familiar with the concept of varietal release and rights of a farmer and plant breeder.

Learning Outcome:

By studying this course, the students will be able to:

- gain knowledge on the importance of plant breeding for developing new cultivars and use of breeding strategies for improvement of crop plants.


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- understand the concept of gene pool and germplasm resources that are fundamental to crop improvement.
- explicate the breeding methods for commercially important crop plants.

Unit 1: Introduction

(2 Hours)

Importance of plant breeding and its history; Breeding systems in crop plants; Self-incompatibility, male sterility and apomixis, Important achievements in plant breeding.

Unit 2: Sources of Variation

(4 Hours)

Plant genetic resources- their management and conservation, utilization of gene pools in breeding programs. Chromosome manipulation- induced mutations, haploidy, polyploidy, somatic hybridization, somaclonal variation.

Unit 3: Conventional Breeding Methods

(8 Hours)

Selection methods for self-pollinated, cross-pollinated and vegetatively propagated crop plants; Hybridization for self-pollinated, cross-pollinated and vegetatively propagated crop plants- procedure, advantage and limitations.

Unit 4: Heterosis Breeding

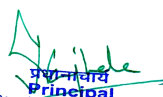
(3 Hours)

Genetic and molecular basis of heterosis (hybrid vigour); Development of hybrid varieties through exploitation of hybrid vigour. Inbreeding depression.

Unit 5: Molecular Genetics and Plant Breeding

(10 Hours)

Molecular markers as tools in plant breeding; Principle of genetic linkage; Concept of genetic distance; Development and choice of mapping populations (F_2 , NILs, RILs, BC etc); Linkage map construction; Quantitative traits - Principles and methods of QTL mapping, QTL Introgression; Marker-assisted breeding- Gene tagging; Marker-aided selection (foreground and background


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selection); Elimination of linkage drags; Marker assisted recurrent selection (MARS). Novel Plant Breeding Tools (TALEN's, CRISPR-Cas9, Base editing).

Unit 6: Intellectual Property Rights and Varietal Release

(3 Hours)

IPR, Patenting; Breeder's Right; Release of New Varieties-Trials & their evaluation, Prerelease, Notification and its Release; Plant variety protection; Farmer's Right.

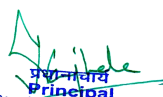
PRACTICAL

(60 Hours)

1. Introduction to open/controlled pollinations in field and laboratory (Breeders kit; temporal details of anthesis, anther dehiscence, CMS, stigma receptivity, emasculation, bagging).
2. Analysis of the breeding system of chosen crop species by calculating pollen:ovule ratio.
3. Calculation of Index of self-incompatibility (ISI).
4. Study of dominant/ codominant nature of different molecular markers.
5. Assessment of phenotypic diversity in different accessions of given plant material using morphological markers.
6. Assessment of genetic diversity and construction of dendrogram using molecular markers.
7. Phenotypic screening of a mapping population/ land races for biotic stress resistance and calculating the log of percentage severity and symptom score.
8. Study of floral biology, emasculation and hybridization techniques in self-pollinated and cross-pollinated crops.
9. Estimation of heterosis, inbreeding depression and heritability.
10. Project: Case study based on gene mapping.
11. Field trip to plant breeding station.

Essential/recommended readings

1. Acquaah, G. (2012). *Principles of Plant Genetics & Breeding*. 2nd edition. Hoboken, NJ, Wiley.


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2. Allard, R.W. (1999). *Principles of Plant Breeding*. John Wiley, New York.
3. Singh, B.D. (2022). *Plant Breeding: Principles and Methods*, 12th edition. New Delhi, Delhi: Kalyani Publishers.
4. Frey, K. J. (1982). *Plant Breeding II*. Kalyani Publishers, New Delhi.

Suggestive readings:

1. Welsh, J. R. (1981). *Fundamentals of Plant Genetics and Breeding*. John Wiley and Sons, New York.
2. Poehlman J. M. and Sleper D. A. (1995). *Breeding Field Crops*, 4th Ed. Panima Publishing Corporation, New Delhi.
3. Chopra, V.L. (2023). *Plant Breeding: Theory and Practice* 2nd Restructured Edition, New India Publishing Agency, New Delhi.

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**Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management**

SEMESTER-IV

Chemistry Component - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Agrochemistry ALS CHEM DSC 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

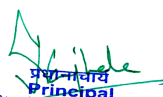
The Learning objectives of this course are as follows:

- to develop a scientific understanding of the diverse approaches to classify the agrochemicals.
- to make them familiar of chemical structure, mode of action and uses of pesticides.
- to impart the knowledge of pesticide formulation, their types, advantages and disadvantages.
- to make them aware of the hazards of agrochemicals and their impact on human health.

Learning Outcomes:

By studying this course, students will be able to:

- learn classification of pesticides.
- analyze the impact of stereochemical aspects on pesticidal activity.


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- carry out preparation of formulations and analysis.
- handle pesticides safely in view of human health and environment.

Unit 1: Pesticides

(5 Hours)

Different classes of pesticides based on use or target pests (Only definitions and examples- no structural requirement): Herbicides, Fungicides, Insecticides, Rodenticides, Acaricides, Bactericides, Chemosterillant, Molluscicide, Nematicides, Plant growth regulators, Repellents, Antifeedants, Sex attractants, Classification of pesticides based on chemical nature, mode of entry, mode of action and toxicity.

Unit 2: Herbicides

(6 Hours)

Structure, uptake, mode of action and uses along with key points on human toxicity, with special reference to the individual compounds mentioned (synthesis excluded):

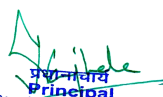
- Aryl alkanoic acids: 2, 4 D, 2,4DB, MCPA and other acid derivatives: dicamba, dichlorobenil, dalapon {along with structure-activity relationship (SAR)}
- Aromatic carbamates: Barban and asulam.
- Triazines: Simazine, Atrazine
- Bipyridinium: Paraquat
- Organophosphorous: Glyphosate
- Sulfonylurea: Chlorosulfuron
- Uracils: Bromacil
- Ureas: Monuron and Isoproturon

Unit 3: Fungicides

(6 Hours)

Structure, mode of action and uses along with key points on human toxicity, with special reference to the individual compounds mentioned (synthesis excluded):

- Copper and mercury derivatives
- Dithiocarbamates: Thiram, Ziram, Nabam
- Dinitro phenols: 2, 4-Dinitro o-Cresol (DNOC)


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- d) Quinines: Dichlone
- e) Benzimidazoles: Benomyl
- f) Organophosphorus fungicides: Kitazine
- g) Phenyl amides: Metalaxyl
- h) Triazoles: Propiconazole
- i) Thiophanates: Thiophanates

Unit 4: Conventional Pesticides

(4 Hours)

With special reference to the individual compounds mentioned (*synthesis excluded*):

Structure, pesticidal properties and stereochemical aspects (*if any*), mode of action, uses and comments on human toxicity

- a) Carbamate insecticides: Carbaryl, Methomyl
- b) Organophosphorus insecticides: Malathion, Parathion
- c) Organochlorine Insecticides: Chlordane, Heptachlor, DDT

Unit 5: Introduction to other Pesticides

(4 Hours)

Structure, stereochemical aspects (*if any*), use and toxicity of the following (*synthesis excluded*):

- a) Alkaloid family: Nicotine
- b) Pyrethrins: Pyrethrin-I and II
- c) Fumigants: Example of Halogenated Hydrocarbons
- d) Rodenticides: Inorganic and organic (Two examples each)
- e) Repellents: DEET, Diethylphthalate

Unit 6: Pesticide Formulations

(5 Hours)

1. Definition and purpose of formulations.
2. Brief discussion on the following type of formulations:
 - a) Solid formulations: dusts (D), granules (G), pellets (P), wettable powders (WP or W), dry flowable (DF), soluble powders (SP); poison baits (B)

- b) Liquid formulations: emulsified concentrates (EC or E), solutions, flowing suspensions (F or L), Suspension Concentrate (SC), aerosols (A)
- c) Other type of formulations: fumigants (F); microencapsulated product (M) for controlled-release.

PRACTICAL

(60 Hours)

1. Preparation of Bordeaux mixture and Bordeaux paste.
2. Preparation of Dithiocarbamate fungicide analogous from aromatic/aliphatic amine and separated as sodium /zinc/ manganese salt.
3. Preparation of homemade rodent bait.
4. Preparation of Emulsifiable concentrate (EC) formulation of given organic compound as oil in water emulsion(O/W).
5. Preparation of EC formulation: Emulsifiable concentrate of neem oil.
6. Preparation of standard hard water.
7. To determine the emulsion stability of given EC formulation.
8. Determination of bulk density of WP formulation.
9. **Project Writing:** For project work pesticides to be selected from the theory portion
 - (a) Use of Globally Harmonized System (GHS) of classification and labelling of chemicals
 - (b) The impact of pesticides on the environment.
 - (c) Pesticide exposure and its impact on human health.

Essential /Recommended readings:

1. Buchel, K. H., (1983) *Chemistry of Pesticides*, John Wiley & Sons Inc ISBN 13 978-0471056829
2. Melnikov,N.N. (1971) *Chemistry of Pesticides*, Edited By: Frances A. Gunther, Jane Davies Gunther, Springer, ISBN: 978-1-4684-6253-1
3. Cremlyn, R. (1978) *Pesticides: Preparation and mode of action*, 1st edition (October 19, 1978) John Wiley & Sons., 0471996319

4. Kenneth, A., Hessall (2013) *The chemistry of Pesticides, their Metabolism, Mode action and uses in crop*, Bio-Green Books, ISBN13: 978-9386237118
5. Sree Ramulu, U. S. (1979) *Chemistry of insecticides and fungicides*, 3rd Edition, Scientific Publishers; Edition: 2020, ISBN: 9789389832020
6. Roberts, T.R., Hutson, D.H., Jewess P.J., (1998) *Metabolic pathways of agrochemicals: insecticides and fungicides*. Royal Society of Chemistry
7. Handa, S.K., (2008) *Principles of Pesticide Chemistry*, Ed. By Agrobios (India) ISBN-13: 9788177542165
8. Singh Anupama et. al (2022) *Basics of Agrochemical Formulations*, Brillion Publishing ; ISBN: 9789392725128
9. Parmar, B.S., Tomar, S.S., (2010) *Pesticide formulation-Theory and practice* , CBS Publisher; ISBN 13: 9788123911243

Suggestive readings

1. Matolcsy, G., Nádas, M., Andriska, V., (1989) *Pesticide Chemistry*, 1st Edition - January 1, 1989; eBook ISBN: 9780080874913
2. Vyas, S. C. (1993) *Handbook of Systemic Fungicides: Compounds*. Tata McGraw-Hill.
3. Ashworth, R. D. B., (1970) *Analysis of technical and formulated pesticides*, Volume 1, CIPAC handbook.
4. Jim A. Turner, (2018) *The Pesticide Manual: A World Compendium*, British Crop Production Council.
5. World Health Organization. (2011). *International code of conduct on the distribution and use of pesticides: guidelines for quality control of pesticides* (No. WHO/HTM/NTD/WHOPES/2011.4). World Health Organization.
6. Zweig, G. (Ed.). (2013). *Principles, Methods, and General Applications: Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives, Vol. 1* (Vol. 1). Elsevier.

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CHEMISTRY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 02)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Organic Chemistry in Pesticide Synthesis ALS CHEM DSE 02	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

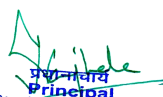
The Learning objectives of this course are as follows:

- to familiarize students to different types of classification of pesticides.
- to familiarize with factors that make the organic compound to be considered as pesticide.
- to understand the correlation of stereochemistry of pesticide and pesticidal activity.
- to inculcate the awareness about the hazards of pesticides.

Learning Outcomes:

By studying this course, students will be able to:

- analyze important aspects attributing pesticidal activity to organic molecules.
- explain the strategies involved in synthesis of different pesticides.


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- illustrate the impact of stereochemical aspects on pesticidal activity.
- handle pesticides safely in view of human health and environment.

Unit 1: Key Consideration for Pesticidal Activity of Organic Compounds

(3 Hours)

- a) Chemical structure (key functional groups in pesticides)
- b) Mode of action to the selected target
- c) Metabolism and metabolites
- d) Toxicity concerns mainly human toxicity and ecotoxicity

Unit 2: Insecticides

(5 Hours)

Structure, stereochemical aspects and toxicity of the following (synthesis excluded):

- a) Alkaloid family: Nicotine
- b) Nicotine analogous: Imidacloprid
- c) Pyrethrins: Pyrethrin-I and II
- d) Pyrethroids: Cypermethrin

Unit 3: Organic Halogenated Compounds as Pesticides

(9 Hours)

- a) Synthesis of Halogenated Hydrocarbons as Fumigants
 - I. Methyl bromide (Bromomethane)
 - II. 1,2-Dibromoethane
 - III. 1,2-Dichloroethane
 - IV. Carbon tetrachloride
- b) Synthesis of DDT and Methoxychlor.
- c) Synthesis of Hexachlorocyclohexane (BHC) and discussion of its stereoisomers.
- d) Synthesis of Chlordane and Heptachlor from Hexachlorocyclopentadiene (HCCP) by Diels Alder reaction and discussion of their stereoisomers.

Ecological problems due to Organic Halogenated Compounds as Pesticides, their toxicity and effect on Human Health

Unit 4: Organophosphorus Insecticides:

(6 Hours)

General chemistry of phosphate esters (Esters of Phosphoric and Phosphorothioic acids)

Synthesis of:

- a) Vinyl organophosphates: Dichlorvos, Mevinphos (Phosdrin)
- b) Phosphorothioates: Parathion, Methyl-parathion
- c) Phosphorodithioate: Malathion
- d) Heterocyclic phosphorodithioate: Phosmet

Unit 5: Carbamates

(4 Hours)

General chemistry of carbamates: N-methyl carbamates and N, N-dimethyl (alkyl) carbamates

Synthesis of Carbaryl, Bendiocarb, MTMC, and Methomyl

Unit 6: Other Agrochemicals

(3 Hours)

Synthesis of DNOC, Captan, 2,4-D, Ziram, Zineb, DEET and their uses.

PRACTICAL

(60 Hours)

The following synthesis should be carried out starting from 0.5-1.0 g of the organic compound. The product to be recrystallized and melting point to be determined.

(Experiments 1 to 6 are synthetic analogues of selected chemical class of pesticides)

1. Synthesis of aryloxy acetic acid class of herbicide (any one of the following)
 - a) 4-chlorophenoxy acetic acid
 - b) 4-methylphenoxy acetic acid
 - c) 2-methylphenoxy acetic acid

2. Preparation of Dithiocarbamate fungicide analogous from aromatic/aliphatic amine and separated as sodium /zinc/ manganese salt.
3. Preparation of urea derivative from phenylisocyanate and aniline.
4. Preparation of carbamate derivative from phenylisocyanate and alcohol/phenol.
5. Preparation of benzimidazole/2-benzylimidazole /2-Methylbenzimidazole.
6. Synthesis of 3,5-dimethylpyrazole.
7. Preparation of mosquito repellent Diethyl phthalate in two steps:
 Step-1: Preparation of phthalic anhydride
 Step-2 : Preparation of Diethyl phthalate
8. To prepare Neem extract from neem leaves and/or seeds.
9. **Project Writing:** Insecticidal properties of Neem extract and its uses.

Essential /Recommended readings:

1. Buchel, K. H. (1983) *Chemistry of Pesticides*, John Wiley & Sons, ISBN 13 978-0471056829
2. Melnikov, N.N. (1971) *Chemistry of Pesticides*, Edited By: Frances A. Gunther, Jane Davies Gunther, Springer, ISBN: 978-1-4684-6253-1
3. Cremlyn, R. (1978) *Pesticides. Preparation and mode of action*, 1st edition John Wiley & Sons, 0471996319
4. Kenneth A, Hessall (2013), *The chemistry of Pesticides, their Metabolism, Mode action and uses in crop*, Bio-Green Books, ISBN13: 978-9386237118
5. Sree Ramulu, U. S. (1979) *Chemistry of insecticides and fungicides*, 3rd Scientific Publishers; Edition: 2020, ISBN: 9789389832020
6. Roberts, T.R., Hutson, D.H., Jewess, P.J. (1998) *Metabolic pathways of agrochemicals: insecticides and fungicides*, Royal Society of Chemistry
7. Matolcsy, G., Nádas, M., Andriska, V. (1989) *Pesticide Chemistry* 1st Edition, eBook ISBN: 9780080874913

Suggestive readings

1. Handa, S.K. (2008) *Principles of Pesticide Chemistry*, Ed. By Agrobios (India) ISBN-13: 9788177542165
2. Vyas, S. C. (1993) *Handbook of Systemic Fungicide Compounds*. Tata McGraw-Hill.
3. Jim A. Turner (2018) *The Pesticide Manual: A World Compendium*, British Crop Production Council.
4. World Health Organization (2011) *International code of conduct on the distribution and use of pesticides: guidelines for quality control of pesticides* (No. WHO/HTM/NTD/WHOPES/2011.4). World Health Organization.
5. Zweig, G. (Ed.), (2013) *Principles, Methods, and General Applications: Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives, Vol. 1* (Vol. 1). Elsevier.
6. "IARC Monograph on Evaluation of Carcinogenic Risk of Chemicals to Humans", Supplement 7, International Agency for Research on Cancer, Lyon, 1987.

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**Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management
SEMESTER-IV**

ZOOLOGY COMPONENT – DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Agricultural Pests ALS ZOO DSC 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

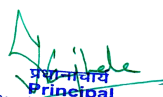
The learning objectives of this course are as follows:

- to impart knowledge about the various agricultural pests and the nature of damage caused by them.
- to apprise the students of the lifecycle of the pest and the specific stage at which it is destructive to the host.
- to acquaint them of the different control measures applied for the management of pests.

Learning Outcomes:

By studying this course, students will be able to:

- identify and differentiate among various types of pests.
- acquire knowledge of the damage caused by agricultural pests.
- better understand the methods of control for the management of the pests.


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Unit 1: Introduction**(3 Hours)**

Classification, identification, distribution and host-range of agricultural pests; Overview of: bionomics, nature and extent of damage, seasonal abundance and management of insect pests.

Unit 2: Pests of Cereals**(2 Hours)**

Biology, nature, extent of damage and control: *Chilozonellus*, *Sesamia inferens*

Unit 3: Pests of Oilseeds**(4 Hours)**

Bionomics, lifecycle and management: *Lipaphis erysimi*, *Athaliaugen sproxima*, *Achaea janata*, *Euproctis lunata*.

Unit 4: Pests of Fibre Crops**(5 Hours)**

Bionomics, life cycle and management: *Helicoverpa armigera*, *Earias vitella*, *Pectinophora gossypiella*, *Oxycaremus laetus*, *Dysdercus koenigii*.

Unit 5: Pests of Paddy and Sugarcane**(5 Hours)**

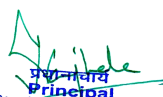
Biology, nature of damage and control: *Leptocorisa varicornis*, *Hispa (Dicladispa) armigera*, *Spodoptera exempta*, *Scirpophaga nivella*, *Pyrilla perpusilla*, *Emmalocera depressella*, *Aleurolobus barodensis*.

Unit 6: Stored Grain Pests**(6 Hours)**

Life cycle, nature of damage and control: *Sitophilus oryzae*, *Rhyzopertha dominica*, *Trogoderma granarium*, *Sitotroga cerealella*, *Callosobruchus chinensis*, *Atherigona varia*, *Calocorisan gustatus*, *Mythimna separate*, *Macrosiphum miscanthi* / *Sitobion avenae*.

Unit 7: Polyphagous Pests**(5 Hours)**

Lifecycle and control: grasshopper, locust, termite, white grub, hairy caterpillar, and non-insect pests (mites, birds, rodents, snails, slugs).


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PRACTICAL

(60 Hours)

1. Identification, life cycle and damage caused by following pests:

Chilo zonellus, *Sesamia inferens*, *Lipaphis erysimi*, *Helicoverpa armigera*, *Earias vitella*, *Pectinophora gossypiella*, *Oxycarenus laetus*, *Dysdercus koenigii*, *Athalia lugen sproxima*, *Achaea janata*, *Euproctis lunata*, *Hispa (Dielispa) armigera*, *Spodoptera exempta*, *Pyrilla perpusilla*, *Emmalocera depressa*, *Sitophilus oryzae*, *Rhyzopertha dominica*, *Trogoderma granarium*, *Sitotroga cerealella*, *Callosobruchus chinensis*, *Atherigona varia*, *Calocoris an gustatus*, *Mythimna separate*, *Macrosiphum miscanthi* / *Sitobion avenae*.

2. Identification and life cycle of grasshoppers and locusts.
3. Study of life cycle and management of non-insect pests through specimens/photographs.
4. Collection and identification of stored grains pests and nature of damage caused by them.
5. Field visits to Central warehouse/FCI godowns/ CFTRI, IGSMRI.

Essential/recommended readings

1. Dhaliwal G.S. and Singh R. (2004) *Host Plant Resistance to Insects - Concepts and Applications*. Panima Publications., New Delhi.
2. Evans J.W. (2005). *Insect Pests and their Control*. Asiatic Publications., New Delhi.
3. Atwal A.S. and Dhaliwal G.S. (2018) *Agricultural Pests of South Asia and their Management*, 7th Edition Kalyani Publ., New Delhi.

Suggestive readings

1. Maxwell F.G. and Jennings P.R. (Eds). (1980) *Breeding Plants Resistant to Insects*. John Wiley and Sons, New York.
2. Sharma V. (2015) *Agricultural Pest Management*, Rajat Publications.

3. Awasthi V. B. (2017) Agricultural Insect Pest and their Control, 2nd edition, Scientific Publisher India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ZOOLOGY COMPONENT – DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 02)

Credits distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology of Animals ALS ZOO DSE 02	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to acquaint students of different phases of development and changes from embryonic to post-embryonic stage.
- to comprehend the basic principles and concepts underlying developmental processes at the cellular and molecular level.
- to learn about gametogenesis, cleavage patterns, morphogenetic movements and the importance of extraembryonic membranes.

- to apprise the students of the applications of this course in addressing the problems of developmental abnormalities and infertility in human.

Learning Outcomes:

By studying this course, students will be able to:

- understand the events that lead to the formation of a multicellular organism from a single cell.
- learn the general patterns and sequential developmental stages during embryogenesis.
- acquire better knowledge of the mechanisms involved in morphogenesis and interactions of cells during gastrulation, placentation, regeneration and metamorphosis.
- appreciate the importance of IVF and amniocentesis for tackling infertility and developmental abnormalities.

Unit 1: Introduction

(2 Hours)

Historical background, phases of development, growth and differentiation, cytoplasmic determinants, teratogens.

Unit 2: Early Embryonic Development

(15 Hours)

Gametogenesis: spermatogenesis, oogenesis; types of eggs, egg membranes; fertilization (External and Internal), blocks to polyspermy, planes and patterns of cleavage, types of blastula, fate maps, morphogenetic movements, gastrulation in frog and chick.

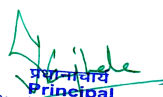
Unit 4: Late Embryonic Development

(5 Hours)

Fate of germ layers, extraembryonic membranes in birds, placenta (structure, types and functions).

Unit 5: Post-embryonic Development

(5 Hours)


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Metamorphic changes in amphibians and insects; regeneration: modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration, limb regeneration in tailed amphibia.

Unit 6: Applications of Developmental Biology

(3 Hours)

Embryonic stem cell; *in vitro* fertilization, amniocentesis.

PRACTICAL

(60 Hours)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Egg, cleavage stages, blastula, gastrula, neurula (neural plate, neural fold and neural tube stages), tailbud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton stages): Stage 3 (Intermediate Streak)-13 hours, stage 4 (Definitive streak)-18 hours, stage 5 (Head process)-21 hours, Stage 7- 24 hours, stage 8- 28 hours, stage 10-33 hours, stage 11- 40 hours, stage 13- 48 hours, stage 19- 72 hours and stage 24- 96 hours of incubation.
3. *In vivo* study of chick embryo development by windowing and candling methods. (Demonstration only).
4. Study of different stages of development of *Drosophila*.
5. Study of different types of placenta (photomicrographs/ slides).
6. Project report on *Drosophila* development/Visit to poultry farm/IVF Centre.

Essential/recommended readings:

1. Gilbert, S.F. (2016) *Developmental Biology*, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA.
2. Balinsky B. I. and Fabian B. C. (2006) *An Introduction to Embryology*. 8th Edition, International Thompson Computer Press.
3. Kalthoff, K. (2001) *Analysis of Biological Development*. 2nd Edition, McGraw Hill Publishers.

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Suggestive readings:

1. Arora, R. and Grover, A. (2018) *Developmental Biology: Principles and Concepts*. 1st Edition, R. Chand & Company.
2. Baweja, V. and Misra, M. (2021) *E-book on Practical Manual of Developmental Biology*.
3. Carlson, B.M. (2007) *Foundations of Embryology*. 6th Edition, Tata McGraw-Hill Publishers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management
SEMESTER-V**

BOTANY COMPONENT - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Physiology and Biochemistry in Plant Development ALS BOT DSC 05	4	2	0	2	Class 12th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to understand the fundamental concepts of plant physiology and metabolism.
- to identify the role of water, minerals, hormones, and light in plant growth and development.
- to understand the basic biochemical mechanisms and mineral nutrition of plants.
- to identify the criteria for the essentiality of elements.
- to understand the role of hormones in plant growth and development.
- to examine the commercial applications of growth regulators.
- to understand the physiology of flowering and senescence.
- to understand the mechanisms of photosynthesis and respiration.
- to examine the biological nitrogen fixation in plants.

Learning Outcomes:

By studying this course, students will be able to:

- comprehend the physiological processes that occur in plants, including the role of water, minerals, hormones, and light in plant growth and development.
- acquaint the basic biochemical mechanisms of plants, including photosynthesis, respiration, nitrogen metabolism, and chemical regulation of growth and development.
- comprehend the process of biological nitrogen fixation, reproductive physiology and senescence of plants.
- develop practical skills in plant physiology and metabolism.

Unit 1: Plant-water relations

(3 Hours)

Water potential and its components, pathway of water movement, ascent of sap, transpiration and its significance, factors affecting transpiration, root pressure and guttation.

Unit 2: Mineral Nutrition

(3 Hours)

Essential elements, Macro- and micronutrients, Criteria for essentiality of elements, Methods of studying mineral requirement (Hydroponics, Aeroponics)

Unit 3: Translocation in Phloem

(3 Hours)

Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 3: Chemical Regulation of Growth and Development

(3 Hours)

Role of hormones in plant growth and development, Commercial applications of growth regulators, Growth retardant and its usefulness

Unit 4: Reproductive Physiology and Senescence

(3 Hours)

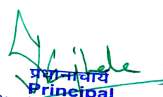

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Photo-periodism and flowering response, Photo-perception and critical photoperiod, Phytochrome and its role in flowering, Vernalization and senescence.

Unit 5: Photosynthesis

(7 Hours)

Historical contributions of Blackman, Emerson, and Hill, Photosynthetic pigments (chlorophyll-a and b, xanthophyll, carotene), Photosystem I and II, reaction center, antenna molecules, Electron transport and mechanism of ATP synthesis, C3 pathway, C4 and CAM plants (in brief, no pathways), Photorespiration.

Unit 6: Respiration

(5 Hours)

Glycolysis, Anaerobic respiration, TCA cycle, Oxidative phosphorylation, Glyoxylate cycle, RQ

Unit 7: Nitrogen Metabolism

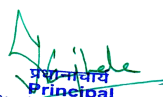
(3 Hours)

Biological nitrogen fixation - nodulation in detail, Nitrate and ammonia assimilation.

PRACTICAL

(60 Hours)

1. To determine the osmotic potential of plant cell sap by plasmolytic method.
2. Calculate stomatal index and stomatal frequency of a mesophyte and a xerophyte.
3. Study Hill's reaction.
4. To study the effect of the environmental factor light on transpiration by excised twig.
5. Study the effect of light intensity on O₂ evolution in photosynthesis.
6. Compare the rate of respiration in any two parts of a plant.
7. To study the activity of catalase and the effect of pH and heavy metals.
8. Demonstrate the effect of auxin on rooting.
9. Demonstration of Bolting.
10. Demonstration of root respiration.


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11. Demonstration of suction due to transpiration
12. A field visit to Hydroponics and Aeroponics facilities.

Essential/ Recommended readings:

1. Hopkins, W. G., Huner, N. P. A. (2009) *Introduction to Plant Physiology*, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd
2. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018) *Plant Physiology and Development International* 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
3. Kochhar, S.L., Kaur, S. and Gujral, S.K. (2020) *Plant Physiology: Theory and Applications*. New Delhi, Delhi: Foundation Books, imprint of Cambridge University Press India Pvt, Ltd.

Suggestive readings:

1. Bajracharya, D. (1999) *Experiments in Plant Physiology: A Laboratory Manual*. New Delhi, Delhi: Narosa Publishing House.
2. Bhatla S.C. and Lal, M.A. (2018) *Plant Physiology, Development and Metabolism*, Springer.
3. Salisbury F.B. and Ross C.W. (1992) *Plant Physiology*, 4th edition, Wadsworth Publishing Company, California.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BOTANY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology of Plants ALS BOT DSE 03	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

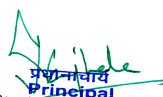
The learning objectives of this course are follows:

- to acquaint the students with internal basic structure and cellular composition of the plant body.
- to correlate structure with important functions of different plant parts.
- to study of various tissue systems and their development and functions in plants
- to have knowledge of the flowering and fruiting, reproduction process, role of pollinators, ovule and seed development.

Learning Outcomes:

By studying this course, students will be able to:

- gain knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.


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- get an insight of various aspects of growth, development of the tissues and differentiation of various plant organs.
- gain the knowledge of basic structure and organization of plant parts in angiosperms and its correlation with morphology and functions.
- get acquainted with pollen development and pollination, ovule development and fertilization, endosperm development and its importance.

Unit 1: Meristematic and permanent tissue:

(4 Hours)

Meristems and derivatives- structural organization of shoot and root apices; permanent tissue: simple and complex tissues.

Unit 2: Dermal System

(2 Hours)

Epidermis, stomata, trichomes and glands

Unit 3: Organs

(4 Hours)

Structure of dicot and monocot root, stem and leaf

Unit 4: Secondary Growth

(4 Hours)

Vascular cambium – structure and function, Secondary growth in root and stem, periderm.

Unit 5: Anther

(4 Hours)

Structure and development, microsporogenesis, Pollen Development, structure of pollen and pollen wall (Basic Concepts).

Unit 6: Ovules

(4 Hours)

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Structure and types, megasporogenesis and mega gametogenesis, mature embryo sac.

Unit 7: Pollination and Fertilization

(4 Hours)

Pollination mechanisms and adaptations; double fertilization; sexual incompatibility- basic concepts

Unit 8: Endosperm and Embryo

(3 Hours)

Types and function of endosperm, embryogenesis, dicot and monocot embryo

Unit 9: Seed development

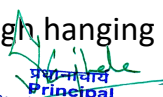
(1 Hours)

Basic concepts of seed development

PRACTICAL

(60 Hours)

1. Study of root and shoot apex through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma, sclerenchyma and their types); Macerated xylary elements, Phloem (Permanent slides/ Photographs/ Digital resources)
3. To cut transverse section of stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Study of secondary growth in *Helianthus* stem.
4. To cut transverse section of root: Monocot: *Zea mays*; Dicot: *Cicer*; Study of secondary growth in *Helianthus* .
5. Study of structure of Dicot and Monocot leaf.
6. Study of anther structure (young and mature).
7. Calculation of percentage of germinated pollen in a given medium through hanging


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drop/sitting drop method.

8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/
campylotropous.
9. Female gametophyte: Mature embryo sac (photographs). Ultrastructure of mature egg
apparatus cells through electron micrographs.
10. Dissection of embryo and endosperm from developing seeds.

Essential/ Recommended readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). *Embryology of Angiosperms*, 5th edition. New
Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Mauseth, J.D. (1988). *Plant Anatomy*. San Francisco, California: The Benjamin/Cummings
Publisher.
3. Franklin, E. R. (2006). *Esau's Plant Anatomy: Meristems, Cells, And Tissues of the Plant
Body: Their Structure, Function, and Development*. New Jersey, U.S.: John Wiley & Sons,
Inc., Hoboken.
4. Shivanna, K.R. (2003). *Pollen Biology and Biotechnology*. Delhi, Delhi: Oxford and IBH
Publishing Co. Pvt. Ltd.

Suggestive readings:

1. Raghavan, V. (2000). *Developmental Biology of Flowering plants*. Netherlands, Europe:
Springer.

2. Johri, B.M. (1984). *Embryology of Angiosperms*. Netherlands, Europe: Springer-Verlag.
3. Bhojwani S.S., Dantu P.K. and Bhatnagar, S.P. (2015) *The Embryology of Angiosperms*, 6th edition. Vikas Publication House Pvt. Ltd. New Delhi.
4. Tayal, M.S. (2021). *Plant Anatomy*, 4th Edition. Meerut, U.P.: Rastogi publications.
5. Crang, R., Lyons-Sobaski, S., and Wise, R., (2018) *Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants*, 1st Edition, Springer Nature Switzerland AG.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CHEMISTRY COMPONENT - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Physical Chemistry; ALS CHEM DSC 05	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- to make students able to understand thermodynamic concepts, properties of thermodynamic systems, laws of thermodynamics and thermochemistry.
- to introduce the basic concept of chemical equilibrium, ionic equilibria and conductance and their correlation among themselves and with other branches of chemistry.
- to provide basic understanding of the behavior of electrolytes and their solution.

Learning Outcomes:

By studying this course, students will be able to:

- understand the laws of thermodynamics, thermochemistry and equilibria.
- explain the concept of pH and its effect on various physical and chemical properties of the compounds.
- use the concepts learnt to predict feasibility of chemical reactions and to analyse the behaviour of reactions in equilibrium.
- apply classroom knowledge to local environmental phenomena and interpret them in relation to the chemistry involved in both conceptual and experimental aspects.

Unit 1: Chemical Energetics

(8 Hours)

Review of thermodynamics and the laws of thermodynamics

Thermochemistry: Important principles and definition of thermochemistry, *Conventions* about the *thermochemical equation*, Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization, enthalpy of hydration, enthalpy of formation, *enthalpy of solution: integral and differential enthalpies of solution and dilution*, *calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data*, the effect of temperature (Kirchhoff's equations) on the enthalpy of reactions.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit 2: Chemical Equilibrium

(6 Hours)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle, relationship between K_p , K_c and K_x for reactions involving ideal gases.

Unit 3: Ionic Equilibria

(10 Hours)

Strong, moderate, and weak electrolytes, degree of ionization, factors affecting the degree of ionization, Ostwald's dilution law, ionization constant, and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, Buffer solutions, Henderson- Hasselbach equation, salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH of different salts, solubility and solubility product of sparingly soluble salts-applications of solubility product principle. Qualitative treatment of acid-base titration curves (calculation of pH at various stages).

Unit 4: Conductance

(6 Hours)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water,

hydrolysis constant of a salt. Conductometric titrations (only acid-base).

PRACTICAL

(60 Hours)

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of the enthalpy of ionization of ethanoic acid.
4. Determination of integral enthalpy (endothermic and exothermic) solution of salts.
5. Determination of enthalpy of hydration of copper sulphate.

Ionic equilibria:

6. Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride- ammonium hydroxide.

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

7. pH metric titration:

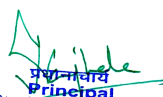
(i) Strong acid vs strong base

(ii) Weak acid vs strong base

Determination of dissociation constant of a weak acid.

Conductance

8. (i) Determination of cell constant
- (ii) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.


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9. Conductometric titration:

- (i) Strong acid vs strong base
- (ii) Weak acid vs strong base
- (iii) Mixture of strong and weak acid vs strong base

Essential/Recommended readings:

1. Peter, A., Paula, J. de. (2011), "*Physical Chemistry*", Fifth Ed., Oxford University Press.
2. Castellan, G. W. (2004), "*Physical Chemistry*", Fourth Ed., Narosa.
3. Kapoor, K. L. (2015), "*A Textbook of Physical Chemistry*", Vol 1, 6th Edition, McGraw Hill Education.
4. Kapoor, K. L. (2015), "*A Textbook of Physical Chemistry*", Vol 2, 6th Edition, McGraw Hill Education.
5. Puri, B.R; Sharma, L.R; Pathania, M.S. (2017), "*Principles of Physical Chemistry*", Vishal Publishing Co.

Suggestive readings:

1. Khosla, B. D., Garg, V. C., Gulati, A. (2011), "*Senior Practical Physical Chemistry* ", R. Chand & Co., New Delhi.
2. Athawale, V. D., Mathur, P. (2001), "*Experimental Physical Chemistry*", New Age International: New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CHEMISTRY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nanotechnology in Agriculture; ALS CHEM DSE 03	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The Learning objectives of this course are as follows:

- to create foundational knowledge of Nanotechnology.
- to educate students about the current green and sustainable methods of preparation of nanomaterials.
- to teach difference between conventional and modern agriculture.
- to give idea about the importance of nanomaterials in agriculture.
- to impart knowledge on toxicity of nanomaterials.

Learning Outcomes:

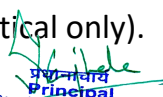
By studying this course, students will be able to:

- identify the different types of nanomaterials and their properties.
- understand the role of nano- agrochemicals in enhancing crop productivity.
- articulate the study of nanomaterials in the treatment of soil.
- summarize the toxicity risks of nanomaterials on soil and environment.

Unit 1: Introduction

(6 Hours)

Basics of nanoscience and technology: Definition, Classification of nanoparticles based on dimension and origin, Quantum confinement, properties of nanoparticles (optical only).


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Synthesis of nanoparticles: Overview of physical and chemical routes, green methods of nanoparticles synthesis.

Introduction to agriculture: Limitations of conventional farming, role of nano- agrochemicals in modern agriculture. Benefits of nanomaterials in agriculture (plant growth, crop protection, crop nutrients, etc.).

Unit 2: Application of Nanomaterials in Agriculture

(14 Hours)

Nano fertilizers: Types and synthesis: Nitrogen-based, Phosphate based and Iron based. Role towards enhancement of crop productivity. Molecular mechanism of nano- fertilizer for plant growth and mechanism.

Advantages over conventional fertilizers, limitations, optimization of nutrient use efficiency (NUE) and environment sustainability.

Nano pesticides: Brief discussion about nano- insecticides, nano- herbicides and nano- fungicides, role in agriculture. Advantages over conventional pesticides and limitations.

Unit 3: Treatment of Soil using Nanomaterials

(6 Hours)

Treatment of polluted soil by nanoremediation. Utilization of nanoparticles like nanoclay and zeolites in soil boosting. Smart pest control.

Unit 4: Nanotoxicity in Agriculture

(4 Hours)

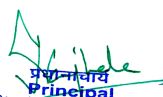
Toxicity of nanoparticles. Toxic effects of metal nanoparticles on soil ecosystem. Toxicity of nanoparticles to crop production. Health and environmental concerns related to nanomaterials.

PRACTICAL

(60 Hours)

1. Basic introduction to the characterization of nanoparticles employing the following techniques (Data and/or images for few reference compounds will be provided for analysis):

- i. UV-Visible spectroscopy


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- ii. Fourier transform infrared spectroscopy (FT-IR)
 - iii. Powder X-ray diffraction (PXRD)
 - iv. Scanning electron microscopy (SEM)
 - v. Transmission electron microscopy (TEM)
2. Sol-gel synthesis of nanoparticles.
 3. Synthesis of metal and metal oxide nanoparticles by green methods:
 - i. Silver nanoparticles and their characterization using UV-visible spectrophotometer.
 - ii. Zinc oxide nanoparticles.
 - iii. Iron oxide nanoparticles using potato extract.
 4. Synthesis of Nano urea.
 5. Analysis of soil:
 - i. Comparative study of pH of untreated and nano fertilizer treated soil
 - ii. Estimation of composition of zinc in nano fertilizer treated soil using complexometry.

Essential/Recommended readings:

1. Varghese, T., Balakrishna, K.M., (2020) *Nanotechnology- An Introduction to synthesis, properties and applications of nanomaterials*. Atlantic Publishers & Distributors (P) Ltd; ISBN: 9788126916375.
2. Shah, M.A.; Shah, K.A., (2019) *Nanotechnology-The Science of Small*. Wiley; ISBN: 9788126579976.
3. Swayam (MHRD) Portal online: Nanotechnology in Agriculture (<https://nptel.ac.in/course/102104069>); Book download link: [102104069.pdf - Google Drive](#) .
4. Axelos, M. A., & Van de Voorde, M. (Eds.). (2017). *Nanotechnology in agriculture and food science*. John Wiley & Sons, ISBN: 3527339892.
5. Chattopadhyay K.K., Banerjee A.N., (2009) *Introduction to Nanoscience and Technology*; PHI Learning Pvt. Ltd. ISBN: 9788120336087.
6. Jogaiah, S., Singh, H. B., Fraceto, L. F., & De Lima, R. (Eds.). (2020). *Advances in Nano-Fertilizers and Nano-Pesticides in Agriculture: A Smart Delivery System for Crop Improvement*. Woodhead Publishing; ISBN: 978-012-820092.

7. Singh, H. B., Mishra, S., Fraceto, L. F., & De Lima, R. (Eds.). (2018). Emerging trends in agri-nanotechnology: fundamental and applied aspects; CABI Publishing, ISBN: 9781786391445.
8. Mallick, M. A., Solanki, M. K., Kumari, B., & Verma, S. K. (Eds.). (2021). *Nanotechnology in Sustainable Agriculture*. CRC Press; ISBN: 9780367369408.
9. Subramanian, K. S., Gunasekaran, K., Natarajan, N., Chinnamuthu, C. R., Lakshmanan, A., & Rajkishore, S. K. (2015). *Nanotechnology in Agriculture*. New India Publishing Agency; ISBN: 9789383305209
10. Tarafdar, J. C. (2021). Nanofertilizers: challenges and prospects.; Scientific Publishers (India); ISBN: 97893888969631.
11. Fraceto, L. F., De Castro, V. L. S., Grillo, R., Ávila, D., Oliveira, H. C., & Lima, R. (2020). *Nanopesticides*. Springer International Publishing. ISBN: 978-3-030-44873-8.

Suggestive readings:

1. Craig, E. (2019) Nanomaterials: An Introduction to Properties, Synthesis and Applications. Larsen and Keller Education (New York). ISBN: 1641721065.
2. Fraceto, L. F. (2022). *Inorganic Nanopesticides and Nanofertilizers: A View from the Mechanisms of Action to Field Applications*. Springer Nature; ISBN: 9783030941543.
3. Prasad, R., Kumar, M., & Kumar, V. (Eds.). (2017). *Nanotechnology: an agricultural paradigm*. Springer. ISBN: 9789811045721.
4. Kumar, V., Guleria, P., Ranjan, S., Dasgupta, N., & Lichtfouse, E. (Eds.). (2021). *Nanotoxicology and Nanoecotoxicology Vol. 1* (Vol. 59). Springer International Publishing; ISBN: 978-3-030-63241-0.

E-contents:

1. E-content on e-PG Pathshala portal of Government of India: (**P08**) Nanoscience and Nanotechnology (**33**)
(<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5VgWkgm+I3FGq9cGlSbNmQ==>).
2. Swayam (MHRD) Portal online: Nanotechnology in Agriculture
(<https://nptel.ac.in/course/102104069>); study material, videos and other material link for course ([NPTEL](https://nptel.ac.in/course/102104069)).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ZOOLOGY COMPONENT – DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Animal Physiology and Metabolism ALS ZOO DSC 05	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to impart knowledge about the functions of organs and organ systems of the body.
- to distinguish between normal and diseased states of the body functions.
- to apprise the students about correlation of the structure of organs with their functions.
- to enable the students to learn the working of different metabolic pathways of the body.

Learning Outcomes:

By studying this course, students will be able to:

- understand the physiology of different systems of the human body.
- comprehend and analyse problem-based questions on physiological aspects.
- recognize and explain the working of physiological systems in unison to maintain homeostasis in the body.

Unit 1: Nerve and Muscle

Types of muscles, ultrastructure of muscle, characteristics of muscle twitch. Structure of neuron, action potential, propagation of nerve impulse (myelinated and non-myelinated nerve fibre).

Unit 2: Digestion

(5 Hours)

Digestion and absorption of carbohydrates, fats and proteins.

Unit 3: Respiration

(4 Hours)

Ventilation, external and internal respiration, transport of oxygen and carbon dioxide in blood.

Unit 4: Heart

(4 Hours)

Structure of heart, origin and conduction of heart beat, cardiac cycle.

Unit 5: Excretion

(3 Hours)

Structure of nephron, mechanism and regulation of urine formation.

Unit 6: Endocrine Glands

(2 Hours)

Structure and function of endocrine glands.

Unit 7: Metabolism of Carbohydrates, Proteins and Lipids

(7 Hours)

Glycolysis, TCA cycle, electron transport chain (respiratory chain), Urea cycle, β -oxidation of fatty acids.

PRACTICAL

(60 Hours)

1. Preparation of temporary mount of neuron and striated muscle.
2. Estimation of haemoglobin using Sahli's Haemoglobinometer.
3. Preparation of haemin crystals.
4. Study of oesophagus, stomach, duodenum, ileum, liver, pancreas, trachea, lung,

kidney (of mammals) through permanent slides.

5. Study of endocrine glands of mammal using permanent slides: pituitary, thyroid parathyroid, pancreas, adrenal, ovary and testis.
6. Study of the activity of salivary amylase under optimal conditions.
7. Interpret the recording of frog's heartbeat (*in situ*) under normal conditions.
8. Study of muscle twitch through videos/photographs and interpret the recording of muscle twitch.

Essential/recommended readings:

1. Tortora, G.J. and Derrickson, B. H. (2017) *Principles of Anatomy and Physiology*. 15th Edition, Wiley Publishers.
2. Campbell and Reece (2020). *Biology*. Pearson Education, (Singapore) Pvt. Ltd.

Suggestive readings:

1. Vander A., Sherman J. and Luciano D. (2017) *Vander's Human Physiology: The Mechanism of Body Function*. 7th Edition, McGraw Hills.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ZOOLOGY COMPONENT – DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Integrated Pest Management ALS ZOO DSE 03	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

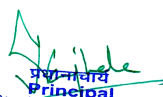
The learning objectives of this course are as follows:

- to familiarize the students with the ecology of pests and the damage caused by them.
- to acquaint the students of the concept of Integrated Pest Management (IPM) using different models.
- to apprise the students of various components of IPM viz. chemical, biological and genetic control.
- to impart knowledge about the various pest surveillance techniques and forecasting of pest outbreaks.

Learning Outcomes:

By studying this course, students will be able to:

- better understand the effects of insecticides on the environment and need for ecofriendly approach for management of insect pests.
- learn the management of agricultural ecosystem using effective pest control strategies and techniques.
- appreciate the role of IPM in sustainable agriculture.


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Unit 1: Concept of Pest and its Ecology**(5 Hours)**

Pest population dynamics, Economic Injury Level (EIL), Economic Threshold Level (ETL), carrying capacity, secondary pest outbreak.

Unit 2: Overview of Integrated Pest Management**(4 Hours)**

Concept of IPM and its components, major IPM strategies.

Unit 3: Insect Pest Management**(6 Hours)**

Types of pest management: cultural, physical and mechanical; pest survey (types) and surveillance: factors affecting surveys; forecasting; pest and pesticide risk analysis; political, social and legal implications of IPM; case studies of successful IPM programmes.

Unit 4: Chemical Control**(5 Hours)**

Classification of insecticides, insecticide adjuvants and formulations, mechanism of insecticide action with reference to chlorinated hydrocarbons, organophosphates, carbamates, plant products, synthetic pyrethroids, fumigants, IGR compounds and pheromones.

Unit 5: Biological Control**(6 Hours)**

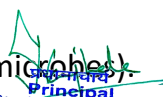
Principle; biocontrol agents: parasitoids, predators and pathogens (NPV, bacteria, fungi and nematodes).

Unit 6: Genetic Control and Legislation**(4 Hours)**

Sterile Insect Release Method (SIRM): radio and chemo sterilization, hybrid sterility; other strategies of genetic control; quarantine laws.

PRACTICAL**(60 Hours)**

1. Study of damage caused by the common insect pests of stored grains and crops (any 6).
2. Study of life history of important insect pests and non-insect pests.
3. Study of common natural enemies of crop pests (parasitoids, predators, ~~microbes~~).


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4. Study of IPM model for control of *Leptocorisa acuta* and *Scirpophaga nivella*.
5. Learn algorithm (flow chart) of IPM strategies for the sustainable agriculture.
6. Study of tools and techniques of IPM: mechanical, physical, cultural control.
7. Study of the equipments used for spraying and dusting of insecticides.
8. Determination of LD50/LC50 of insecticides based on assessment of SIT efficacy through data.
9. Submission of project report on visit to IARI, IPFT, Hindustan Insecticides Ltd., FCI complex.

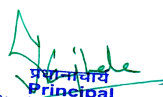
Essential/recommended readings:

1. Atwal A.S. and Dhaliwal G.S. (2018) *Agricultural Pests of South Asia and their Management*, 7th Edition Kalyani Publ., New Delhi.
2. Dhaliwal G.S. and Singh R. (2004) *Host Plant Resistance to Insects – Concepts and Applications*. Panima Publ., New Delhi.
3. Hill, Dennis S (2012) *Agricultural insect pests of the tropics and their control*, 2nd Edition; Permission of Cambridge University, printed at Shree Maitrey Printech Pvt.
4. Horowitz, A. Rami and Ishaaya, Isaac. (2009) *Insect Pest Management - Field and Protected Crops* by Mary Lou Flint and Robert van den Bosch, (1981).
5. Flint MC & Bosch RV. (2012). *Introduction to Integrated Pest Management*. Springer, New York.

Suggestive readings:

1. Pedigo, L.P. (1996) *Entomology and pest management*, prentice hall, New Delhi
2. Raymond A. Cloyd, Philip L. Nixon and Nancy R. Pataky. 2004. *IPM for Gardeners: A Guide to Integrated Pest Management*, Timber Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.


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**Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management
SEMESTER-VI**

BOTANY COMPONENT - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 06)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Biotechnology: Concepts and Applications ALS BOT DSC 06	4	2	0	2	Class 12th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to give students knowledge of techniques used in plant biotechnology and its applications.
- to explore the use of biotechnology to generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
- to understand the biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals, food industry, agriculture, horticultural and ecology. This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.
- to perform the techniques currently used to generate information and detect genetic variation.

Learning Outcomes:

By studying this course, students will be able to:

- comprehend the basic concepts, principles and processes of plant biotechnology.
- apply the acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural fields.
- use the basic biotechnological techniques to explore molecular biology of plants.
- explain the use of biotechnological techniques for plant improvement and biosafety concerns.

Unit 1: Introduction to Biotechnology

(2 Hours)

Historical timeline; Brief overview of techniques and methods in Biotechnology, sectors of Biotechnology.

Unit 2: Plant Tissue Culture

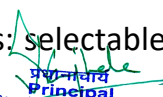
(8 Hours)

Historical perspective (Haberlandt, Laibach, White, Reinert and Steward, Murashige, Cocking, Guha and Maheshwari, Bhojwani, Morel and Martin); Composition of media; Nutrients (major and minor), vitamins and hormones; Plasticity and Totipotency; Regeneration: Organogenesis (Direct and Indirect) and Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, haploids, triploids, cybrids, production of virus-free plants).

Unit 3: Recombinant DNA Technology and Genetic Transformation

(12 Hours)

Restriction Endonucleases (History, Types I - IV, biological role and applications); Modifying enzymes and their applications (nucleases, ligases, alkaline phosphatase, polynucleotide kinase) Introduction to prokaryotic and eukaryotic cloning vectors: pBR322, pUC 18, pUC19, BACs, Lambda phage, YACs. Gene Cloning: Restriction digestion of DNA, ligation, bacterial transformation and selection of recombinant clones; Methods of gene transfer to plants: *Agrobacterium*-mediated transformation (Ti plasmids), Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenic plants; selectable marker


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genes (Positive selection markers – antibiotic- and herbicide-resistance conferring genes) and reporter genes (Luciferase, GUS, GFP).

Unit 3: Applications of Transgenic Technology

(8 Hours)

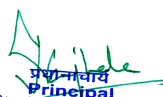
Pest resistant (Bt-cotton) and herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato. Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Edible vaccines; Introduction to genome editing; Biosafety of transgenic plants.

PRACTICALS

60 hours

1. Preparation of nutrient media for plant cell cultures- Murashige & Skoog's (MS) medium and B5 medium.
2. Initiation of axenic cultures (seed sterilisation and inoculation)
3. Micropropagation (shoot induction) using leaf and/or nodal explants of tobacco/*Datura*/*Brassica* etc.
4. Study of anther culture, embryo and endosperm culture, somatic embryogenesis using digital resources/ photographs.
5. Preparation of artificial seeds.
6. Isolation of plasmid DNA.
7. Induction of callus and analysis of effects of growth regulators on *in vitro* regeneration using tobacco as a model plant
8. Preparation of competent cells and transformation of *E. coli* by heat shock method.
9. Restriction digestion and gel electrophoresis of plasmid DNA.
10. Construction of restriction map of circular and linear DNA from the data provided.
11. Visit to a Research laboratory.

Essential/recommended readings:


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1. Bhojwani, S.S., Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Bhojwani, S.S., Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.
3. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6th edn. Washington, U.S.: ASM Press.
4. Brown, T. A. 2020. Gene Cloning & DNA Analysis: An Introduction. 8th edn. UK: Wiley Blackwell.
5. Slater, A., Scott, N. W. & Fowler, M. R. (2010) Plant Biotechnology: The Genetic Manipulation of Plants. 2nd edn. New York, USA: Oxford University Press Inc.
6. Primrose, S. B. and Twyman, R.M. (2013) Principles of Gene Manipulation and Genomics. 7th edn. Wiley-Blackwell Publishing.

Suggested Readings :

1. Stewart, C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and Applications. New Jersey, U.S.: John Wiley & Sons Inc.
2. Snustad, D.P., Simmons, M.J. (2010). Principles of Genetics, 5th edition. Chichester, England: John Wiley and Sons.
3. Bhojwani, S.S. and Dantu, P.K. (2013). Plant Tissue Culture: An Introductory Text. Springer New Delhi Heidelberg New York Dordrecht London

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BOTANY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Systematics ALS BOT DSE 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to gain knowledge about the basics of plant systematics.
- to get an insight into the interrelationships of plant systematics and allied subjects.

Learning Outcomes:

By studying this course, students will be able to:

- understand technical terminology used in plant taxonomy.
- apply the terminologies to describe, identify and classify the flowering plants.
- search and analyze taxonomic information from internet-based scientific databases and other resources.
- comprehend and compare various systems of classification.
- recognize diversity in local/regional flora.

Unit 1: Introduction

Plant identification, Classification, Nomenclature, Biosystematics.

Unit 2: Identification

(4 Hours)

Field inventory, Herbarium Techniques, Functions of Herbarium, Important herbaria and botanical gardens of the world and India, Virtual Herbarium, E-flora: Flora, Monographs, Journals.

Unit 3: Systematics-An Interdisciplinary Science

(5 Hours)

Evidence from cytology, phytochemistry [Alkaloids, Phenolics, Glycosides, (in brief)] and molecular data (cp.DNA, mt-DNA, nuclear DNA, PCR amplification, sequence data analysis)

Unit 4: Taxonomic Hierarchy

(2 Hours)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological & evolutionary)

Unit 5: Botanical Nomenclature

(7 Hours)

Principles and rules (ICN); Ranks and names; Typification, Author citation, Valid publication, Rejection of names, Principle of priority and its limitations; Names of hybrids and cultivated plants.

Unit 6: Basic Terms and Concepts of Phylogeny

(4 Hours)

Cladistics: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades and grades). Methodology of Cladistics, Methods of illustrating evolutionary relationships (phylogenetic tree, cladogram).

Unit 7: Systems of Classification

(7 Hours)

Major contributions of Parasara, Charaka, Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Cronquist, Bremer and MW Chase; Classifica

tion systems of Benth and Hooker (up to series) and Engler and Prantl (up to series); Angiosperm Phylogeny Group (APG IV) Classification (major clades).

PRACTICAL

(60 Hours)

1. To prepare at least 2 herbarium specimens and identify them using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's classification).
2. Description of taxa using semi-technical terms and identification of the families according to Bentham and Hooker's classification.

Note: Any twelve families from the following list to be studied with at least two specimens (or one where limitations exist).

List of Suggested Families (*mandatory)

Acanthaceae, Rubiaceae, *Apiaceae, Apocynaceae, *Asteraceae, *Brassicaceae, *Euphorbiaceae, *Fabaceae, *Lamiaceae, Liliaceae, *Malvaceae, Moraceae, *Poaceae, *Ranunculaceae, *Solanaceae.

Essential/recommended readings:

1. Simpson, M. G. (2019). *Plant systematics*. 3rd Edition, Academic press.
2. Singh, G. (2019). *Plant Systematics- An Integrated Approach*. 4th edition. CRC Press, Taylor and Francis Group.
3. Pandey, A. K., Kasana, S. (2021). *Plant Systematics*. 2nd Edition. CRC Press Taylor and Francis Group
4. <http://www.mobot.org/MOBOT/research/APweb/>
5. Maheshwari, J. K. (1963). *The flora of Delhi*. Council of Scientific & Industrial Research.
6. Maheshwari, J. K. (1966). *Illustrations to the Flora of Delhi*. Council of Scientific & Industrial Research.
7. Harris, J. G., Harris, M. W. (2001). *Plant Identification Terminology: An Illustrated Glossary*. Spring Lake, Utah: Spring Lake Pub. Spring Lake, Utah.

Suggestive Readings:

1. The Angiosperm Phylogeny Group, Chase, M.W., Christenhusz, M.J.M, Fay M.F., Byng, J.W., Judd, W.S., Soltis, D.E., Mabberley, D.J., Sennikov, A.N., Soltis, P.S., Stevens, P.F. (2016). *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV*. Botanical journal of the Linnean Society 181 (1): 1-20.
2. <https://www.mobot.org/MOBOT/research/APweb/treeapweb2s.gif>
3. <https://www.digitalatlasofancientlife.org>
4. <http://apps.kew.org/herbcat/navigator.do>
5. <https://efloraofindia.com/>
6. <https://powo.science.kew.org/>
7. Page, R.D.M., Holmes, E.C. (1998). *Molecular Evolution: A Phylogenetic Approach*. Blackwell Publishing Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CHEMISTRY COMPONENT – DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC 06)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Analytical Techniques in Chemistry ALS CHEM DSC 06	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

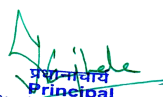
The learning objectives of this course are as follows:

- to make students aware of the concept of accuracy, precision, Statistical test data-F, Q and t test.
- to expose students to the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectra.
- to familiarize students to different electroanalytical methods of analysis.
- to make students familiar to important separation methods like solvent extraction and chromatography.

Learning Outcomes:

By studying this course, students will be able to:

- analyse various sources of errors in chemical analysis.
- apply methods to minimize error.


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- understand basic principle of instrumentation (UV-VIS spectrophotometer, Infrared spectrometer, Mass spectrometer, NMR Spectrometer).
- apply basic principles of separation techniques (chromatography and solvent extraction) and apply them to separate mixtures.
- analyse samples independently in the laboratory.

Unit 1: Qualitative and Quantitative Aspects of Analysis

(4 Hours)

Errors, Accuracy and Precision. The Gaussian distribution, mean and standard deviation, confidence intervals. Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test.

Unit 2: Optical Techniques of Analysis

(8 Hours)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, Verification of Beer's-Lambert Law by using colorimeter for different solutions and its limitations. UV-Visible Spectrometry: Basic principles of instrumentation for single and double beam instruments. Determination of concentration of unknown compounds, composition of metal complexes using Job's method of continuous variation and mole ratio method.

Unit 3: Electroanalytical Techniques

(6 Hours)

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values. Application of conductance measurement: i) Ionic product of water ii) Solubility and solubility product of sparingly soluble salts.

Unit 4: Separation Techniques

(6 Hours)

Solvent extraction: Classification, principle and efficiency of the technique. Chromatography: Principles of Chromatographic separations, Classification of Chromatographic techniques, Paper

Chromatography, Thin Layer Chromatography, Column Chromatography, efficiency of separation (Resolution, Efficiency of Resolution, Plate Height) Application of these techniques in analysis of biological samples.

Unit 5: Spectroscopy

(6 Hours)

Basic principle of IR and NMR spectroscopy, interpretation of IR spectra of simple organic molecules with functional groups amine, amide, carbonyl, hydroxy. Chemical shift and low-resolution spectra, factors affecting chemical shift, interpretation of ^1H -NMR spectra of simple organic molecules like methanol, ethanol, acetaldehyde, acetone, acetic acid, aromatic protons and pesticide. Elementary discussion on Mass Spectrometry.

PRACTICAL

(60 Hours)

1. Verification of Lambert-Beer's law and determination of concentration of a coloured species (KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$).
2. Determine the concentration of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture by using colorimeter.
3. Spectrophotometric analysis of Co^{2+} and Ni^{2+} ions in a mixture.
4. Perform the following conductometric titration
 - i) Strong acid vs strong base
 - ii) Weak acid vs strong base
5. Perform the following potentiometric titration
 - i) Strong acid vs strong base
 - ii) Weak acid vs strong base
6. Determination of isoelectric point of amino acids.
7. Separation of Co^{2+} and Ni^{2+} mixture by paper chromatography and to determine their R_f values.

8. Separation of amino acids present in the given mixture by paper chromatography and to determine their R_f values.
9. Interpretation of simple organic compounds by IR spectra. (Spectra to be provided).
10. Study and interpretation of ^1H -NMR spectra of simple organic compounds (Spectra to be provided).
11. Interpretation of the structure of simple pesticide molecule (two examples) from the given IR and NMR data/spectra

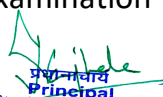
Essential/ Recommended readings:

1. Willard, H.H. (1988), *Instrumental Methods of Analysis*, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D. (2004), *Analytical Chemistry*, 6th Edition, John Wiley & Sons, New York.
3. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley and Sons.
4. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), *Principles of Instrumental Analysis*, Thomson Asia Pvt. Ltd.
5. Donald L. Pavia, Gary M. Lampman, George S. kriz (2014), *Introduction to Spectroscopy*, Thomas Press Ltd.
6. Singh, Pradeep Pratap; Ambika (2018), *Organic Spectroscopy*, Viva Books

Suggestive readings:

1. Harris, D. C. (2007), *Quantitative Chemical Analysis*, 6th Edition, Freeman.
2. Khopkar, S.M. (2008), *Basic Concepts of Analytical Chemistry*, New Age International Publisher.

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CHEMISTRY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medicinal Chemistry; ALS CHEM DSE 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to impart fundamental knowledge on the structure, chemistry, and therapeutic value of drugs.
- to familiarize the structure activity relationships (SAR) of drugs.
- to understand the importance of physicochemical properties and metabolism of drugs.
- to study chemical synthesis of important drugs under each class.

Learning Outcomes:

By studying this course, students will be able to:

- understand the chemistry of drugs with respect to their pharmacological activity.
- explain the drug metabolic pathways, adverse effect and therapeutic value of drugs.
- analyze the Structural Activity Relationship (SAR) of different class of drugs.
- write the chemical synthesis of some drugs.

Unit 1: Basic Principles of Medicinal Chemistry

(10 Hours)

History and development of medicinal Chemistry. Stereochemical aspects: optical, geometrical, conformational, Isosterism. Physiochemical properties: solubility, acid-base, chemical bond,

partition coefficient. Drug receptor interaction and International Nonproprietary Names (INNs) of drugs.

Unit 2: Pharmacokinetics

(4 Hours)

ADME: Drug absorption, drug distribution, drug metabolism - Phase 1, Phase 2 metabolism, drug excretion, Drug Half Life.

Unit 3: Medicinally Important Classes of Compounds

(10 Hours)

Introduction, Structure, Synthesis, Therapeutic value and elementary SAR of representative drugs of the following classes:

- Analgesics agent: Ibuprofen
- Antipyretic agent: Paracetamol
- Anti-inflammatory agent: Aspirin
- Antibacterial and antifungal agents: Sulphonamides; Sulphanethoxazol, Sulphacetamide
- Antiviral agent: Acyclovir
- Antibiotics agents: Penicillin, Cephalosporin, Chloromycetin and Streptomycin
- Antileprosy agent: Dapsone

Unit 4: Drugs Acting on Central Nervous System

(6 Hours)

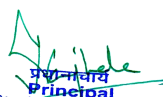
Introduction, structure, therapeutic value and elementary SAR of representative drugs of the following classes:

- Central Nervous System agents: Phenobarbital, Diazepam
- Morphine and related drugs
- Narcotic antagonists: Nalorphine hydrochloride
- Miscellaneous: Cardiovascular (Glyceryl trinitrate), HIV-AIDS related drugs (AZT-Zidovudine)

PRACTICAL

(60 Hours)

1. Preparation of aspirin and its analysis.


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2. Preparation of paracetamol and its analysis.
3. Preparation of sulphacetamide of sulphonamide and its analysis.
4. Determination of alcohol contents in liquid drugs/galenical.
5. Determination of ascorbic acid in vitamin C tablets by iodometric or coulometric titrations.
6. Assay of drugs (any two)
 1. Chlorpromazine
 2. Phenobarbitone
 3. Atropine
 4. Ibuprofen
 5. Aspirin

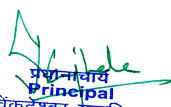
Essential/ Recommended Readings:

1. Patrick, G. (2017), *Introduction to Medicinal Chemistry*, Oxford University Press.
2. Lemke, T. L.; William, D.A.; Roche, V. F.; Zito, S. W. (2012), *Principles of Medicinal Chemistry*, 7th Edition, Wolter Kluwer I Lippincott Williams and Wilkins.
3. Burger, (2021) *Medicinal Chemistry, Drug Discovery and Development*, Vol I to VIII, 8th Edition, Wiley.

Suggestive Reading:

1. Beale, J. M.; Block, J. H. (2010), *Organic Medicinal and Pharmaceutical Chemistry*, 12th Edition, Wolters Kluwer India Pvt. Ltd.
2. Singh H.; Kapoor V.K. (1996), *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan.

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ZOOLOGY COMPONENT - DSC

DISCIPLINE SPECIFIC CORE COURSE (DSC-06)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Immunology and Immunotechnology ALS ZOO DSC 06	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

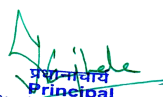
The learning objectives of this course are as follows:

- to acquaint the students about cells of innate and acquired immune system and their interactions.
- to learn the structure of antibody, different isotypes and their biological functions.
- to acquire knowledge of different types of vaccines.
- to apprise the students of the mechanisms of antigen processing and presentation.
- to train the students in various immunotechniques applied in diagnostics and therapeutics.

Learning Outcomes:

By studying this course, students will be able to:

- have better understanding of the concepts of innate and acquired immunity.
- acquire knowledge of antigenicity and immunogenicity of biomolecules.
- comprehend and analyse different cellular and humoral components of the immune system.


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- appreciate the applications of immunotechniques used in diagnostics and therapeutics.

Unit 1: Overview of Immune System

(3 Hours)

Historical perspectives of immunology, clonal selection theory, brief outline of immune dysfunctions (hypersensitivity, autoimmunity and immunodeficiency).

Unit 2: Innate and Adaptive Immunity

(7 Hours)

Anatomical barriers, inflammation, cells of immune system; adaptive immunity: cell-mediated and humoral, active and passive, natural and artificial.

Unit 3: Antigens

(4 Hours)

Antigenicity and immunogenicity; Immunogens: factors influencing immunogenicity; adjuvants and haptens; properties of B and T-cell epitopes.

Unit 4: Immunoglobulins and Vaccines

(7 Hours)

Structure and functions of different classes of immunoglobulins, different types of vaccines.

Unit 5: Major Histocompatibility Complex

(4 Hours)

Structure and functions of MHC molecules (MHC I and II), endogenous and exogenous pathways of antigen processing and presentation.

Unit 6: Immunotechniques

(5 Hours)

Double immunodiffusion assay, haemagglutination assay (ABO typing), immunoelectrophoresis, immunofluorescence, ELISA, hybridoma technology: monoclonal antibodies in therapeutics and diagnosis.

PRACTICAL

(60 Hours)

1. Demonstration of lymphoid organs of rat/mouse. (Subject to UGC guidelines).
2. Study of primary and secondary lymphoid organs through slides/photographs/videos.
3. Preparation of stained blood film to study various types of cells.
4. Preparation of serum using rat /mouse (Subject to UGC guidelines).
5. Perform Ouchterlony's double immunodiffusion (DID) to study immunoprecipitation and interpretation of patterns of identity, non-identity and partial identity.
6. Identification of ABO blood group by haemagglutination using antisera.

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7. Cell counting and viability test of splenocytes from farm bred animals/cell lines.
8. Demonstration of ELISA and Immuno-electrophoresis.
9. Project on any topic related to theory.

Essential/ Recommended Readings:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006). *Immunology*, VI Edition, W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
3. Punt, J., Stranford, S., Jones, P., Owen J., A. (2018) Kuby Immunology, W H Freeman Publications.

Suggestive readings:

- 1 Abbas, K. Abul and Lichtman H. Andrew (2017) *Cellular and Molecular Immunology*. IX Edition, Saunders Publication.
- 2 Kaur, H., Toteja, R., and Makhija, S. (2021). *Textbook of Immunology*. IK International Publishing House and Wiley India Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ZOOLOGY COMPONENT - DSE

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Social and Beneficial Insects ALS ZOO DSE 04	4	2	0	2	Class 12 th Pass with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to acquaint students of the social organization found in insects.
- to apprise them of beneficial aspects of insects.
- to impart knowledge about the techniques involved in culturing and rearing of bees, silkworms and lac insect.

Learning Outcomes:

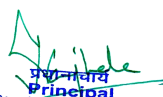
By studying this course, students will be able to:

- identify different types of social and beneficial insects.
- differentiate the various castes and their role in the social life of insects.
- acquire skill for mass rearing of beneficial insects and their products.

Unit 1: Social Insects

(7 Hours)

Characteristics and systematic position. Social organization: caste determination, communication, social parasitism and symbioses, social insect pathogens. Life cycle, social organisation and types of ants, bees, wasps and termites.


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Unit 2: Apiculture**(7 Hours)**

Habit and habitat of honey bee (*Apis*), bee keeping techniques, bee pasturage, artificial bee hives. Economic importance of bee. Bee enemies, bee diseases and their control.

Unit 3: Sericulture**(6 Hours)**

Life cycle of silkworm *Bombyx mori*. Types of silkworm species and their salient features. Rearing techniques of mulberry, muga, eri and tassar silkworms. Enemies and diseases of silkworms and their management.

Unit 4: Lac Culture**(5 Hours)**

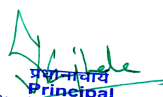
Habit, habitat and biology of *Laccifera lacca*. Host trees of lac insect, pruning, inoculation and lac harvesting. Enemies of lac insect and their control.

Unit 5: Ecological aspects of beneficial insects**(5 Hours)**

Ecological role of insects: pollination, weed control, improving soil fertility and as scavengers. Medicinal use of insects and insect products. Entomophagy.

PRACTICAL**(60 Hours)**

1. Study of life cycle of ants, bees, termites, silk worm and lac insect through museum specimens/photographs.
2. Study of different nests build by ants, bees and termites.
3. Construction and maintenance of artificial bee hives and study of equipments related to apiculture.
4. Rearing techniques of mulberry, muga, eri and tassar silkworms.
5. Study of different types of enemies and diseases of silkworms.
6. Study of lac culture technique: pruning, inoculation, cropping and harvesting.
7. Study of economically important insect products.


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Essential/Recommended readings:

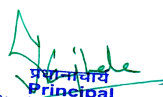
1. Watson, J. A. L., Okot-Kother, B. M. and Noiroh C. (1985) *Caste differentiation in social insects*. Pergamon Press.
2. Dunston AP. (2007) *The Insects: Beneficial and Harmful Aspects*. Kalyani Publishers., New Delhi.
3. Brian, M. V. (1983) *Social insects: ecology and behavioural biology*. Chapman and Hall, London, New York.
4. D. B. Tembhare (2017) *Modern Entomology*. Himalaya Publishing House.
5. Dokuhon, Z.S. (1998) *Illustrated Textbook on Sericulture*. Oxford & IBH publishing Co., Pvt. Ltd. Calcutta.
6. Shukla, G.S. and Upadhyay, V.B. (2014) *Applied and Economic Zoology*, Rastogi Publications.

Suggestive readings:

1. Maxwell F.G. and Jennings P.R. (Eds). (1980) *Breeding Plants Resistant to Insects*. John Wiley & Sons, New York.
2. *Encyclopedia of Social Insects* (2021) Springer International Publishing.

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UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/

Dated: 28.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1/(18-1-21), 38-1/ (38-1-16) & 60-1/ (60-1-12) dated 18.08.2022, 08.12.2022 & 03.02.2023 respectively]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

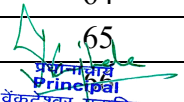
**Add the following:
Skill Enhancement Courses (SECs)
Under
UGCF-2022**

**Listed under Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the
University
(with effect from Academic Year 2022-23)**

A student who pursues any undergraduate programme in the University and its Colleges is offered a pool of Skill Enhancement Courses. A list of such courses as passed by the Executive Council in its meetings dated 18.08.2022, 08.12.2022 and 03.02.2023 are listed below:

Course	Serial no
Beginners Course to Calligraphy	1
Communication in Everyday Life	2
Communication in Professional Life	3
Creative writing	4
Business Communication	5
Introduction to Arabic Calligraphy	6
Negotiation and Leadership	7
PERSONALITY DEVELOPMENT AND COMMUNICATION	8
POLITICAL COMMUNICATION AND LEADERSHIP	9
Public Speaking in English Language and Leadership	10
Patkatha Lekhan	11
Rangmanch	12
Rachnatmak Lekhan	13
Anuvad Kala	14
Srijnatmak Lekhan	15
IT Skills and Data Analysis – I	16
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Advanced Spreadsheet Tools	19
Statistical Software Package	20
Financial Database and Analysis Software	21
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VISUAL COMMUNICATION AND PHOTOGRAPHY	30
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Beginners Course to Calligraphy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Beginners Course to Calligraphy	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To teach students the art of Calligraphy.
- To make students better at handwriting and embellish the scripts.
- To help the students communicate with creativity.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- Students will be skilled in calligraphy scripts.
- Learning flourishing will help to develop good writing.
- Practice sessions will further a project at the end of semester.
- Will induce skills to set up a business, too.

SYLLABUS

Course Contents:

Unit 1: Introduction to Calligraphy

(10 hours)

- Definition, History of calligraphy, Calligraphy at the Global level, Types of Calligraphy: Classical Calligraphy & Modern Calligraphy
- Practice Sessions: Introducing students to Calligraphy and its types through images, videos and animations.

Unit 2: Introduction to the Writing tools**(20 hours)**

- Tool Kit, Different Types of Pens, Different Types of Nibs, Different Types of Brushes, Different Types of Inks
- Practice Sessions: Display of Writing items, Discussion on the usage of different types of pens, nibs and brushes through hands-on activities

Unit 3: Foundation to Calligraphy**(30 hours)**

- How to write letters?, Majuscules, Miniscules, Numbers, Learning Strokes, Sans Serif B- point, Celtic, Italian Script, Roman Script, Gothic Script
- Practice Sessions: Learning and practicing strokes- Upstroke, Downstroke, Overturn, Underturn, Compound curve, Oval, Ascending loop
- Hands-on activities and Assessment on Sans Serif B-point, Celtic, Italian Script, Roman Script, Gothic Script, Flourishing

Essential/recommended readings

- Suepsuan, P. A. (2021). Start Calligraphy The Right way to write: Learn Calligraphy The Complete Book - Modern Calligraphy Pen For Beginners, Learning Resources Step By Step Number Line, Mastering Modern Calligraphy. Independently published.
- C., & Co., T. P. (2020). Modern Calligraphy Set for Beginners: A Creative Craft Kit for Adults featuring Hand Lettering 101 Book, Brush Pens, Calligraphy Pens, and More. Paige Tate & Co.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Communication in Everyday Life	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To lay down a basic foundation for basic communication that is a part of a student's everyday life.
- To inculcate the fundamentals of communication with the aim to enhance listening, speaking and writing skills.
- To hone practical skills that can be used in day-to-day affairs.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to improve mediation skills.
- After studying this course, students will be able to building human relationships.
- After studying this course, students will be able to foster societal understanding & develop an independent perspective.
- After studying this course, students will be able to enhance social communication skills of students.

SYLLABUS

Course Contents:

UNIT 1

(8 hours)

Theory of Communication

- Meaning, Features, Uses, Cycle, Feedback, Advantages
- Barriers
- 7 C's of Communication

UNIT 2

(14 hours)

Listening Skills

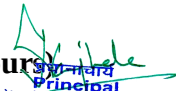
- Netiquettes
- Audio-book Listening & Discussions
- Note-taking

UNIT 3

(14 hours)

Speaking Skills

- Oral Presentation- Audio-Visual aids, Audience & Feedback, Delivery of Presentation, Handling Questions
- Group Discussion- Culture & History, Current Affairs, Society-related
- Public Speaking- Public Speech, Extemporaneous


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- Interview- Personal, Conversational, Public

UNIT 4

(8 hours)

Reading Skills

- Close Reading
- Skimming
- Scanning

UNIT 5

(16 hours)

Writing Skills

- Summarising
- Paraphrasing
- Note-making
- Essays- Expository Essay, Descriptive Essay, Narrative Essay
- Letter Writing- Formal Letter, Informal Letter
- Reports- Incidence, Newspaper, Organisational Report
- Analysis & Interpretation- Textual
- Intra & Inter-personal Skills - Monologue, Dialogue

Suggested Readings

- Chaudhary, Shoma. “Understanding Interviews, Billy Elliot is my Story, Only Less Happy”. Tehelka: The People’s Paper, 18 February 2006.
- Kumar, Dinesh. “Understanding Values, Our Muddled Generation”. The Hindu, 26 March 2006.
- Learning to Write I, “Free Writing”. In Fluency in English II, ed. Varma, Pramodini and Mukti Sanyal, pp. 1-5, Oxford, New Delhi, 2015.
- Learning to Write II, “Editing”. In Fluency in English II, ed. Varma, Pramodini and Mukti Sanyal, pp. 25-27, Oxford, New Delhi, 2015.
- Learning to Write III, “What makes Good Writing Good”. In Fluency in English II, ed. Varma, Pramodini and Mukti Sanyal, pp. 48-51, Oxford, New Delhi, 2015.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Communication in Professional Life	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To prepare the students for their upcoming professional fields.
- To inculcate the fundamentals of professional and business communication.
- To learn aspects of global communication.
- To enhance employability skills of the learners by enabling them to write effective resumes and face interviews with confidence

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to improve presentation skills to be learnt by effective use of verbal and non-verbal communication for the professional field.
- After studying this course, students will be able to acquire practical employability skills to be disseminated through focussed sessions on practical employable knowledge.
- After studying this course, students will be able to enhance professional communication.
- After studying this course, students will be able to improve persuasion and negotiation skills which will be useful for the professional field.

SYLLABUS

Course Contents:

UNIT 1

(8 hours)

- Theory of Business Communication
- Introduction
- What is Business Communication?
- Language of Business Communication
- Cultural Components – Cross-Cultural Communication, Cultural Shock, Stereotyping, Ethnocentrism
- Miscommunication & Effective Communication

UNIT 2

(14 hours)

Listening Skills

- Netiquettes
- Audio-book Listening & Discussions
- Note-taking

UNIT 3

(18 hours)

Speaking Skills

- Presentation Skills- Oral Presentation, Ppt. Preparation, Ppt. Presentation
- Group Discussion
- Talks- Domain-specific, Ted-Talks, Business Meets, Motivational Talks
- Telephonic Skills
- Persuasion Skills
- Meeting & Negotiation
- Interview- Promotion Interview, Job Interview, Business Interview
- Functions and activities of PR

UNIT 4

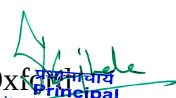
(20 hours)

Writing Skills

- Summarising & Paraphrasing
- Job-Oriented Skills- CV, Resume & Bio- Data, Job Application Letter
- Documentation
- Advertisements & Invitation
- Letter Writing- Applications, Business Letters
- Report- Analytical Report, Project Report
- Digital Communication in Social Space- Social Media Posts (Twitter, Facebook), Blog Writing, Review Writing
- Advertisement/Invitation/Poster Designing- Canva/MS Word/Coral
- Memo, Office Order, Minutes
- Making Online Academic/Work Profile- LinkedIn

Suggested Readings

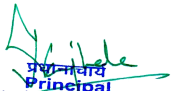
- Kaushik, J.C. and K.K. Sinha eds., English for Students of Commerce, Oxford University Press, New Delhi.
- Sethi, Anjana & Bhavana Adhikari, Business Communication, Tata McGraw Hill.
- Anjana Neira Dev, et.al, eds. Business English, Department of English, University


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वी.के.ए. कैंपस, दिल्ली कैंपस, New Delhi-21

of Delhi, 2011, Pearson Publications, New Delhi.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Creative Writing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Creative Writing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To build creative writing skills of students in the main modes of creative writing viz poetry, fiction (novel, short stories), non-fiction (life narratives, autobiographies and biographies) and drama.
- To inculcate practical skills in students by mapping their creative talent which be beneficial for employability too.
- To perform hands-on-activities to students to develop their creative skills through practical sessions.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to be sensitive to the texture of literary language.
- After studying this course, students will be able to develop craft in creative writing.
- After studying this course, students will be able to develop sense of expressing themselves through poetry/short story/biography.
- After studying this course, students will be able to induce an understanding of the relationship between an individual and society.
- After studying this course, students will be able to get into different fields and pursue versatile career opportunities.
- After studying this course, students will be able to develop an understanding of theatre and performance through drama will also help them to develop observatory and behavioural skills.
- After studying this course, students will be able to develop a critical thought process and a knack in putting it in words. Students may also utilise the learnings of proofreading and editing for their academic and professional growth.
- After studying this course, students will be able to go for publishing their own work.
- After studying this course, students will be able to write a book and submit to professional bodies & academic organisations.

SYLLABUS

Course Contents:

UNIT 1

- Introduction to Creative Writing- Meaning, Importance

- Imagination & Writing- Peer-interaction, Activities on Imagination
- Tropes, Motifs and Figures- Learning tropes, motifs and figures through videos, Discussion on the findings
- Craft of Writing- Figure of Speech, Word Play, Character Creation
- Character Creation- Dialogue Enaction, Learning Characters through discussion on famous writings, Character Analysis, Writing activities on creating different types of characters (gender/social background/ethnicity etc.)

UNIT 2

(18 hours)

- Close Reading
- Analysis and Interpretation- Reading different works in Literature, Discussion in small groups, Practice Writing Session
- Proofreading & Editing- Practice sessions on Proofreading & Editing of different types of writing

UNIT 3

(24 hours)

- Steps of Creative Writing- Pre-Writing, Writing, Post-Writing/Final Draft
- Types of Creative Writing- Poetry, Fiction, Non-Fiction (Life Narratives), Drama
- Creative Writing & Media- Film Review, Book Review, Other Writings in Media, Submission, Publication
- Learning to write Poetry- Reading & understanding Poetry; Practising tone, rhyme, metre, verses; Writing sessions
- Learning to write Fiction- Reading & understanding Fiction; Practicing different elements of fiction (Short story, Novella, Novel); Writing sessions
- Learning to write Non-Fiction- Reading & understanding Non-Fiction (Biographies & Autobiographies); Practicing different elements of non-fiction; Writing sessions
- Learning to write Drama- Reading & understanding Drama; Practicing different elements (plot, character, climax, verbal & non-verbal cues) of Drama; Writing sessions
- Submission & Publication (in Print & Digital) - Discussions over how & where to submit and publish (online/offline), Hands-on activities

Suggested Readings

- *Creative Writing: A Beginners' Manual* by Anjana Neira Dev et al. for The Department of English, University of Delhi (New Delhi: Pearson, 2008).

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Business Communication	2	1	0	1	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To train students to enhance written as well as oral communication in the corporate world.
- To help students in understanding the principles and techniques of business communication.
- To understand the use of electronic media for communication.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to explain the need for communication in management.
- After studying this course, students will be able to appreciate the need of effective writing for communication.
- After studying this course, students will be able to demonstrate the skill of effective report writing and summarizing annual reports.
- After studying this course, students will be able to analyse business correspondence and e-correspondence.
- After studying this course, students will be able to appreciate oral presentations.

SYLLABUS

Course Contents:

Unit 1: Introduction to the essentials of Business Communication (9 hours)

Meaning, process and functions. Need and importance. Medium: verbal & non-verbal communication. Channels: formal & informal. Levels of communication. Direction of communication: downward, upward, lateral, & diagonal. Effective communication: difficulties/barriers and solutions. Interactive and non-interactive techniques of communication. Listening as a tool of communication, Guidelines for effective listening.

Unit 2: Effective Writing (9 hours)

Guidelines for clear writing. References, bibliographical research tools. Citing methods, footnotes, discussion footnotes. Use of library and internet for collection, classification and interpretation of data and information.

Unit 3: Report Writing

Types of reports. Formal report: components and purpose. Organising information: outlining

& numbering sections, section headings, sub-headings, & presentation. Writing reports on field work/visits to industries, business concerns. Summarising annual reports of companies: purpose, structure and principles. Drafting minutes.

Unit 4: Business Correspondence and E-Correspondence (9 hours)

Need and importance of business letters. Office memorandum, office circulars, notices and orders. Technology for communication. Effective IT communication tools. Electronic mail: advantages, safety and smartness in email. E-mail etiquettes.

Unit 5: Spoken English and Oral Presentation (9 hours)

Effective negotiation: elements, process and general guidelines. Telephonic conversation. Conducting & facing interviews. Conducting & participating in group decisions. Making presentations: content and organising. Features of a good presentation. Delivering a presentation.

Practical Exercises:

The learners are required to:

- learn how to summarise annual reports of companies.
- prepare presentations using power-point.
- participate in Group discussions and mock interviews.
- smartly draft business emails.

Essential/recommended readings

- C.B.Gupta (2019). Essentials of Business Communication, Sultan Chand & Sons.
- Kaul, A. Effective Business Communication, 2nd ed. PHI learning
- Lesikar, R.V. & Flatley, M.E. (2001). Basic Business Communication Skills for Empowering the Internet Generation, Tata McGraw Hill Publishing Company Ltd. New Delhi.
- Ludlow, R. & Panton, F.(1992). The Essence of Effective Communications, Prentice Hall of India Pvt. Ltd., New Delhi.
- Meyer C,Dev(2021). Communicating for Results,Oxford University Press
- Quintanilla, Kelly M, (2021), Business and Professional Communication, 4e, Sage Textbook
- R. C. Bhatia (2008), Business Communication, Ane Books Pvt Ltd, New Delhi.
- Raman and Singh(2012). Business Communication. Oxford University Press
- Scot, O., Contemporary Business Communication. Biztantra, New Delhi.

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Introduction to Arabic Calligraphy

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Arabic Calligraphy	2	0	0	2	Class XII	NA

Course Objectives: 1. To make the learners familiar with Arabic Calligraphy. 2. To make them aware of different Arabic scripts.	Course Learning Outcomes: The student will be able to: 1. Know about the history of Arabic Calligraphy. 2. Read and write Arabic letters and text. 3. Recognize different Arabic scripts/fonts. 4. Write in two Arabic scripts: Naskh and Ruq'ah.
Unit 1 (20 hours) - Calligraphy - Arabic Calligraphy -Origin and Development of Arabic Calligraphy -Lesson on Arabic Alphabet -Introduction to Arabic script Ruq'ah -Introduction to Arabic script Naskh	Unit 2 (20 hours) - Importance and Characteristics of the Arabic Script Ruq'ah in modern time. - Importance and Characteristics of the Arabic Script Naskh in modern time. - Familiarity with different Arabic scripts. - Al-Aqlaam Al-Sittah - Pioneers of the Arabic scripts/calligraphy. • Ibn Muqlah • Ibn Al-Bawwab
Unit 3 (20 hours) -Benefits of Good handwriting -Famous Arabic fonts of computer -Practice of the Arabic scripts: Naskh and Ruq'ah	

Teaching Learning Process

- The teacher will introduce different aspects of Arabic scripts to students.
- The students will practice the prescribed scripts to make their handwriting beautiful.
- The teacher will also use computer to familiarize the students with different Arabic scripts of it.

References:

1. M. Ziauddin: Muslim Calligraphy, Kitab Bhawan, Delhi
2. عالم خليل مي: خط نور مولانا
ندديو، سيكن؟ كاو
كيو رقع
رة؛ القا، وتطوره ي 4 شأته 6 العر ط 189 + :، لو عادل. د.
3. غزة، منصور G مكتبة سم، ارة C وم حضارة ي 6 العر ط 189، العيد شيخ سليمان يم؛ ابرا. د.
4. فلسطين .

Additional Resources:

1. Muhammad Sohail: Administrative and Cultural History of Islam, New Delhi.
2. خلال ي من 6 العر ط 189 : سلامية W والدراسات للبحوث ا ملك فيصل مركز .
السعودية العر ا ملكة، طوطات 18Y

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Negotiation and Leadership

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Negotiation and Leadership	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the importance of negotiation skills
- To expose the students to diverse contexts and situations that require negotiation skills
- To learn about the management of critical and crisis situations
- To evolve relationship building skills

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to apply negotiation skills to obtain desired results
- After studying this course, students will be able to understand the various aspects of a crisis situation for appropriate management.
- After studying this course, students will be able to learn how to manage complex negotiation situations.
- After studying this course, students will be able to understand the process of relationship building.
- After studying this course, students will be able to test and judge the legitimacy of the terms of negotiation

SYLLABUS

Course Contents:

Unit 1 (15 hours)

Negotiation Fundamentals Key concepts and core vocabulary of negotiation process, deal-making and dispute resolution, Assumptions and biases that are barriers to effective negotiation, Collaborative approaches, risk & opportunities to achieve win-win outcomes

Negotiation Canvas Introduction of a framework for negotiation preparation and how to use it, Elements of negotiation canvas i.e relationship, alternatives, legitimacy, options, interests among others, Difference between position and interests

Unit 2 (15 hours)

Managing critical moments

Types of negotiation approaches used by negotiators Critical moments that can make or break the deal How to identify these critical moments, Strategies to manage critical moments in the negotiation

Effective Communication and Relationship Building

Role of communication and relationship in negotiation, Understanding the other party's psychology to understand their interests, build trust and improve the scope of the negotiation, Unconditionally constructive behaviours, Methods of building trust, and empathy, Overcoming communication barriers, difficult behaviours and information asymmetry

Unit 3 (15 hours)

Discovering, creating and claiming value

Methods of value discovery during negotiation, How is value divided and claimed between the negotiating parties?, What are the tradeoffs, mutual gains and contingencies?, Concept of distributive bargaining, equitable solutions, and ZOPA (zone of possible agreement), Biases and enemies of value creation

Complex Negotiations

Strategies for negotiations are not straightforward, involve several issues, include multiple stakeholders, and /or involve powerful parties, Hofstede's Culture dimensions, Dealing with people with difficult behaviours

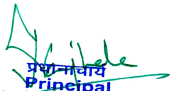
Unit 4 (15 hours)

Managing Alternatives

Concept of BATNA (Best Alternative to Negotiated Agreement), Methods to evaluate alternative options/offers, Management of one's alternatives and other party's alternatives during negotiation.

Legitimacy and Building Commitment

When to say yes to agreed terms, and when to walk away, Criteria for decision-making on negotiated terms, Assessment of the legitimacy of negotiated terms, Leading and following to commit to the negotiated agreement, Steps from plan to execution


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Essential/Recommended Readings

- Getting to Yes: Negotiating Agreement Without Giving in by Roger Fisher, William L. Ury, and Bruce Patton. Penguin Books
- Difficult Conversations: How to Discuss What Matters Most by Douglas Stone, Bruce Patton, Sheila Heen. Penguin Books
- Value Negotiation: How to Finally Get the Win-Win Right by Horacio Falcão. Pearson Education

Articles

- The Seven Myths of Win-Win Negotiations, by Horacio Falcão
- Control the Negotiation before it begins by Deepak Malhotra

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Personality Development and Communication

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Personality Development and Communication	2	1	0	1	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop inter personal and effective communication skills.
- To develop problem solving skills and understand its influence on behaviour and attitudes of individuals.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the importance of oral and written communication in day-to-day working of the organisation.
- After studying this course, students will be able to develop inter personal skills and problem-solving skills.
- After studying this course, students will be able to understand the role of body language in effective communication.

SYLLABUS

Course Contents:

Unit 1

(12 hours)

Introduction, need for Communication, Process of Communication, Written and Verbal Communication, Visual communication, Signs, Signals and Symbols, Silence as a Mode of Communication, Inter-cultural, Intra-cultural, Cross-cultural and International communication, Communication through Questionnaires, Business Letter Writing, Electronic Communication.

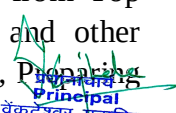
Unit 2

(12 hours)

Business Cases and Presentations, Letters within the Organizations, Letters from Top Management, Circulars and Memos, Business Presentations to Customers and other stakeholders, presenting a Positive Image through Verbal and Non-verbal Cues, and Delivering the Presentations, Use of Audio-visual Aids, Report Writing.

Unit 3

(12 hours)


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Barriers to Communication, Improving Communication Skills, Preparation of Promotional Material, Non-verbal communication, Body language, Postures and gestures, Value of time, Organizational body language, Importance of Listening, Emotional Intelligence. Working individually and in a team, Leadership skills, Leadership Lessons, Team work and Team building, Feedback, Feed forward Interpersonal skills – Delegation, Humour, Trust, Expectations, Values, Status, Compatibility and their role in building team – work Conflict Management – Types of conflicts, how to cope with conflict.

Unit 4

(9 hours)

Negotiation Skills, Types of Negotiation, Negotiation Strategies, Selling skills – Selling to customers, Selling to Superiors Selling to peer groups, team mates and subordinates, Conceptual selling, Strategic selling, Selling skills – Body language.

Essential/recommended readings

- Kushal Jin – Business Communication, VK India.
- Krishnamacharyulu, C. S. G, Ramakrishnan Lalitha – Personality Development, Interpersonal Skills and Career Management, Himalaya Publishing.
- Corvete Budjac – Conflict Management: A Practical Guide to Developing Negotiation Strategies, Pearson.

Suggestive Readings

- Mitra, B. K., Personality Development and Soft Skills, Oxford University Press.
- Kumar Sanjay and Pushplata, Communication Skills, Oxford University Press.
- Mandal S. K., Effective Communication and Public Speaking, Jaico Publishing.

Note: Latest edition of the readings may be used

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Political Leadership and Communication

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Political Leadership and Communication	2	1	0	1	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the cross-cutting multi-disciplinary linkage of the subject.
- To gain a basic understanding of specific concepts and critical review of political communication and election campaign studies.
- To be able to construct a linkage between political communication and leadership.
- To learn conceptual frameworks and qualitative research skills for the analysis of modes and techniques of political communication and leadership.

Learning outcomes

The Learning Outcome of this course is as follows:

- After studying this course, students will be able to have a professional/career-oriented insight by facilitating their journey as Media managers, policy makers, political analysts, Journalists, Public relations officers in government agencies, political parties and higher education.

SYLLABUS OF SEC-7

Unit I: Explaining Political Communication

(9 hours)

- Meaning, Nature and Scope
- Evolution and Transformation

Unit II: Exploring Leadership

(9 hours)

- Themes, Theories and Typologies
- Participation and Performance

Unit III: Expanding Political Communication and Leadership: Orientation and Action (9 hours)

- Developing Communication and Leadership through Research
- Strengthening Techniques of Communication and Leadership

Unit IV: Extending Political Communication and Leadership: Research Issues and Challenges (9 hours)

- Researching Communication and Leadership through Survey: Opinion Poll, Exit Poll.
- Examining Contemporary Issues and Challenges in Communication and Leadership

Unit V: Executing Political Communication and Leadership: Empirical and Professional Implications (9 hours)

- Psephology as an Art and Vocation
- Exploring Career Options

Essential/recommended Readings:

- Pole (2009). Blogging the Political: Politics and Participation in a networked Society. New York: Routledge.
- D. A. Graber (2005). 'Political Communication Faces the 21st Century', Journal of Communication, September: 479-507.
- Frank Esser and Barbara Pfetsch (eds.). (2004). Comparing Political Communication-Theories, Cases and Challenges. Cambridge: Cambridge University Press.
- G. Gerbner, L. Gross, M. Morgan and N. Signorielli (1982). 'Charting the Mainstream: Television's Contribution to Political Orientations', Journal of Communication, 32(2): 100-27.
- H. A. Semetko and M. Scammell (eds.) (2012). The SAGE Handbook of Political Communication. London: Sage.
- John C Maxwell (2008). Developing the Leader Within You. New Delhi: Harper Collins.
- Kiran Prasad (ed.) (2003). Political Communication: The Indian Experience. New Delhi: B.R. Publishers.
- Max Depree (2004). Leadership is an Art. RHUS Publications.
- Yogesh Atal (2014). 'Matdataoin Ka Sansar', Pratiman, Vol.2, No.1.
- Yogesh Atal (2018). 'Chunav Shastra Aur Rajniti', Pratiman, No.11.

Web Source

- <http://www.politicalcommunication.org/history.html>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Public Speaking in English Language and Leadership

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Public Speaking in English and Leadership	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart leadership skills to students along with adequate communication skills to curate strong leaders in the emerging social, political and corporate world.
- To create leaders with ethics and resilience in industry based fields as well as social fields.
- To allow students to realise their leadership skills and curate them through a hand-on practical approach which will be helpful in generating employable skills for them.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to learn effective communication through Public Speaking will instil leadership development among students.
- After studying this course, students will be able to lead in different fields at the undergraduate level, be responsible citizens and employ leadership skills in their future endeavours, too.
- After studying this course, students will be able to strengthen their critical mindset, help them being assertive and put forward constructive viewpoints employing the skills learnt in the practice sessions.

SYLLABUS

Course Contents:

UNIT 1

(8 hours)

- Introduction to Effective Communication- Features, Advantages & Disadvantages
- Importance of Listening
- Oral communication- Meaning, Features & Importance
- Reading Public Speech- Reading documented speeches delivered in the past; Understanding the art of word play, vocabulary and putting thoughts into words

UNIT 2

(18 hours)

- Public Speaking-
 - What is Speech?, Overcoming Fear of Public Speaking, Language of Public Speech
 - Drafting a Public Speech (Reading, research, writing, Fact check, Re-writing, Delivery)
 - 3P's of Public Speaking (Preparation, Practice, Performance)
 - Rhetoric Skills, Art of Informative & Persuasive speaking, Concluding Speech with Power
- Types of Public Speaking-
 - Physical & Online
 - Political, Organisational, Educational & Motivational
 - Ted Talks, Public Speaking in Media
- Listening in groups and Discussion- Listening famous speeches (from history & everyday life); Analysis of its elements & classroom discussion
- Writing Public speech- Classroom Practice Sessions

UNIT 3

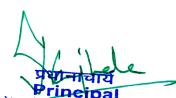
(18 hours)

- Leadership Skills- (2 hrs.)
 - Meaning, Features & Importance
 - Historical Overview
 - Leadership in Academic Life, Corporate Space, Public Life, Social Leadership and Political Leadership
- Leadership & Innovations- (2 hrs.)
 - Audience analysis
 - Audience Engagement & Leadership
 - Influencing through Leadership
- Execution & Delivery of Public Speech- Learning rhetorics through speeches in the form of Audio/ Video; Learning Body Language & Paralanguage through ICT
- Developing leadership competence through Public Speaking- Intra-class Speech Competitions; Extempore; Group Discussion

UNIT 4

(16 hours)

- Importance of Public Speaking in developing Leadership Skills
- Ethics in Public Speaking & Leadership
- Mock Parliament/MUNs
- Workshop


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घोला कुआँ, नई दिल्ली / Dhoola Kuan, New Delhi-21

Suggested Readings:

- Beebe, S. A., & Beebe, S. J. (2012). Public speaking: An audience-centred approach. (8th ed.). Boston: Pearson.
- Cardon, P. (2014). Business communication: Developing leaders for a networked world. (international ed.). New York: McGraw-Hill.
- Jaffe, C. I. (2013). Public speaking: Concepts & skills for a diverse society. (7th ed.). Boston: Cengage Learning.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

पटकथा लेखन

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
पटकथा लेखन	2	0	0	2	12 th Pass	NIL

Course Objective:

- पटकथा लेखन का परिचय कराना ।
- विद्यार्थी की लेखन-क्षमता और भाषा-कौशल को बढ़ावा देना ।
- विद्यार्थी को लेखन में रोजगार सम्बन्धी क्षेत्रों के लिए तैयार करना ।

Course Learning Outcomes:

- पटकथा लेखन तथा उसके तकनीकी शब्दों से विद्यार्थी अवगत हो सकेगा ।
- पटकथा लेखन की जानकारी मिलने के उपरान्त विद्यार्थी के लिए रोजगार की संभावनाएँ बनेंगी ।
- विद्यार्थी भाषायी सम्प्रेषण को समझते हुए लेखन से सम्बन्धित विभिन्न पक्षों से अवगत हो सकेगा ।
- विद्यार्थी में अभिव्यक्ति कौशल का विकास हो सकेगा ।

SYLLABUS

यूनिट 1

(4 सप्ताह)

- पटकथा लेखन: परिचय
- पटकथा के तत्व
- पटकथा के प्रकार
- पटकथा की शब्दावली

यूनिट 2

(4 सप्ताह)

- पटकथा लेखन में शोध का महत्व
- चरित्र की निर्मिति और विकास
- एक दृश्य का लिखा जाना
- तीन अंक (थ्री एक्ट) और पाँच अंक (फाइव एक्ट) को समझना



यूनिट 3

(4 सप्ताह)

- वेबसीरीज के लिए पटकथा लेखन
- लघु फ़िल्म के लिए पटकथा लेखन
- वृत्तचित्र के लिए पटकथा लेखन
- विज्ञापन फ़िल्म के लिए पटकथा लेखन

यूनिट 4

(3 सप्ताह)

- पटकथा का पाठ और विश्लेषण
- किसी आईडिया को स्क्रीन प्ले के तौर पर विकसित करना

सन्दर्भ पुस्तकें:

- पटकथा कैसे लिखें: राजेंद्र पांडेय - वाणी प्रकाशन, दिल्ली, संस्करण 2015
- पटकथा लेखन : एक परिचय - मनोहर श्याम जोशी - राजकमल प्रकाशन, दिल्ली संस्करण 2000
- कथा-पटकथा: मन्नु भंडारी - वाणी प्रकाशन, दिल्ली, संस्करण 2014
- व्यावहारिक निर्देशिका: पटकथा लेखन: असगर वज़ाहत - राजकमल प्रकाशन, दिल्ली संस्करण 2011
- आईडिया से परदे तक: रामकुमार सिंह - राजकमल प्रकाशन, दिल्ली संस्करण 2021

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बोला कुर्मी, नई दिल्ली / Dhaula Kuan, New Delhi-21

Examination Scheme & Mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

यूनिट 3

(4 सप्ताह)

अभिनय की तैयारी: वाचिक, आंगिक, आहार्य, सात्विक

यूनिट 4

(2 सप्ताह)

आशु अभिनय, थिएटर गेम्स, संवाद-वाचन, शारीरिक अभ्यास, सीन वर्क

यूनिट 5

(1 सप्ताह)

मंच प्रबंधन: सेट, रंग-सामग्री, प्रचार-प्रसार, ब्रोशर-निर्माण

सन्दर्भ पुस्तकें:

- संक्षिप्त नाट्यशास्त्रम् - राधावल्लभ त्रिपाठी, वाणी प्रकाशन, दिल्ली, 2009
- रंग स्थापत्य: कुछ टिप्पणियाँ - एच. वी. शर्मा राष्ट्रीय नाट्य विद्यालय प्रकाशन, दिल्ली, 2004
- पारंपरिक भारतीय: रंगमंच अनंतधाराएँ - कपिला वात्स्यायन, अनुवाद - बदी उज़्जम्मा, नेशनल बुक ट्रस्ट, दिल्ली, 1995
- हिंदी रंगमंच का लोकपक्ष, सं. प्रो. रमेश गौतम, स्वराज प्रकाशन, दिल्ली 2020
- मंच आलोकन - जी. एन. दासगुप्ता, अनुवाद - अजय मलकानी, नेशनल बुक ट्रस्ट, दिल्ली, 2006
- रंगमंच के सिद्धांत - सं. महेश आनंद, देवेन्द्र राज अंकुर, राजकमल प्रकाशन, दिल्ली 2008

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घोस कुर्मी, नई दिल्ली / Ghosla Kurni, New Delhi-21

Examination Scheme & Mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

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रचनात्मक लेखन

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
रचनात्मक लेखन	2	0	0	2	12th Pass	NIL

Learning Objectives

- विद्यार्थियों के मौखिक और लिखित अभिव्यक्ति कौशल को विकसित करना।
- उनमें कल्पनाशीलता और रचनात्मकता का विकास करना।
- साहित्य की विविध विधाओं और उनकी रचनात्मक शैली का परिचय कराते हुए लेखन की ओर प्रेरित करना।
- प्रिंट एवं इलेक्ट्रानिक माध्यमों के लिए लेखन की प्रवृत्ति को विकसित करना।

Learning outcomes

The Learning Outcomes of this course are as follows:


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इस पाठ्यक्रम के अध्ययन के पश्चात् विद्यार्थियों में:

- मौखिक और लिखित अभिव्यक्ति कौशल को विकसित होने में मदद मिलेगी।
 - उसमें कल्पनाशीलता और रचनात्मकता का विकास हो सकेगा।
 - साहित्य की विविध विधाओं और उनकी रचनात्मकता शैली का परिचय होगा जिससे वे स्वयं भी इन विधाओं में लेखन की अग्रसर हो सकेंगे।
-
- प्रिंट एवं इलेक्ट्रानिक माध्यमों के लिए लेखन की ओर भी ये अग्रसर होंगे।



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SYLLABUS

इकाई 1

(5 सप्ताह)

रचनात्मक लेखन: अवधारणा: स्वरूप आधार एवं विश्लेषण

- भाव एवं विचार की रचना में अभिव्यक्ति की प्रक्रिया
- अभिव्यक्ति के विविध क्षेत्र: साहित्य पत्रकारिता, विज्ञापन, भाषण
- लेखन के विविध रूप: मौखिक-लिखित, गद्य-पद्य, कथात्मक-कथेतर
- अर्थ निर्मिति के आधार: शब्द और अर्थ की मीमांसा शब्द के पुराने-नए प्रयोग, शब्द की व्याकरणिक कोटि

इकाई 2

भाषा भंगिमा और साहित्य लेखन

(5 सप्ताह)

- भाषा की भंगिमाएँ: औपचारिक-अनौपचारिक, मौखिक-लिखित, मानक भाषिक संदर्भ: क्षेत्रीय, वर्ग-सापेक्ष, समूह-सापेक्ष
- रचना-सौष्ठव: शब्दशक्ति, प्रतीक, बिम्ब, अलंकारवक्रता
- कविता: संवेदना, भाषिक सौष्ठव, छंदबद्ध-छंदमुक्त, लय, गति, तुक
- कथा-साहित्य: वस्तु, पात्र, परिवेश, कथ्य और भाषा

Unit III

(5 weeks)

विविध विधाओं एवं सूचना माध्यमों के लिए लेखन

- नाट्य-साहित्य: वस्तु, पात्र, परिवेश, कथ्य, रंगमंच और नाट्य-भाषा
- विविध गद्य विधाएँ: निबंध, संस्मरण, आत्मकथा, व्यंग्य, रिपोर्टाज, यात्रा-वृत्तांत
- प्रिंट माध्यम के लिए लेखन: फीचर, यात्रा-वृत्तांत, साक्षात्कार, विज्ञापन

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- इलेक्ट्रानिक माध्यम के लिए लेखन: विज्ञापन, पटकथा, संवाद

Practical Exercises if any:

नोट: उपर्युक्त का परिचय देते हुए इनका अभ्यास भी करवाया जाए।

References and suggested Readings

1. साहित्य चिंतन: रचनात्मक आयाम: रघुवंश
2. शैली: रामचंद्र मिश्र
3. रचनात्मक लेखन: सं. रमेश गौतम
4. कविता क्या है: विश्वनाथ प्रसाद तिवारी
5. कथा-पटकथा: मन्नू भंडारी
6. पटकथा लेखन: मनोहर श्याम जोशी
7. कला की जरूरत: अर्नेस्ट फिशर: अनुवादक: रमेश उपाध्याय
8. साहित्य का सौंदर्यशास्त्र: रवींद्रनाथ श्रीवास्तव
9. कविता: रचना-प्रक्रिया: कुमार विमल

Examination scheme and mode:

Total Marks: 100

Internal Assessment: 25 marks

Practical Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

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ANUVAD KALA
(Art of Translation)
(अनुवाद कला)

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES
OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ANUVAD KALA (Art of Translation) (अनुवाद कला)	2	1	0	1	Class 12 th pass in any subject	Working Knowledge of the concerned language

Credits: 2

L/T/P= 1/0/1

LEARNING OBJECTIVES:

- The course is committed to continue its pioneering work in defining new literary paradigms and fostering new directions for exploration in literary studies, including such areas as the relationship between translation and transnationalism.
- To develop a deeper appreciation of cultural diversity by introducing the technique of translation studies.
- To develop the creativity of the students and enhance their writing skills

LEARNING OUTCOMES:

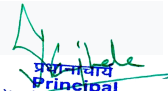
- Students will have an understanding of major approaches to the study of translation.
- They will be able to identify, analyse, interpret and describe the critical ideas, values, and themes that appear in literary texts and to understand the ways these ideas, values, and themes, inform and impact cultures and societies both in source language and its translated version.
- They will be able to improve their skill of translation.

Unit I: अनुवाद सिध्दांत- अनुवाद सिद्धांत (Translation Principles)

(Theory)

(8 Hours)

- अनुवाद की परिभाषा, प्रकृति और महत्व
अनुवाद की परिभाषा, प्रकृति और महत्व


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Definition, nature and importance of translation

- ਅਨੁਵਾਦ ਦੇ ਸੰਦ: ਕੋਸ਼, ਕੋਸ਼ਾਂ ਦੇ ਵਿਭਿੰਨ ਪ੍ਰਕਾਰ, ਪਰਿਭਾਸ਼ਕ ਸ਼ਬਦਾਂ ਦਾ ਗਿਆਨ ਹਾਸਿਲ ਕਰਨਾ

ਅਨੁਵਾਦ ਉਪਕਰਣ: ਸ਼ਬਦਕੋਸ਼, ਵਿਭਿੰਨ ਪ੍ਰਕਾਰ ਦੇ ਸ਼ਬਦਕੋਸ਼, ਪਰਿਭਾਸ਼ਿਕ ਸ਼ਬਦਾਂ ਦਾ ਜ਼ਾਨ ਪ੍ਰਾਪਤ ਕਰਨਾ

Translation tools: Dictionaries, different types of dictionaries, gaining knowledge of defining words

- ਅਨੁਵਾਦ ਦੇ ਰੂਪ: ਮਨੁੱਖੀ ਅਤੇ ਮਸ਼ੀਨੀ

ਅਨੁਵਾਦ ਦੇ ਰੂਪ: ਮਾਨਵੀ ਅਤੇ ਮਸ਼ੀਨੀ

Forms of translation: human and machine

Unit II: ਅਨੁਵਾਦ ਕਾਰਜ ਨੂੰ ਦਰਪੇਸ਼ ਚੁਣੌਤੀਆਂ-ਅਨੁਵਾਦ ਪ੍ਰਕ੍ਰਿਆ ਮੈਂ ਆਨੇ ਵਾਲੀ ਚੁਨੌਤੀਆਂ

(Challenges to the translation process)

(Theory)

(7 Hours)

- ਵਿਭਿੰਨ ਖੇਤਰਾਂ ਲਈ ਅਨੁਵਾਦ ਦੇ ਮਸਲੇ (ਮੈਡੀਕਲ, ਤਕਨਾਲੋਜੀ, ਵਿਗਿਆਨ)

ਵਿਭਿੰਨ ਖੇਤਰਾਂ ਦੇ ਲਈ ਅਨੁਵਾਦ ਦੇ ਮੁੱਦੇ (ਚਿਕਿਤਸਾ, ਪ੍ਰਾਯੋਗਿਕੀ, ਵਿਗਿਆਨ)

Translation issues for various fields (Medical, Technology, Science)

- ਮਸ਼ੀਨੀ ਅਨੁਵਾਦ ਨਾਲ ਸੰਬੰਧਤ ਮਸਲੇ

ਮਸ਼ੀਨੀ ਅਨੁਵਾਦ ਦੇ ਸੰਬੰਧਤ ਮੁੱਦੇ

Issues related to machine translation

- ਸਭਿਆਚਾਰਕ ਵੱਖਰੇਵੇਂ ਕਾਰਨ ਉਪਜੀਆਂ ਚੁਣੌਤੀਆਂ

ਸਾਂਸਕ੍ਰਿਤਿਕ ਵਿਭਿੰਨਤਾओं ਦੇ ਉਤਪੰਨ ਚੁਨੌਤੀਆਂ

Challenges arising from cultural differences

Unit III: ਸਾਹਿਤਕ ਅਨੁਵਾਦ: ਹਿੰਦੀ/ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ - ਸਾਹਿਤਿਕ ਅਨੁਵਾਦ: ਹਿੰਦੀ/ਅੰਗਰੇਜ਼ੀ

ਸੇ ਪੰਜਾਬੀ -Literary Translation: Hindi/English to Punjabi)

(Practical)

(15 Hours)

- ਕਵਿਤਾ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ

ਕਵਿਤਾ ਦਾ ਅਨੁਵਾਦ

Translating poetry

- ਕਹਾਣੀ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ

ਕਹਾਣੀ ਦਾ ਅਨੁਵਾਦ

Translating Short Story

- ਵਾਰਤਕ ਰਚਨਾ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ

ਗਦ ਕ੍ਰਿਤੀ ਦਾ ਅਨੁਵਾਦ

Translating prose

Unit IV: ਜਨ ਸੰਚਾਰ ਹਿੰਦੀ/ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ- जनसंचार हिंदी/अंग्रेजी से पंजाबी
(Mass Communication Hindi/English to Punjabi)

(Practical) (15 Hours)

- **ਖ਼ਬਰ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ**

समाचार का अनुवाद

Translating news

- **ਇਸ਼ਤਿਹਾਰ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ**

विज्ञापनों का अनुवाद

Translating Advertisement

- **ਨੋਟਿਸ ਦਾ ਅਨੁਵਾਦ ਕਰਨਾ**

नोटिस का अनुवाद

Translating Notice

ESSENTIAL READINGS:

- Bhola Nath Tiwari (2018), *Anuvad Vigyan*, Kitabghar Prakashan, Delhi.
- Bijay Kumar Das (2005), **A Handbook of Translation Studies**, Atlantic Publishers and Distributors Pvt Ltd, Delhi.
- Jaspal Kaur (Dr.) 2013, **Anuvad te Maukhik Anuvad Kala**, Manpreet Parkashan, Delhi.
- Ram Chander Verma Shashtri “n.d.”, **Anuvad Kala**, Ashok Prakashan, Delhi.
- Sushil Kumar (2003), **Anuvad da Samvaad**, Udaan Publication, Mansa.

SUGGESTED READINGS:

- Morley, David (2007), **The Cambridge Introduction to Creative Writings**, New York, Cambridge.
- Robinson, Peter (2010), **Poetry and Translation**, Liverpool University Press, England.
- Ray, Mohit K. (Ed.) (2008), **Studies in Translation**, Atlantic Publishers, Delhi.

(Note: Teachers are free to recommend additional related standard source books, if required so.)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SIRJNNATMAK LEKHAN

(Creative Writing)

(सृजनात्मक लेखन)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
SIRJNNATMAK LEKHAN (Creative Writing) (सृजनात्मक लेखन)	2	1	0	1	Class 12 th pass in any subject	Working Knowledge of the concerned language

Credits: 2

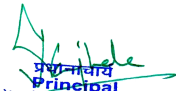
L/T/P= 1/0/1

LEARNING OBJECTIVE:

- To understand and appreciate skill of creative writing. To understand main ideas and details in different aspects of creative writing.
- To understand the contemporary position of Punjabi mass media and importance of creative writing in this field.
- To understand the importance of the skill of creative writing in the profession of electronic media.

LEARNING OUTCOMES:

- Students will demonstrate an understanding of terms, themes, strategies to learn the skill of creative writing.
- They can express their understanding of the relationship between Punjabi mass media (print and electronic) and the skill of creative writing.
- To know the scope of creative writing as a profession.


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Sri Venkateswara College
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घौला कुर्सी, नई दिल्ली / Dhola Kuan, New Delhi-21

UNIT I ਸਾਹਿਤ ਸਿਰਜਣਾ: ਬੁਨਿਆਦੀ ਨੁਕਤੇ- ਸਾਹਿਤ ਸ੍ਰਿਜਨ: ਮੂਲ ਬਿੰਦੂ

(Literary Creation: Basic Points)

(Theory)

(8 Hours)

- ਸਾਹਿਤ ਦੀ ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਸਾਹਿਤ ਦੀ ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

Definition, scope and characteristics of literature

- ਸਾਹਿਤ ਅਤੇ ਸਮਾਜ: ਪਰਸਪਰ ਅੰਤਰ-ਸੰਬੰਧ

ਸਾਹਿਤ ਅਤੇ ਸਮਾਜ: ਪਰਸਪਰ ਅੰਤਰ-ਸੰਬੰਧ

Literature and Society: Mutual Interrelation

- ਸਾਹਿਤ ਅਤੇ ਹੋਰ ਅਨੁਸ਼ਾਸਨ: ਮਨੋਵਿਗਿਆਨ, ਦਰਸ਼ਨ ਸ਼ਾਸਤਰ ਅਤੇ ਸਮਾਜ ਸ਼ਾਸਤਰ

ਸਾਹਿਤ ਅਤੇ ਹੋਰ ਅਨੁਸ਼ਾਸਨ: ਮਨੋਵਿਗਿਆਨ, ਦਰਸ਼ਨ ਸ਼ਾਸਤਰ ਅਤੇ ਸਮਾਜ ਸ਼ਾਸਤਰ

Literature and other disciplines: Psychology, Philosophy and Sociology

Unit II ਕਾਵਿ ਲੇਖਣ - ਕਵਿਤਾ ਲੇਖਨ (Poetry writing)

(Theory & Practical)

(3+10 Hours)

- ਕਵਿਤਾ: ਪਰਿਭਾਸ਼ਾ, ਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਕਾਵਿ: ਪਰਿਭਾਸ਼ਾ, ਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

Poetry: definition, forms and characteristics

- ਕਾਵਿ ਭਾਸ਼ਾ, ਕਾਵਿ-ਬਿੰਬ ਅਤੇ ਪ੍ਰਤੀਕ, ਛੰਦ, ਬਹਿਰ

ਕਾਵਿ ਭਾਸ਼ਾ, ਕਾਵਿ ਬਿੰਬ ਅਤੇ ਪ੍ਰਤੀਕ, ਛੰਦ, ਬਹਿਰ

Poetic language, poetic images and metaphors, verse

- ਗੀਤ, ਗ਼ਜ਼ਲ ਅਤੇ ਖੁੱਲ੍ਹੀ ਕਵਿਤਾ ਦੀ ਸਿਰਜਣਾ ਕਰਨਾ

ਗੀਤ, ਗ਼ਜ਼ਲ ਅਤੇ ਖੁੱਲ੍ਹੀ ਕਵਿਤਾ ਦੀ ਸਿਰਜਣਾ ਕਰਨਾ

Composing songs, ghazals and open verse

Unit III ਕਹਾਣੀ ਲੇਖਣ - ਲਘੁਕਥਾ ਲੇਖਨ (Short Story writing)

(Theory & Practical)

(2+10 Hours)

- ਨਿੱਕੀ ਕਹਾਣੀ: ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਲਘੁਕਥਾ: ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

Short Story: definition, scope and characteristics

- ਕਥਾਨਕ, ਪਾਤਰ ਚਿਤਰਣ, ਵਾਰਤਾਲਾਪ ਅਤੇ ਭਾਸ਼ਾ ਸ਼ੈਲੀ

ਕਥਾਨਕ, ਪਾਤਰ ਚਿਤਰਣ, ਵਾਰਤਾਲਾਪ ਅਤੇ ਭਾਸ਼ਾ ਸ਼ੈਲੀ

Plot, characterization, dialogue and language style

- ਨਿੱਕੀ ਕਹਾਣੀ ਲੇਖਣ

ਲਘੁਕਥਾ ਲੇਖਣ

Composing a short story

Unit IV ਨਿਬੰਧ ਲੇਖਣ- ਨਿਬੰਧ ਲੇਖਨ (Essay writing)

(Theory & Practical)

(2+10 Hours)

- ਨਿਬੰਧ: ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਨਿਬੰਧ: ਪਰਿਭਾਸ਼ਾ, ਸਰੂਪ ਅਤੇ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

Essay: definition, scope and characteristics

- ਵਿਸ਼ੇ ਦੀ ਚੋਣ ਅਤੇ ਲੋੜੀਂਦੀ ਸਮੱਗਰੀ ਦੀ ਖੋਜ

ਵਿਸ਼ੇ ਦੀ ਚੋਣ ਅਤੇ ਲੋੜੀਂਦੀ ਸਮੱਗਰੀ ਦੀ ਖੋਜ

Selection of topic and search of required material

- ਨਿਬੰਧ ਲੇਖਣ

ਨਿਬੰਧ ਲੇਖਣ

Composing an essay

ESSENTIAL READING:

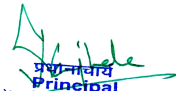
- Aabid Ali And Sandeep Kumar, 2017, **Creative and Mass Writing Methods**, Nirmal Publishing House, Kurukshetra.
- Anjana Neira Dev, Marwah Anuradha and Pal Swati, (2008), **Creative Writing: A Beginner's Manual**, Pearson Education India, Delhi.
- Jaggi, Rattan Singh, (2003), **Sahit de Roop**, Punjabi University, Patiala.
- Jagjit Kaur (Dr.) & Manjit Singh (Dr.) (eds.), (2013), **Sirjnnatmak Lekhan ate Jan-Sanchar Madhiyam**, Manpreet Parkashan, Delhi.

SUGGESTED READING:

- Dil, Balbir Singh (1991), **Punjabi Nibandh: Saroop, Sidhant ate Vikas**, Punjabi University, Patiala.
- Gautam, Ramesh (2016), Madhuri Sabodh, Rajinder Gautam and Prabhat Ranjan, **Rachnatmak Lekhan**, Bhartiya Jnanpith, New Delhi.
- Joginder Singh (Prof.), **Pinal te Arooz**, Punjabi Sahit Academi, Ludhiana.
- Phul, Gurdial Singh (Prof.), Suri, Kartar Singh (Prof.) (1954), **Naval Kala te Punjabi Navalkari**, Lok Sahit te Parkashan, Amritsar.
- Sidhu, Gurumail (2020), **Khulli Kavita De Maapdandh**, Chetna Parkashan, Ludhiana.

INTERNET LINKS:

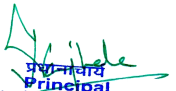
- ਕਵਿਤਾ ਕਿਵੇਂ ਲਿਖੀਏ ਲਈ ਲਿੰਕ: <https://www.youtube.com/watch?v=X2LtYOJuJd8>


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ਦਿੱਲੀ ਵਿਸ਼ਵਵਿਦਿਆਲਯ / University of Delhi
ਧੌਲਾ ਕੁਆਂ, ਨਵੀਂ ਦਿੱਲੀ / Dhoola Kuan, New Delhi-21

- ਕਹਾਣੀ ਕਿਵੇਂ ਲਿਖੀਏ ਲਿੰਕ: <https://www.youtube.com/watch?v=IkZ69t1G5Zc>
- ਪੰਜਾਬੀ ਸਾਹਿਤ ਬੋਧ ਲਈ ਲਿੰਕ: <https://punjabilibrary.com/product/punjabi-sahit-bodh/>
- ਨਾਵਲ ਕਲਾ ਤੇ ਪੰਜਾਬੀ ਨਾਵਲਕਾਰ ਲਈ ਲਿੰਕ:
<http://www.panjabdigilib.org/webuser/searches/displayPage.jsp?ID=7263&page=1&CategoryID=1&Searched>

*(Note: Teachers are free to recommend additional related standard source books, if required so.)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.


 ਮੁੱਖ ਮਾਮਲਾ
 Principal
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 ਦਿੱਲੀ ਯੂਨੀਵਰਸਿਟੀ / University of Delhi
 ਧੌਲਾ ਕੁਆਂ, ਨਵੀਂ ਦਿੱਲੀ / Dhoola Kuan, New Delhi-21

IT Skills and Data Analysis - I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IT Skills and Data Analysis - I	2	0	0	2	Class XII	NIL

Learning Objectives

The primary objectives of the course will be to:

- Familiarise the student with the quantitative skills required for representing and interpreting data for the purpose of decision making.
- Equip the student with some fundamental concepts, which play a critical role in understanding and visualizing real world data.
- Enable the student to analyze data and problem situations using relevant IT tools.

Learning Outcomes

By the end of the course students will be able to

- Represent and interpret data in tabular and graphical forms
- Understand and interpret the measures of central tendency and dispersion.
- Use IT tools such as spreadsheets to visualise and analyse data.

PEDAGOGY

Relevant concepts and theory will be introduced which will be supplemented by hands-on activities enabled by the use of spreadsheets. This is a two credit course and will comprise two lecture periods per week. As this is essentially an activity-based course, it will involve two consecutive lecture periods, once in a week.

SYLLABUS

Practical

Unit I : What is Statistics ? (24 hours)

This unit provides an introduction to the fundamentals of datasets, sources of data, frequency distributions and graphical representations of data. The aim is to give students a hands-on experience of initiating data analysis through a spreadsheet.

- Concept of datasets (Variables, Observations)
Reference 1, Chapter 2
- Different types of variables (Quantitative and Qualitative)
Reference 1, Chapter 2
- Distinction between primary and secondary sources of data
Reference 1, Chapter 2
- Basic idea of using questionnaire to collect primary data for analysis
Reference 2, Chapter 1 [Section 1.6]
- How to construct a questionnaire
Reference 1, Chapter 1
- Concept of frequency distribution: cumulative and relative frequencies
Reference 2, Chapter 2
- Introduction to spreadsheet
Reference 2, Chapter 2
 - Tabular and graphical presentation of data: data tables, frequency curve, histogram, bar graphs, pie charts (through the use of spreadsheets)
Reference 2, Chapter 2

Unit II: Measures of Central Tendency and Dispersion (36 hours)

The focus of this unit will be to familiarise the student with summary statistics to describe datasets. In particular, two important characteristics of data, viz., central tendency and dispersion, will be used to summarise datasets using a spreadsheet. The concept of the Normal distribution and its characteristics will be discussed to highlight its relevance in modelling real life phenomenon.

- Measures of central tendency: mean, median, mode
Reference 2, Chapter 3
- Examples of situations where it is appropriate to use the mean, median and mode as a measure of central tendency
Reference 2, Chapter 3
- Weighted mean
Reference 2, Chapter 3
- Measures of dispersion: range, variance, standard deviation
Reference 2, Chapter 3

- Quartiles, deciles and percentiles
Reference 2, Chapter 3
- Visualize the measures of central tendency and dispersion through frequency curve and histogram
Reference 2, Chapter 3
- Skewness and kurtosis
Reference 2, Chapter 3
- Normal curve and its basic properties : visual representation of population characteristics (height, weight, IQ etc.)
Reference 2, Chapter 5 [Section 5.6]

References (Readings and Resources)

1. Rowntree, D., Statistics without tears - A primer for non-mathematicians, Allyn and Bacon, 2018.
2. Levin, Rubin, Rastogi and Siddiqui, Statistics for Management, 7th Edn, 2014

Suggested Data Sources

The following data sets are suggested to carry out the activities

1. <https://data.worldbank.org/>
2. <https://www.statista.com/>
3. <https://data.gov.in/>
4. <https://censusindia.gov.in/>
5. <https://www.kaggle.com/>
6. <http://data.un.org/>

Weekly Plan

Weeks I and II: Students learn about the concept of datasets (Variables, Observations) ; Different type of Variables (Quantitative and Qualitative); Distinction between primary and secondary sources of data

Weeks III and IV: Basic idea of using questionnaire and how to construct a it; Concept of frequency distribution - cumulative and relative frequencies; Introduction to spreadsheet

Weeks V and VI: Tabular and graphical presentation of data: data tables, frequency curve, histogram, bar graphs, pie charts. Students to explore various representations on spreadsheet using datasets

Weeks VII and VIII: Introduction of Measures of Central Tendency: Mean, Median, Mode through appropriate examples explaining the use of each one of them in various situations. Understanding the concept of Weighted mean;

Weeks IX and X: Measures of dispersion: Range, Variance, Standard deviation; Visualizing the measures of central tendency and dispersion through frequency curve and histogram. Understanding Quartiles, deciles and percentiles numerically.

Weeks XI and XII: Representation of population characteristics using the basic properties of a Normal Curve, skewness and kurtosis.

Weeks XIII and XIV: Assignments based on Units 1 and 2 using spreadsheets to consolidate the learning of concepts covered.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

IT Skills and Data Analysis - II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IT Skills and Data Analysis - II	2	0	0	2	Class XII	IT Skills and Data Analysis - I

Learning Objectives

The primary objectives of the course will be to

- Familiarise the student with the quantitative skills required for correlating the data for the purpose of decision making.
- Equip the student to visualise functions which play a critical role in understanding and visualizing real world data.
- Enable the student to analyze data and problem situations using relevant IT tools.

Learning Outcomes

By the end of the course students will be able to

- Establish relationships between variables using correlation and regression analysis.
- Visualize functions and differentiate between linear and nonlinear functions.
- Use IT tools such as spreadsheets to visualise and analyse data.

PEDAGOGY

Relevant concepts and theory will be introduced which will be supplemented by hands-on activities enabled by the use of spreadsheets. This is a two credit course and will comprise two lecture periods per week. As this is essentially an activity-based course, it will involve two consecutive lecture periods, once in a week.

SYLLABUS

Unit I: Functions and their graphical representations (16 hours)

This unit introduces the graphical visualisation of functions to understand the relationship between two variables.

- Definition and graphical representation of a function, vertical line test
Reference 3
- Polynomial functions: linear, quadratic and cubic functions
Reference 3
- Reciprocal, exponential and logarithmic functions
Reference 3
- Concept of slope of a function through graphical representation
Reference 3

Unit II: Relationship between Variables (28 hours)

Students will learn about scatter diagrams and correlation analysis as a means to describe the nature and strength of association between two variables. The concept of regression analysis will be introduced as a method for quantifying the relationship between two variables. Further, multiple linear regression will be discussed for situations where more than one independent variable is needed to estimate the dependent variable. The focus will be mainly on interpreting estimated regression coefficients.

- Scatter diagrams
Reference 2, Chapter 12
- Correlation analysis : measure and interpretation of correlation coefficient and coefficient of determination
Reference 2, Chapter 12
- Hypotheses, model specification and testing
Reference 2, Chapter 12
- Bi-variate regression analysis: method of least squares, curve of best fit as a model for prediction
Reference 2, Chapter 12
- Multiple Linear Regression
Reference 2, Chapter 13

Weeks 12 – 14: Project Presentations and Viva (16 hours)

References (Readings and Resources)

1. Rowntree, D., Statistics without tears - A primer for non-mathematicians, Allyn and Bacon, 2018.

2. Levin, Rubin, Rastogi and Siddiqui, Statistics for Management, 7th Edn, 2014
3. Boundless Algebra : <https://courses.lumenlearning.com/boundless-algebra/>

Suggested Data Sources

The following data sets are suggested to carry out the activities

1. <https://data.worldbank.org/>
2. <https://www.statista.com/>
3. <https://data.gov.in/>
4. <https://censusindia.gov.in/>
5. <https://www.kaggle.com/>
6. <http://data.un.org/>

Weekly Plan

Weeks I and II: Understanding the definition of a function; graphical representation of a function and vertical line test; visualising various kinds of functions (Linear, quadratic and cubic functions)

Weeks III and IV: Reciprocal, exponential and logarithmic functions; Interpreting and visualising the concept of slope of a function through graphical representations.

Weeks V and VI: Scatter Diagrams; Correlation analysis - measure and interpretation of correlation coefficient and coefficient of determination.

Weeks VII to IX: Hypotheses, model specification and testing; Understanding Bi-variate Regression analysis: Method of Least Squares; Curve of best fit as a model for prediction.

Weeks X and XI: Multiple Regression Analysis

Weeks XII to XIV: Project Presentations and Viva

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Basic IT Tools

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic IT Tools	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable students develop IT skills that are a pre-requisite in today's work environment.
- To equip them with basic computing skills that will enhance their employability in general.
- To enable the student to analyse and present information in a meaningful manner.

Learning outcomes

The Learning Outcomes of this course are as follows:

- By studying this course, students will be able to use word-processor to generate documents with appropriate formatting, layout, review and referencing.
- By studying this course, students will be able to manage data in worksheets and workbooks and analyze it using spreadsheet functions and inbuilt formulas.
- By studying this course, students will be able to draw analysis on data using spreadsheets to make decisions.
- By studying this course, students will be able to make meaningful representations of data in the form of charts and pivot tables.
- By studying this course, students will be able to manage data in database tables and use the same for generating queries, forms and reports.

SYLLABUS

Course Contents:

Unit 1: Introduction to Spreadsheets

(16 hours)

Spreadsheets: Concept of worksheets and workbooks, creating, opening, closing and saving workbooks, moving, copying, inserting, deleting and renaming worksheets, working with multiple worksheets and multiple workbooks, controlling worksheet views, naming cells using multiple names, name create and name define; Exchanging data using clipboard, object linking and

embedding; Printing and Protecting worksheets: Adjusting margins, creating headers and footers, setting page breaks, changing orientation, creating portable documents and printing data and formulae; Implementing file level security and protecting data within the worksheet; Understanding absolute, relative and mixed referencing in formulas, referencing cells in other worksheets and workbooks, correcting common formula errors, working with inbuilt function categories like mathematical, statistical, text, lookup, information, logical, database, date and time and basic financial functions.

Unit 2: Data Analysis in Spreadsheets

(16 hours)

Consolidating worksheets and workbooks using formulae and data consolidate command; Choosing a chart type, understanding data points and data series, editing and formatting chart elements, and creating sparkline graphics, Analysing data using pivot tables: Creating, formatting and modifying a pivot table, sorting, filtering and grouping items, creating calculated field and calculated item, creating pivot table charts, producing a report with pivot tables. Introduction to recording and execution of macros.

Unit 3: Word Processing

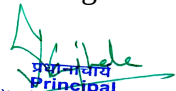
(12 hours)

Introduction: Creating and saving your document, displaying different views, working with styles and character formatting, working with paragraph formatting techniques using indents, tabs, alignment, spacing, bullets and numbering and creating borders; Page setup and sections: Setting page margins, orientation, headers and footers, end notes and foot notes, creating section breaks and page borders; Working with tables: Creating tables, modifying table layout and design, sorting, inserting graphics in a table, table math, converting text to table and vice versa; Create newspaper columns, indexes and table of contents, Spell check your document using inbuilt and custom dictionaries, checking grammar and style, using thesaurus and finding and replacing text; Create bookmarks, captions and cross referencing, adding hyperlinks, adding sources and compiling and bibliography; Mail merge: Creating and editing your main document and data source, sorting and filtering merged documents and using merge instructions like ask, fill-in and if-then-else; Linking and embedding to keep things together.

Unit 4: Databases

(16 hours)

Introduction to Database Development: Database Terminology, Objects, Creating Tables, working with fields, understanding Data types, Changing table design, Assigning Field Properties, Setting Primary Keys, using field validation and record validation rules, Indexing, working with multiple tables, Relationships & Integrity Rules, Join Properties, Record manipulation, Sorting & Filtering; Select data with queries: Creating Query by design & by wizard (Select, Make Table, Append, Delete, Cross Tab, Update, Parameterized Query, Find Duplicate and Find Unmatched), Creating multi table queries, creating & working with table joins. Using operators & expressions: Creating simple & advance criteria; Working with forms: Creating Basic forms, working with bound, unbound and calculated controls, understanding property sheet, Working with Data on Forms: Changing Layout, creating Sub Forms, creating list box, combo box and option groups; Working with Reports: Creating Basic Reports, Creating Header & Footer, Placing Controls on reports, sorting & grouping, Creating Sub reports.


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Essential/recommended readings

- Swinford, E., Dodge, M., Couch, A., Melton, B. A. (2013). Microsoft Office Professional 2013. United States: O'Reilly Media.
- Wang, W. (2018). Office 2019 For Dummies. United States: Wiley. Microsoft Lambert, J. (2019). Microsoft Word 2019 Step by Step. United States: Pearson Education.

Suggestive readings

- Jelen, B. (2013). Excel 2013 Charts and Graphs. United Kingdom: Que.
- Alexander, M., Jelen, B. (2013). Excel 2013 Pivot Table Data Crunching. United Kingdom: Pearson Education.
- Alexander, M., Kusleika, R. (2018). Access 2019 Bible. United Kingdom: Wiley.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Spreadsheet Tools	2	0	0	2	Class XII	Basic Knowledge of MS Excel

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable the students to use Excel for advanced data analysis
- To equip the students to with automation skills on excel
- To enable the students to use excel for informed decision making.

Learning outcomes

The Learning Outcomes of this course are as follows:

- By studying this course, students will be able to make meaningful representations of data in the form of charts and pivot tables.
- By studying this course, students will be able to draw analysis on data using spreadsheets and use interpretation to make decisions.
- By studying this course, students will be able to generate word documents with appropriate formatting, layout, proofing.
- By studying this course, students will be able to manage data for generating queries, forms and reports in a database.

SYLLABUS

Unit 1: Excel Advanced Techniques

(12 hours)

Templates, Efficiency, and Risk (Standard Deviation, Variance, and Coefficient of Variation), Data Validation; *Functions and Power functions, Array Formulae (Frequency Distribution, mode.mult, mode.sngl), Tables, Advanced Range Names, What-if-analysis: Goal-seek, Data tables, and Scenario Manager; Data analysis ToolPak: Descriptive Statistics, Moving averages, Histogram, Covariance, correlation, and Regression analysis (only for projection); solver add-in. Problem Solving using Solver (optimal product mix, workforce scheduling, transportation, capital budgeting, financial planning), Integrating excel with other tools: MS word, outlook, PowerPoint, Access, Power BI.

Unit 2: Excel Interactivity and Automation

(16 hours)

Index and Match, Offset, Dynamic Charting, Database functions, Text functions, Logical functions: IfError, IsError, Aggregate, Circular Reference, Formula Auditing, Floating Point Errors, Form Controls (Button, Combo, Check box, Spinner, List, Option), Visual Basic (only basic). Recording Macros, Absolute and relative macros, editing macros, Use of spinner

buttons and command buttons; Sub Procedure, Function Procedure (creating New Functions); Working with Loops: Do_while loop, For_Next loop; Creating User Forms: Message Box, Input Box; If_Then_Else.

Unit 3: Introduction to VBA

(16 hours)

Conditional Formatting, Charts that Inspire (Waterfall, Column, Line, Combo, Thermometer, Scatter, Histogram) Slicers, Sparklines, Graphics Tricks and Techniques, Worksheet Automation using Macros: Absolute and relative macros, editing macros, Creating new functions using macros, Use of spinner buttons and command buttons.

Unit 4: Data Analysis and Decision-Making

(16 hours)

Working with External Data, Advanced Uses of PivotTables, PowerPivot, Reporting with PowerPivot, Power query, Dashboard, Creating a spreadsheet in the area of: Loan and Lease statement; Ratio Analysis; Payroll Accounting; Capital Budgeting (NPV & IRR), Portfolio Management, Breakeven analysis, and Sensitivity analysis; Operations Management: Constraint, Forecasting & Trend Analysis optimization, Assignment Problems; Depreciation Accounting (Single Method); Graphical representation of data; Frequency distribution and its statistical parameters; Correlation and Regression Analysis

Essential/recommended readings

- Excel 2016 Power Programming with VBA, Michael Alexander, Dick Kusleika, Wiley.
- Financial Analysis and Modelling Using Excel and VBA, Chandan Sengupta, Second Edition, Wiley Student Edition.
- MS Excel 2016, Data Analysis & Business Modelling, Wayne Winston, PHI.

Suggestive readings

- Microsoft Excel 2016 - Data Analysis and Business Modelling Paperback – 1 May 2017 Wayne L. Winston, Microsoft Press.
- Microsoft Excel Practical Formulae: From Basic Data Analysis to Advanced Formulae
- Manipulation Diane Griffiths.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

STATISTICAL SOFTWARE PACKAGE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistical Software Package	2	0	0	2	Class XII	Basic course in Statistics

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with data analysis using a statistical software package like SPSS or any other equivalent.
- To provide skills for research analysis and increase employability.
- To lay a foundation for advance data analysis work and higher education.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand basic functions of statistical software package for managing variables and generate descriptive statistics to describe the data and analyze data through graphs and charts.
- After studying this course, students will be able to test differences in sample means.
- After studying this course, students will be able to identify relationships between variables and develop models for predicting dependent variables on the basis of independent variables.
- After studying this course, students will be able to understand data structures and identify clusters in data.
- After studying this course, students will be able to identify principal components that are relevant from a host of variables.

SYLLABUS

Unit 1: Getting started with the Software

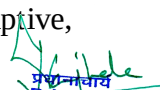
(16 hours)

Introduction: Data Entry, Storing and Retrieving Files, Generating New Variables; Managing Data – Listing cases, replacing missing values, computing new variables, recoding variables, selecting cases, sorting cases, merging files, Graphs – Creating and editing graphs and charts; Descriptive Statistics Procedures: Frequencies, Descriptive, Explore, Cross Tabulation.

Unit 2: Hypothesis Testing for Means

(12 hours)

T-tests: One sample test, Independent samples and paired samples t-test; ANOVA – One-way analysis of variance with post hoc analysis, Two-way analysis of variance.


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Unit 3: Testing for Association between Variables**(16 hours)**

Chi-square Test of Independence; Bivariate Correlation Analysis: Simple Scatter Plot; Correlation Coefficient: Pearson, Spearman Rho and Kendall Tau Coefficient. Factor analysis.

Unit 4: Regression Analysis**(16 hours)**

Linear Regression: Simple Linear Regression, Multiple regression analysis with matrix scatterplot. Multiple Regression: Standard (Enter) and Stepwise Method. Binary Logistic Regression.

Essential/recommended readings

- Performing Data Analysis using IBM SPSS, Lawrence S. Meyers, Glenn C. Gamst, A. J. Guarino, Wiley Publication
- SPSS for Windows Step by Step A Simple Guide and Reference, Darren George and Paul Malley
- SPSS in Simple Steps, Kiran Pandya, Smruti Bulsari, Sanjay Sinha, Dreamtech Press

Suggestive Readings

- Using SPSS in Research, Dr. Radha Mohan, Neelkamal.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

FINANCIAL DATABASE AND ANALYSIS SOFTWARE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Financial Database and Analysis Software	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable students to obtain data from financial database.
- To enable to use R language for statistical & econometric data analysis.
- To develop skills that can help in solving your research problems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the utility of a financial database
- After studying this course, students will be able to extract data from financial database (Prowess IQ)
- After studying this course, students will be able to perform data analysis using R
- After studying this course, students will be able to apply 'R' and ProwessIQ in financial analysis and research.

SYLLABUS

Unit I (Financial Database)

(12 hours)

An Introduction to financial database ProwessIQ from CMIE: Creating company set-, creating spreadsheets, use of elements in Ribbons – Company address and identity indicators, business segments and products, Ownership structure and governance indicators, Financial Statements, Stock prices and capital changes, Capex and M&A, indices and index number. Formulating queries and advance queries Student is expected to be able to extract different types of data for an index, an industry and company data Selection of company/s, period to be studied. Data extraction from balance sheet, profit & loss statement and cash flow statements Stock market data- price and volume, BSE/NSE, adjusted prices Saving and exporting data to a spreadsheet

for further analysis.

Unit II (Fundamentals of R)

(16 hours)

Overview of the R language, Input and output of data in R, Help command and Directory in R, In-built functions in R, Operators in R; Assignment, Arithmetic, logical, and Relational operators, Using R studio, Scripts, Text editors for R, Graphical User Interfaces (GUIs) for R, installing packages and libraries, Variable classes (numeric, character, logical, complex, missing), Data Types in R; Vectors, Matrices, Arrays, Lists, Factors, and Data Frames, Important operations of these Data Types, Using data from external files- reading & writing data to external files, Creating and storing R workspaces.

Unit III (Descriptive Analysis and Data Visualizations)

(16 hours)

Data preparation; Data cleaning and Missing value treatment, Data Exploration and Manipulation, Data Visualization; Bar chart, pie chart, Histogram, Frequency curve, Scatter plot, Box & Whisker plot etc., Important R functions for Describing a data; Mean, Median, Range, Standard deviation, Variance, Five number summary, Correlation coefficients for a bivariate data.

Unit IV (Predictive Analysis)

(16 hours)

Simple and Multiple Regression using R, Estimating Regression Equation by Ordinary Least Squares in R, Violations of Classical Assumptions: multicollinearity, heteroscedasticity, autocorrelation and model specification errors, their identification, their impact on parameters; tests related to parameters and impact on the reliability and the validity of inferences in case of violations of Assumptions; methods to take care of violations of assumptions, goodness of fit. Time Series Analysis using R (Basic idea only).

Essential/recommended readings

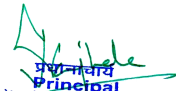
- Gardener, M., *Beginning R: The Statistical Programming Language*, Wiley & Sons. 2018
- Wickham, H., et al. *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*, O'Reilly, 2017
- Motwani, B., *Data Analytics with R*, Wiley & Sons, Indian edition 2021
- Chang, R *Graphics Cookbook- Practical Recipes for Visualizing Data*; O' Reilly Media
- Gujarati, D.N. et al. *Basic Econometrics*, McGraw Hill India, 5e, 2018

Useful web links

- <https://prowessiq.cmie.com>
- CRAN website: <https://cran.r-project.org/>
- <https://rstudio.com/products/rstudio/download/> (R studio)
- <http://r-statistics.co>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Statistics with 'R'

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistics with R	2	0	0	2	Class XII	Basic course in Statistics

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data.
- To enable students to extract data, and perform basic statistical operations entailing data analysis such as – data cleaning, data visualisation, data summarisation, and regression amongst others.

Learning outcomes

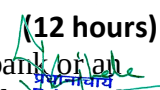
The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to extract and Read data into R, manipulate, and analyse it
- After studying this course, students will be able Tto debug, organize, and comment R code
- After studying this course, students will be able to understand the R environment for downloading, installing, and using packages
- After studying this course, students will be able to do basic programming to write own functions
- After studying this course, students will be able to use loops
- After studying this course, students will be able to create standard and customized graphics
- After studying this course, students will be able to perform basic statistical operations and regression.

SYLLABUS

Unit 1: Data Extraction and Spread Sheet Exploration

Extraction of economics and financial data from Prowessiq, RBI, IMF, World bank or an equivalent financial/economic database. The students should be able to save and export the data to 'R-environment' for further analysis.

(12 hours)

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Unit 2: Basics of R-language

(28 hours)

Overview of the R language: Installing R and R Studio : Using R studio, Scripts, Text editors for R, Graphical User Interfaces (GUIs) for R, Creating and storing R workspaces, installing packages and libraries, Mathematical operations.

Data Types in R – Numeric, Integer, Character, Logical, Complex and missing data. Data Structures in R

- Vectors – Creation, Arithmetic operations of Vectors, Vector Sub setting, Sorting and Sequencing functions.
- Matrix and Arrays – Creation, Arithmetic Operations of matrix, Sub setting, Use of Drop Function.
- Factors – Converting a vector into factor, assigning levels and labels, ordered Factor.
- List – Creating a list, accessing elements from a list, adding a new element and eliminating an existing element from the list, converting list to vectors.
- Data Frames – Creation of Data Frame, adding new columns, rows and removing columns, accessing column using the \$ sign, importing a data set (important file formats such as csv, txt and spreadsheet), aggregate function and subsetting of dataframes, tapply function, manipulation using dplyr package (select, filter, arrange, mutate and group by function, pipe operator).

Programming Fundamentals: Logical operators, conditional statements (if, else, else if statements in R), While loops, For loops, repeat loops.

Creating functions in R.

Reading data in R (file formats such as csv, txt, and xlsx), Writing data to external files (file formats such as csv, txt, and xlsx), writing a table to a file, print function.

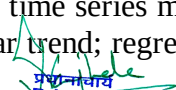
Unit 3: Basic Statistics and Regression

(20 hours)

Summarizing and exploring data: Descriptive statistics (mean, median, mode, variance, skewness, five-point summary), dealing with missing data in R, Data cleaning (dplyr package, tidyr package and pipe operator), Exploratory Data Analysis; data visualization using inbuilt functions and ggplot2 package (pie chart, bar chart, line chart, histogram, box plot, scatter plot, Normal QQ plot).

Regression analysis using R: Regression vs Correlation, Simple and multiple regression, Ordinary least square, Assumptions of classical normal linear regression model (CNLRM), corplot package, car package, lmtest package, scatter plot (using plot function and ggplot2 package) to understand the relationship between variables, lm, abline, predict, resid function, interpreting ‘summary table’ of the regression model, normality of residuals (qqnorm and qqPlot functions), multicollinearity (correlation matrix, corplot and vif function), autocorrelation (acf plot and Durbin Watson test), heteroscedasticity (graphically, bptest, ncvTest), impact on estimates and inferences in case of violations of assumptions of CNLRM, methods to take care of violations.

Time series data, components of a time series data, additive and multiplicative time series model, ts function, diff function, plot of a time series data, time series data with linear trend; regression analysis using ‘lm’ function, stationarity in time series (concept only).


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Essential/recommended readings

- Gardener, M. (2018), Beginning R: The Statistical Programming Language, Wiley & Sons.
- Sekhar, S.R.M., et al. (2017), Programming with R, Cengage Learning India.
- Wickham, H., et al. (2017), R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, O'Reilly'.
- Field, A., Miles, J and Field (2012), Z. Discovering Statistics using R (Indian Reprint 2022), SAGE
- SimpleR - Using R for Introductory Statistics: John Verzani.
- The R Guide.
- Analysis of Epidemiological Data Using R and Epicalc: Virasakdi Chongsuvivatwong.
- Statistics Using R with Biological Examples: Kim Seefeld and Ernst Linder.
- An Introduction to R: Software for Statistical Modeling & Computing: Petra Kuhnert and Bill Venables.
- Gujarati, D.N. et al (2018), Basic Econometrics, McGraw Hill India, 5th Ed.
- CRAN website: <https://cran.r-project.org/>
- <https://prowessiq.cmie.com>,
- <https://data.worldbank.org/indicator>,
- [https://rstudio.com/products/rstudio/download/\(Rstudio\)](https://rstudio.com/products/rstudio/download/(Rstudio))
- <http://r-statistics.co>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

R Programming for Business Analytics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
R Programming for Business Analytics	2	0	0	2	XII pass	NIL

Learning Objectives

- To introduce the basic concepts in R programming.
- To equip the students with the popular statistical programming language R.
- To familiarize the students with utility of 'R' for managerial decision making.

Learning outcomes

Upon successful completion of this course the student will be able to:

- Learn Syntax and Semantics of R Programming
- Understand the file system and data handling in R.
- Visualize and analyse the data using statistical methods.
- Apply best practice model design methodologies to real problems using R

SYLLABUS

Unit I: Introduction to R, Data Handling and Data Visualization (16 hours)

Introduction to R and familiarization of R Studio, Basic components in R Studio. R Syntax and programming, Understanding *tidyverse*, *tibble*, *dplyr*, *ggplot2*, *tidyr*, *purrr*, *readr*, *forcats*, *stringr* for tidying, manipulating and plotting data,

Unit II: Optimization Models using R

(12 hours)

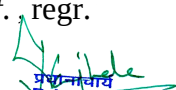
Linear Programming Models, Optimization models, understanding *optim()*,

Unit III: Machine Learning with R - Introduction to Supervised Learning

(16 hours)

Classification based on similarities with k-nearest neighbours, odds with logistic regression, maximizing separation with discriminant analysis, classifying with decision tree, regression with kNN, random forest, XGBoost, Understanding *mlr*, *classif*, *regr*.

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Unit IV: Machine Learning with R - Introduction to Unsupervised Learning (16 hours)

Dimension Reduction- Maximizing variance with Principal Component Analysis;
k-meancluster, understanding *cluster*. .

Essential/recommended readings

- Boehmke, B. & Brandon, G.(2020). Hands-on Machine Learning with R, CRC Press.
- Horton, N.J. & Kleinman, K.(2015) Using R & R Studio for Data Management, Statistical Analysis, and Graphics, CRC Press.
- Peng, R. D. (2016). *R programming for data science* (pp. 86-181). Victoria, BC, Canada: Leanpub.
- Lander, J. P. (2014). *R for everyone: Advanced analytics and graphics*. Pearson Education.
- Teetor, P. (2011). *R cookbook: Proven recipes for data analysis, statistics, and graphics*. "O'Reilly Media, Inc."
- Zhao, Y., & Cen, Y. (2013). *Data mining applications with R*. Academic Press.

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Essentials of Python	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce programming concepts using python
- To use python programming to solve problems of different domains

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the basics of programming language
- After studying this course, students will be able to develop, document and debug modular python programs
- After studying this course, students will be able to apply suitable programming constructs and built in data structures to solve a problem

SYLLABUS

Unit I (12 hours)

Introduction

What can Python do? Why Python? Python Syntax compared to other programming languages, Python Installation.

The print statement, Comments, Python Data Structures & Data Types, String Operations in Python, Simple Input & Output, Simple Output Formatting, Operators in python

Python Program Flow

Indentation, The If statement and its' related statement, An example with if and it's related statement, The while loop, The for loop, The range statement, Break &Continue, Assert, Examples for looping

Functions& Modules

Create your own functions, Functions Parameters, Variable Arguments, Scope of a Function, Function Documentations, Lambda Functions& map, n Exercise with functions, Create a Module, Standard Modules

Unit 2

(16 hours)

Exceptions Handling

Errors, Exception handling with try, handling Multiple Exceptions, Writing your own Exception

File Handling

File handling Modes, Reading Files, Writing& Appending to Files, Handling File Exceptions, The with statement

Classes In Python

New Style Classes, Creating Classes, Instance Methods, Inheritance, Polymorphism, Exception Classes & Custom Exceptions

Generators and iterators

Iterators, Generators, The Functions any and all, With Statement, Data Compression

Unit 3

(16 hours)

Data Structures

List Comprehensions, Nested List Comprehensions, Dictionary Comprehensions. Functions, Default Parameters, Variable Arguments, Specialized Sorts

Collections

namedtuple(), deque, ChainMap, Counter, OrderedDict, defaultdict, UserDict, UserList, UserString

Writing GUIs in Python (Tkinter)

Introduction, Components and Events, An Example GUI, The root Component, Adding a Button, Entry Widgets, Text Widgets, Check buttons

Python SQL Database Access

Introduction, Installation, DB Connection, Creating DB Table, INSERT, READ, UPDATE, DELETE operations, COMMIT & ROLLBACK operation, handling Errors

Network Programming

Introduction, A Daytime Server, Clients and Servers, The Client Program, The Server Program

Date and Time

Sleep, Program execution time, more methods on date/time

Unit 4

(16 hours)

Filter, Map, Reduce, Decorators, Frozen set, Collections

Regular Expression

Split, Working with special characters, date, emails, Quantifiers, Match and find all, character sequence and substitute, Search method

Threads ESSENTIAL

Class and threads, Multi-threading, Synchronization, Treads Life cycle, use cases

Accessing API ESSENTIAL

Introduction, Facebook Messenger, Openweather

DJANGO

Django Overview, Django Installation, Creating a Project, Usage of Project in depth Discussion, Creating an Application, Understanding Folder Structure, Creating a Hello World Page, Database and Views, Static Files and Forms, API and Security

Essential/recommended readings

- "Starting Out with Python plus My Programming Lab with Pearson eText -- Access Card Package (3rd Edition) Tony Gaddis ISBN-13: 978-0133862256".
- Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition).
- Head-First Python: A Brain-Friendly Guide (2nd Edition) by Paul Barry.
- Learn Python the Hard Way: 3rd Edition by Zed A. Shaw.
- Python Programming: An Introduction to Computer Science (3rd Edition) by John M. Zelle.
- Python Cookbook: Recipes for Mastering Python 3 (3rd Edition) by Brian Jones and David Beazley
- <https://docs.djangoproject.com/>
- Introduction to Programming using Python by Y. Daniel Liang. Publisher Pearson
- Taneja, S., Kumar, N. Python Programming- A modular Approach, Pearson Education India, 2018.
- Balaguruswamy E., Introduction to Computing and Problem Solving using Python, 2 nd edition, McGraw Hill Education, 2018

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

ANALYTICS / COMPUTING WITH PYTHON

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analytics/ Computing with Python	2	0	0	2	Class XII	Basic Course of Python

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce machine learning techniques to students using Python programming
- To enable students to use various tools and packages for advanced data analysis

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to learn about Python's main features and how they make Python a great tool for financial analysts.
- After studying this course, students will be able to get familiarized with Anaconda and Jupyter Notebook.
- After studying this course, students will be able to learn basics of Machine learning.
- After studying this course, students will be able to apply these techniques on data.

SYLLABUS

Unit I

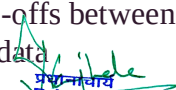
(20 hours)

Python: General overview, Python vs. Excel , Anaconda and Jupyter notebook: Interface overview, Data types in Python, Python basic syntax: Assignment statements, creating variables, indentation, conditionals, and loops, writing user defined functions. Working with libraries: Pandas, NumPy, Matplotlib, and Seaborn. Python SQL Database Access: Introduction, Installation, DB Connection, Creating DB Table.

Unit II

(20 hours)

Pandas: Working with Data Frame, Importing from Excel or .csv files, Powerful filters and indexes. Numpy: Selecting data with loc and iloc, Using NumPy for speed, Trade-offs between arrays and lists, Array functions. Data cleansing and normalization: Libraries for data visualization, Types of charts/graphs and how to build them.


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Unit III

(20 hours)

Machine learning: Introduction, Definitions, Supervised, unsupervised, python libraries for machine learning: Sci-kit learn, Regression: Linear regression, logistic regression, over-fitting and regularization.

Essential/recommended readings

- Pilgrim, M. (2004). Dive Into Python. Apress. Ch. 1,2,4
- S Raschka, Python Machine Learning, V Mirjalili (2020), Ch 3
- Mitchell, T. M. (1997). Machine Learning. New York: McGraw-Hill.

Suggestive Readings

- Liu, Y. (2019). Python machine learning by example: Implement machine learning algorithms and techniques to build intelligent systems (Second edition.). Packt Publishing.
- Boschetti, A. (2016). Regression Analysis with Python (1st ed.). Packt Publishing. Retrieved from <https://www.perlego.com/book/4457/regression-analysis-with-python-pdf> (Original work published 2016)
- Sivanandam, S.N., & Deepa, S.N. (2011). Principles of soft computing.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Business Intelligence and Data Visualisation

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Business Intelligence and Data Visualisation	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand data and generate insights from it is by visualising it using a range of data visualization tools available.
- To understand large volume of data, discover trends, communicate effectively with all stakeholders and influence decisions.
- To develop Business Analytics skillset about how to create effective charts and interactive dashboards is extremely useful

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand and describe the main concepts of data visualization
- After studying this course, students will be able to determine the right type of graph for different types of data available or provided through hands on experience with handling real data sets
- After studying this course, students will be able to read reports, charts, graphs, figures, maps and derive meaning from them
- After studying this course, students will be able to create reports, data visualizations, and dashboards using Power BI and Tableau
- After studying this course, students will be able to understand how to automate tasks, perform ETL, create data models, perform computations, and present insights using data visualization and dashboards.

SYLLABUS

Unit-1 (POWER BI) (22 hours)

DATA PREPARATION- Connecting to different data sets, Basic data prep and model on Power Query, Drill down and Tooltip, AI visuals (Q&A, Analyze, Decomposition)

DATA VISUALIZATION AND DASHBOARDS- Inbuilt visuals, Custom visuals, Learn from existing reports, Visualization as a Tooltip, Final dashboard – putting it together Filter, slicer, bookmarks, buttons

Unit-2 (POWER BI) (22 hours)

PERFORMING COMPUTATIONS - Combine multiple files and folders, Merge and append, Custom calculations Conditional columns, Column from examples, Advanced Editor.

DAX - Introduction to Measures, Calculated Columns vs Quick Measures, Creating a Date Table, Time Intelligence Functions

POWER BI SERVICE - Publishing to Power BI Service, Power BI dataflows, Dashboards and Cross-Reporting

Unit- 3 (TABLEAU) (16 hours)

VISUALIZATIONS- Introduction to Dimensions and Measures, Bar Chart, Line Chart, Table, Heat Map, Treemap, Packed Bubble, Tooltip

CALCULATIONS- Calculated Fields, Parameters, Introduction to Level of Detail (LOD)

FINAL DASHBOARD- Animations, Tooltips, Dashboard and Stories

Essential/recommended readings

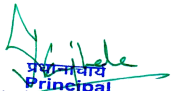
- The Definitive Guide to DAX – 2nd Edition Marco Russo Alberto Ferrari
- M Is for (Data) Monkey: A Guide to the M Language in Excel Power Query Ken Puls & Miguel Escobar
- Tableau Your Data! Fast and Easy Visual Analysis with Tableau Software by Daniel G. Murray. 1st Edition, WILEY.
- Steve Wexler, Jeffrey Shaffer, Andy Cotgreave: The Big Book of Dashboards – visualizing your data using real world business scenarios; Wiley
- Ryan Sleeper: Practical Tableau
- Cole Nussabaumer Knafllic : Storytelling with data- a data visualization guide for business professionals ; Wiley
- Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics by Nathan Yau. 1st Edition

Useful Weblinks

- <https://docs.microsoft.com/en-us/power-bi/>
- <https://powerbi.microsoft.com/en-us/customer-showcase/>
- <https://powerquery.microsoft.com/en-us/>
- <https://www.sqlbi.com/>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Digital Marketing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Digital Marketing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquaint the students with the knowledge of growing integration between the traditional and digital marketing concepts and practices in the digital era.
- To familiarize the students with the tools and techniques used by the digital marketers for driving the marketing decisions to attain marketing objectives.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the concept of digital marketing and its integration with traditional marketing.
- After studying this course, students will be able to understand customer value journey in digital context and behaviour of online consumers.
- After studying this course, students will be able to understand email, content and social media marketing and apply the learnings to create digital media campaigns.
- After studying this course, students will be able to examine various tactics for enhancing a website's position and ranking with search engines.
- After studying this course, students will be able to leverage the digital strategies to gain competitive advantage for business and career.

SYLLABUS

Unit 1: Marketing in the Digital World

(12 hours)

Digital marketing: Concept, Features, Difference between traditional and digital marketing, Moving from traditional to digital Marketing; c

Digital Marketing Channels: Intent Based- SEO, Search Advertising; Brand Based-Display Advertising; Community Based-Social Media Marketing; Others-Affiliate, Email Content, Mobile.


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Customer Value Journey: 5As Framework; The Ozone O3 Concept Key; Traits of online consumer

Unit 2: Content and Email Marketing

(8 hours)

Content Marketing: Step-by-step Content Marketing Developing a content marketing strategy Email Marketing: Types of Emails in email marketing, Email Marketing best practices

Unit 3: Social Media Marketing and Display Marketing

(18 hours)

Social Media Marketing: Building Successful Social Media strategy; Social Media Marketing Channels; Facebook, LinkedIn, YouTube (Concepts and strategies)

Display Advertising: Working of Display Advertising; Benefits and challenges; Overview of Display ad Process.; Define- Customer, Publisher, Objectives; Format-Budget, Media, Ad Formats, Ad Copy.

Unit 4 Search Engine Marketing

(22 hours)

Introduction of SEM: Working of Search Engine; SERP Positioning; online search behaviour, DMI's 5P Customer Search Insights Model.

Search Engine Optimization: Overview of SEO Process; Goal Setting-Types.

On-Page Optimization: Keyword Research, SEO Process -Site Structure, Content, Technical Mechanics, Headings, Image & Alt text, Social Sharing, Sitemaps, Technical Aspects-Compatibility, Structured Data Markup.

Off Page Optimisation: Link Formats, Link Building, Content Marketing, Social Sharing; Black and White Hat Techniques

Search Advertising: Overview of PPC Process; Benefits of Paid Search; Basis of Ranking; Goal Setting-Objectives; Account Setting-Creation of Google Ads, Campaign architecture, Campaign setup, Targeting, Bid Strategy, Delivery, Ad Scheduling, Ad Rotation, Keyword Selection; Ad Copy composition, Ad Extension

Essential/recommended readings

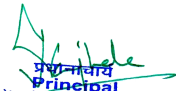
- Dodson, I. (2016). The art of digital marketing: the definitive guide to creating strategic, targeted, and measurable online campaigns. John Wiley & Sons.
- Kartajaya, H., Kotler, P., & Setiawan, I. (2016). Marketing 4.0: moving from traditional to digital. John Wiley & Sons.
- Ryan, Damien: Understanding Digital Marketing - Marketing Strategies for Engaging the Digital Generation. Kogan Page Limited

Suggested Readings

- Moutusy Maity: Internet Marketing: A practical approach in the Indian Context: Oxford Publishing
- Seema Gupta: Digital Marketing: Mcgraw Hill
- Ultimate guide to digital Marketing by Digital Marketer

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Social Media Marketing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Social Media Marketing	2	1	0	1	Pass in XII	Pass in 'Digital Marketing' (SEC-Sem 1)

Learning Objectives

- To provide basic knowledge of social media marketing concepts
- To enhance skills as social media marketer and start a career in social media marketing.

Learning Outcomes

After completion of the course, learners will be able to:

1. Evaluate the role of social media in marketing, advertising and public relations.
2. Assess the optimal use of various social media platforms for social media marketing.
3. Analyse the importance of social media for developing an effective marketing plan, and assess ways to measure its performance.
4. Describe practical skills required for creating and sharing content through online communities and social networks.
5. Demonstrate and appreciate social media ethics to use social media spaces effectively.

SYLLABUS:

Unit 1: Introduction to Social Media Marketing: (4 hours)

Social Media Marketing- Concept and Importance.

Social Media Platforms- Online communities and Forums; Blogs and Microblogs, Social Networks, other contemporary social media platforms: Goals, Role in Marketing and Use as listening tools. Trends in SMM. Social Media Influencers.

Unit 2: Social media marketing Plan and Performance Measurement: (6 hours)

SMM Plan- Setting Goals, Determining Strategies, Identifying Target Market, Selecting Tools, Selecting Platforms, Implementation: Measuring Effectiveness - Conversion rate, amplification rate, applause rate: on page and on post level.

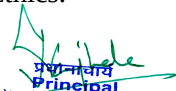
Unit 3: Content Creation and Sharing using Case Campaigns: (5 hours)

Blogging, Streaming Video and Podcasting: Criteria and approach-70/20/10 with risk variants, 50-50 content, Brand Mnemonic, Brand story. Contextualising content creation. Social Media Ethics.

Practical Exercises: 30 hours

The learners are required to:

1. Discuss the importance of social media in marketing, advertising and public relations.


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relevant case studies.

2. Examine the use of social media by your institution to improve alumni engagement.
3. Identify social media platforms for marketing a good, a service, an institution, an event and a person.
4. Promote any college event of your choice using social media. Measure the effectiveness of your campaign.
5. Create a blog/ vlog on any topic of your interest. Measure performance of your blog post.
6. Prepare a social media marketing plan for any product of your choice.
7. Prepare a calendar for scheduling various posts/campaigns via buffer or tweet deck. Find out the conversion rate, amplification rate, and the applause rate. Calculate the engagement rate and economic value/per visitor of the concerned campaigns.
8. Observe the engagement rate in twitter campaigns of your college and suggest improvements, if needed.
9. Assess the reviews/ratings, comments, likes, and dislikes of blog posts in the categories of health and nutrition, or yoga counselling, or family therapy.
10. Examine the twitter handles of Delhi Government or of Delhi University and find out how consistent they are in their reaction checks?
11. Design a social media plan for sensitising citizens for timely tax payments (Assuming that you are an honest tax-payer and feel that everyone should be like you).

Essengtial Readings

- Ahuja V(2015). Digital Marketing. Oxford University Press.
- Blanchard, O. (2011). Social Media ROI: Managing and Measuring Social Media Efforts in Your Organization. United Kingdom: Pearson Education.
- Charlesworth, A. (2014). An Introduction to Social Media Marketing. United Kingdom: Taylor & Francis.
- Gupta, S. (2020). Digital Marketing. India: McGraw Hill Education (India) Private Limited.
- Johnson, S. (2020). Social Media Marketing: Secret Strategies for Advertising Your Business and Personal Brand on Instagram, YouTube, Twitter, And Facebook. A Guide to being an Influencer of Millions. Italy: AndreaAstemio.
- Keller, K. L., Kotler, P. (2016). Marketing Management. India: Pearson Education.
- Maity M(2022). Digital Marketing. Oxford University Press.
- Mamoria C.B, Bhatacahrya A, Marketing Management. Kitab Mahal, Delhi
- Mathur, V. & Arora, S. Digital Marketing PHI Learning
- McDonald, J. (2016). Social Media Marketing Workbook: How to Use Social Media for Business. United States: CreateSpace Independent Publishing Platform.
- Parker, J., Roberts, M. L., Zahay, D., Barker, D. I., Barker, M. (2022). Social Media Marketing: A Strategic Approach. United States: Cengage Learning.
- Quesenberry, K. A. (2015). Social Media Strategy: Marketing and Advertising in the Consumer Revolution. United States: Rowman & Littlefield Publishers.
- Rishi, B., Tuten, T.L., (2020) Social Media Marketing, 3ed., Sage Textbook
- Setiawan, I., Kartajaya, H., Kotler, P. (2016). Marketing 4.0: Moving from Traditional to Digital. Germany: Wiley.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Digital Film Production

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Digital Film Production	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the art of digital video making and editing
- To learn about the tools required for video making and editing
- To learn about the various aspects in pre and post production of videos.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the importance of various aspects of audio-video production
- After studying this course, students will be able to prepare an effective layout for making an effective video.
- After studying this course, students will be able to apply the tools required for video production and editing.

SYLLABUS

Course Contents:

Unit 1: Introduction, Financial Planning and Budgeting (15 hours)

Audio Production: Concept of Sound, Types of sound, Audio range, Know your equipment's (Acoustic, Microphone, Recorder, Audio Mixer, Cables & connectors), Process of recording, Mixing, Sound processing, Recording level, Audio Editing, Dubbing & voiceover (Process, steps)

Unit 2: (15 hours)

Video Production (Pre-Production): Concept, What is pre-production, Concept/visualization, R & D, Screen play writing, Storyboard making, Shooting script writing, Peoples involved in pre-production, Set making, Copyright , Music making, Budgeting, Production Design, Location hunting, Hiring of equipment & crew members

Unit 3: (15 hours)

Video Production (Production): Know your equipment, Camera & accessories, Lights & Camera support, Clapboard, Sound equipment, Field Monitor, Blocking, Rehearsal, Lighting, Shooting

Unit 4: (15 hours)

Video Production (Post Production): Compiling the concept and Shooting material to final stage, Peoples involved in Post-production, Know your equipment, Editing, Color grading, Publicity, Transmission, Distribution and Rating

Practical Exercises and Projects

- Recording & Mixing of multi-track audio
- Budget Making & Script writing 05 minutes program
- Shooting for 05 minutes program (News / Music Video / Documentary / Feature / Chat show / Discussion etc.)
- Editing of 05 minutes video program

Audio Production (Project)

- Knowing the audio equipment's & software
- Recording process
- Mixing & Editing of various sound
- Exporting sound in various audio formats & project

Video Production (Project)

- Story writing, Storyboard making, Shooting script writing
- Location hunting, Breakdown making, Budget making
- Set making, Lighting, Shooting
- Editing, BGM posting, Color grading, Publicity, Exhibition & Transmission

Suggested Readings:

- Digital Filmmaking for Beginners A Practical Guide to Video Production (ELECTRONICS) by Michael K. Hughes, McGraw Hill TAB.
- Digital Filmmaking for Beginners A Practical Guide to Video Production, McGraw Hill TAB
- The Digital Filmmaking Handbook, Mark Brindle
- Video Production, Vasuvi Belavdi, Oxford Higher Education

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Visual Communication and Photography

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Visual Communication and Photography	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To synthesize a comprehensive view of principles involved in Visual Communication.
- To appreciate and express the cultural significance of photography as visual art and understand its evolution and purposes.
- To develop an awareness of compositional and organizational strategies for the effective deployment of formal elements of visual art.
- To read visual texts with a deep knowledge of visual history and theory.
- To create an ability of situating the content and form of the visual representation of thematic context.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to acquire knowledge of the cultural and historical importance of the visual medium.
- After studying this course, students will be able to explore the fundamentals and underlying theories of Visual Communication.
- After studying this course, students will be able to develop a thorough knowledge of concepts, and skills in creating photographs.
- After studying this course, students will be able to learn to identify and analyze semiotics in photographs.
- After studying this course, students will be able to develop a craftsmanship in creating aesthetically pleasing photographs.

SYLLABUS

Course Contents:

Unit 1: Historical Background and Basics of Visual Communication (15 hours)

Unit Description: The Unit I will give a brief history of the visual arts from the caveman to modern man. Skills of artistic schools of thought and Intertextuality in art in relation to culture.

Topics- Concept and History of Visual Communication, Human Eye and Visual Process, Visual culture and Information Education Communication, Theories of visual communication - Gestalt Theory of visual communication, Perceptual theory of Visual communication, Semiotics and cognitive approach in visuals

Unit II: Theories of Visual Communication (15 hours)

Unit Description: This unit will put emphasis on theories, semiotics and the study of signs. Through semiotic theories improve critical thinking skills, and learn to use semiotics to think logically and to analyze visual media in context of culture.

Topics: Fundamentals of Design: Definition. Approaches to Design, Centrality of Design, Elements of Design, Principles of Visual and other Sensory Perceptions. Colour psychology and theory (some aspects), Definition, Optical / Visual Illusions, etc., Various stages of design process, Learning skills to read signs and signifier in visuals for social messaging

Unit III: Photography as Visual Communication (15 hours)

Unit Description: This unit will provide skills to learn camera and lighting techniques.

Topics: Introduction to photography, Camera – structure and function of camera , Characteristics of light, Sources of Light – Nature, Artificial and Available, Lighting techniques – three-point lighting, Exposure – focusing, aperture, shutter speed, Depth of field. , Kinds of light indoor and outdoor – Electronic flash and artificial lights, Light meters

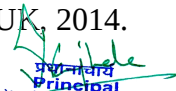
Unit IV: Camera Compositions and Accessories (15 hours)

Unit Description: This unit will provide skills about camera accessories and designing aesthetically rich compositions.

Topics: Camera lenses and accessories, Basic shots, angle, and view, Composition, Role of photographic image in visual communication, Basics of photojournalism, photo-features, photo - essays, writing captions, visual storytelling.

Essential Readings

- Barnes, Susan B. An Introduction to Visual Communication: From Cave Art to Second Life, Peter Lang Pub, 2011.
- Berger, Arthur Asa, Seeing is Believing: An Introduction to Visual Communication, McGraw-Hill Education, 2012.
- Lester, Paul Martin, Visual Communication: Images with Messages (6ed), Cengage Learning, 2013.
- Photography: A Critical Introduction - edited by Liz Wells London, Routledge, Oxon, 2015.
- Farrell, I. Complete Guide to Digital Photography, Quercus Publishing, UK, 2014.


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Suggested Readings

- Mandav, Pradeep, Visual Media Communication, Authors Press, 2001.
- Williams, Rich, Visual Communication: Integrating Media, Art, and Science, Routledge, 2007

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CAD for Fashion	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the concept of fashion sketching and fabric rendering
- To learn different softwares for fashion designing and rendering

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the basics of garment sketching and fabric rendering manually.
- After studying this course, students will be able to gain the knowledge about various computer design softwares – Adobe Photoshop, CorelDraw, Adobe Illustrator and Open source
- After studying this course, students will be able to learn the application of selected computer design softwares for fashion sketching.
- After studying this course, students will be able to develop proficiency in CAD for the creation of fabric textures and colour schemes.
- After studying this course, students will be able to Design a theme-based fashion collection using computer design software.

SYLLABUS

Course Contents:

Unit I: Fashion sketching

(30 hours)

Unit Description: Fashion sketching plays an important role in designing to preview and visualize designs before sewing actual clothing. Thus, this unit aims to help students develop the skills in designing apparel through flat sketching of garment components both manually and digitally.

Topics: Flat sketching of garment components by hand – necklines, collars, sleeves, skirts, tops, and trousers, Introduction to vector-based drawing softwares – CorelDraw, Adobe Illustrator and open-source software like Inkscape, Introduction to features and tools of CorelDraw/Illustrator/Inkscape, Project - Application of software tools for drawing technical flats on any vector-based computer design software

Unit II: Fabric rendering

(30 hours)

Unit Description: This unit will help students to develop skills to render the fabrics and silhouettes used in the garment. Students will be taught to imitate fabric textures in their drawing both manually and through computer aided design softwares. In addition, they will also learn to develop their own textile prints and their colour ways.

Topics: Learning to simulate textures of various fabrics manually - cotton, silk, fur, net, leather, velvet, denim, corduroy, georgette, chiffon, knit, crochet, lace, embroidery and prints. Understanding the basics of design repeat and how to create seamless prints manually. Introduction to raster -based editing softwares –Adobe Photoshop and open-source software like GIMP, Photopea etc.

Introduction to features and tools of Photoshop/Photopea/GIMP

Application of software tools for creating seamless patterns.

Project - Application of software tools for designing various textile products with different fabric textures in three different colour schemes

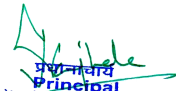
All the above work will be collated as a digital portfolio.

Essential Readings

- Abbing, B., (2019). Fashion Sketchbook, Bloomsbury Publication, UK
- Aldrich, W., (1994). CAD in Clothing and Textiles, 2nd Edition, Wiley- Blackwell Publishing, USA
- Jain, S. & Geetha M. (2018). CorelDraw Training Guide, BPB Publications, India
- Lazear, M. Susan, (2007). Adobe Photoshop for Fashion Design, Pearson Publishing
- Callender, J. (2011). 2000 Pattern Collection, Anova Books Company Limited, London.

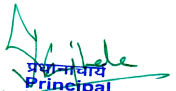
Suggested Readings

- CorelDraw tutorial: <https://www.youtube.com/watch?v=89VZfov7p8Q>
- Photoshop tutorial: <https://helpx.adobe.com/in/photoshop/tutorials.html>
- Shuffle Botham, R., 2014, Photoshop cc, In Easy Steps Limited, UK


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Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Graphic Designing & Animation

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Graphic Designing & Animation	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the skill of animation.
- To learn about the application of 2D and 3D animation.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the importance of animation and graphics design
- After studying this course, students will be able to learn graphics design in 2D and 3D animation.
- After studying this course, students will be able to learn the application of graphics design in 2D and 3D animation in advertising and other areas.

SYLLABUS

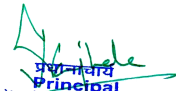
Course Contents:

Unit 1: 2D Animation

(30 hours)

Introduction to 2D Animation: Introduction to 2D Animation, Drawing concept, Colour theory & basics, Incorporating sound into 2D animation

Layout & Designing: Basic of sketching, still life and assignment of basic drawing, Composition of basic elements, Work in different media, such as drawing, collage, and painting, Explore the relationship between elements and principal, Pixel and resolution: Vector and Bitmap Graphics


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Graphics and advertising (Practical)

- Creating Digital Layout
- Professional image editing (PHOTOSHOP)
- Advertising and relevant case , Graphics and illustration (Corel Draw, Paint)
- Vector Composition , 2D animation (Macromedia Flash)

Broadcast Design (Practical)

- Working with visual images
- Story Boarding
- Titles and Credit Making
- Stop motion animation

Production / Post-Production (Practical)

- Paint & animate (scanning, tracing, ink & Paint)
- Understanding Background composition
- Basic Understanding of 2D animation and technique
- Animation with flash, Portfolio Making

Unit 2: 3D Animation

(30 hours)

3D Modeling: Introduction to 3D space in Blender, Introduction to Modeling Techniques, In-organic Modeling, Organic Modeling

3D Shading: Use of Materials & Shader, Shader and Texture Editing, Shading Organic Model, Shading In-Organic Models

3D Animation and Rigging (Practical)

- Introduction to 3D Animation
- Create, Edit and working with Animation Graph, Rigging using Blender
- Setting up controllers for joints
- Simple Skeleton structure with proper joint orientation

3D Lighting and Rendering (Practical)

- Understanding Lighting in Cycles
- Direct and Indirect Lighting
- Light Linking, Final Composition
- Creating composition and Light with the Shaded Models

3D Dynamics (Practical)

- Introduction to Dynamics, Active and Passive Bodies
- Creating basic Simulation and collision using Rigid body
- Cloth Simulation, Simulation of Brick wall collision
- Introduction to Fluid Effects, Creating fluid simulation

Project

(Digital Imaging)

- Design Print advertisement for Service
- Design Print advertisement for Product
- Design Print advertisement an Event
- Design Print advertisement on Social Awareness
- Design a collage with a social message

2D Animation

- Drawing fundamentals using lines
- Sketching of cartoon characters
- 2D Logo designing
- Storyboarding of a 30 seconds film
- Portfolio making of an organization

3D Animation

- Exploring the Interface of 3D application & Basic Modeling
- Create different types of Materials and create a Shading
- Create a simple walk cycle using the character rigs
- Create a composition and Light set up
- Create a Fluid simulation & rendering

Suggested Readings:

- The Illusion of Life: Disney Animation, Ollie Johnston and Frank Thomas, Disney Editions.
- Blender Production Creating Short Animations from Start to Finish, Roland Hess, Routledge.
- Animating with Blender: Creating Short Animations from Start to Finish, Roland Hess, Focal Press
- Simplified Drawing for Planning Animation, Wayne Gilbert, Anamie Entertainment Ltd.
- Getting Started in 3D with Maya, Adam Watkins, Routledge.
- Creating Characters with Personality: For Film, TV, Animation, Video Games, and Graphic Novels, Tom Bancroft, Watson-Guption
- Force: Dynamic Life Drawing for Animators, Mike Mattesi, Focal Press

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Programming using Python

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Programming using Python	2	0	0	2	Class XII	NIL

Learning Objectives

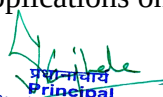
The Learning Objectives of this course are as follows:

- To provide exposure to basic problem-solving techniques with computers
- To develop logical thinking abilities and to propose novel solutions for real-world problems through programming language constructs.
- To deepen the empirical knowledge on applying programming in business domains.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to interpret the basic representation of the data structures and sequential programming
- After studying this course, students will be able to gain knowledge of, and ability to use control framework terminologies.
- After studying this course, students will be able to work out using the core data structures as lists, dictionaries, tuples, and sets.
- After studying this course, students will be able to choose appropriate programming paradigms, interrupt and handle data using files to propose solutions through reusable modules
- After studying this course, students will be able to propose possible error-handling constructs for unanticipated states/inputs.
- After studying this course, students will be able to implements exemplary applications on real-world problems.


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Syllabus

Unit-1: Introduction

(8 hours)

Relationship between computers and programs, Basic principles of computers, File systems, Using the Python interpreter, Introduction to binary computation, Input / Output

Unit-2: Data types and control structures

(8 hours)

Operators (unary, arithmetic, etc.), Data types, variables, expressions, and statements, Assignment statements, Strings and string operations, Control Structures: loops and decision

Unit-3: Modularization and Classes

(8 hours)

Standard modules, Packages, Defining Classes, Defining functions, Functions and arguments (signature)

Unit-4: Data structures and Object-oriented design

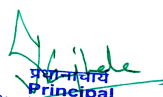
(8 hours)

Data Structures (array, List, Dictionary), Error processing, Exception Raising and Handling Programming types, Object Oriented Programming, Object Oriented Design, Inheritance and Polymorphism

Practical Exercises

(28 hours)

- Running instructions in Interactive interpreter and a Python Script
- Write a program to purposefully raise Indentation Error and Correct it
- Write a program to compute distance between two points taking input from the user. (Pythagorean Theorem)
- Write a program add.py that takes 2 numbers as command line arguments and prints its sum.
- Write a Program for checking whether the given number is an even number or not.
- Using a for loop, write a program that prints out the decimal equivalents of 1/2, 1/3, 1/4, 1/10
- Write a program using a for loop that loops over a sequence. What is the sequence?
- Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero.
- Find the sum of all the primes below two million. Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10 terms will be: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89,
- By considering the terms in the Fibonacci sequence whose values do not exceed four million, find the sum of the even-valued terms.
- Write a program to count the numbers of characters in the string and store them in a dictionary data structure.


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- Write a program to use split and join methods in the string and trace a birthday with a dictionary data structure.
- Write a program combining lists that combines these lists into a dictionary.
- Write a program to count the frequency of characters in a given file. Can you use character frequency to tell whether the given file is a Python program file, C program file or a text file?
- Write a program to print each line of a file in reverse order.
- Write a program to compute the number of characters, words and lines in a file.
- Write a function ball collide that takes two balls as parameters and computes if they are colliding. Your function should return a Boolean representing whether or not the balls are colliding. Hint: Represent a ball on a plane as a tuple of (x, y, r), r being the radius. If (distance between two balls centers) $\leq$ (sum of their radii) then (they are colliding)
- Find mean, median, mode for the given set of numbers in a list.
- Write a function nearly equal to test whether two strings are nearly equal. Two strings a and b are nearly equal when a can be generated by a single mutation on b.
- Write a function dups to find all duplicates in the list.

Essential/recommended readings

- "Starting Out with Python plus My Programming Lab with Pearson eText --Access Card Package (3rd Edition) Tony Gaddis ISBN-13: 978-0133862256".
- Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition).
- Head-First Python: A Brain-Friendly Guide (2nd Edition) by Paul Barry.
- Learn Python the Hard Way: 3rd Edition by Zed A. Shaw.
- Python Programming: An Introduction to Computer Science (3rd Edition) by John M. Zelle.
- Python Cookbook: Recipes for Mastering Python 3 (3rd Edition) by Brian Jones and David Beazley.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

DOCUMENT PREPARATION & PRESENTATION SOFTWARE

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Document Preparation & Presentation Software	2	0	0	2	Class XII	NIL

Learning Objectives:

- To develop proficiency in the use of document preparation software such as document LaTeX, LibreOffice.
- To make a presentation using LaTeX, LibreOffice.
- To serve as a tool for conveying/communicating one's ideas, views, and observations.

Learning Outcomes

On completion of the course, a student will be able to

- Create a text document using LaTeX using a standard template.
 - Incorporate well-formatted mathematical equations, algorithms, figures, tables and references in a document.
 - Use Zotero for reference management.
 - Format text, including alignment, emphasis and fonts.
 - Handle basic aspects of document structure, including sections, subsections, paragraphs, and bulleted and enumerated lists.
 - Page set a document including header, footer, and page numbering.
- Make a presentation.

Syllabus

Practical

Unit 1: Introduction

(4 Hours)

1. Create a LaTeX/ LibreOffice document having several paragraphs, including comments in LaTeX.
2. Organize content into sections, including preface/abstract. Using the article and book class of LaTeX. Handling errors.

Unit 2: Styling Pages

(6 Hours)

1. Loading and using packages, setting margins, header and footer, and page orientation.
2. Organizing the document into multiple columns

Unit 3: Formatting Content

(10 Hours)

1. Formatting text (styles, size, alignment)
2. Adding colours to a block of text/ page
3. Adding ordered and unordered lists
4. Inserting mathematical expressions – subscripts, superscripts, fractions, binomials, aligning equations, operators, Greek and mathematical symbols, and mathematical fonts.

Unit 4: Tables and Figures

(10 Hours)

1. Create basic tables
2. Adding different types of borders to a table
3. Merging rows and columns
4. Splitting tables across multiple pages.
5. Incorporating figures and subfigures, explore different properties like rotation and scaling.

Unit 5: Algorithms and Equations

(12 hours)

1. Incorporating algorithms, body typesetting, organizing algorithms across multiple pages.
2. Incorporating equations, indentation, and captioning.

Unit 6: Referencing and Indexing

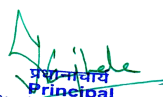
(6 hours)

1. Insert captions, labels, and references
2. Incorporate cross-referencing (refer to sections, table, and images)
3. Incorporate a bibliography
4. Create a back index.

Unit 7: Making Presentations

(12 hours)

1. Create a slideshow
2. Incorporate logo
3. Highlight important points
4. Create a title page
5. Make a table of contents
6. Incorporate special effects in a slideshow.


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Exercises:

For the following figures, create LaTeX documents using concepts from above:

1.

Hello World!

Prof. Naveen Kumar

November 15, 2022

Hello World! Today I am learning L^AT_EX. L^AT_EX is a great program for writing math. I can write in line math such as $a^2 + b^2 = c^2$. I can also give equations their own space:

$$\gamma^2 + \theta^2 = \omega^2$$

2.

Integrals, Sums and Limits

Dr. Neeraj Kumar Sharma

1 Integrals

Integral $\int_a^b x^2 dx$ inside text.

The same integral on display:

$$\int_a^b x^2 dx$$

and multiple integrals:

$$\begin{aligned} &\iint_V \mu(u, v) du dv \\ &\iiint_V \mu(u, v, w) du dv dw \\ &\oint_V f(s) ds \end{aligned}$$

2 Sums and products

Sum $\sum_{n=1}^{\infty} 2^{-n} = 1$ inside text.

The same sum on display:

$$\sum_{n=1}^{\infty} 2^{-n} = 1$$

Product $\prod_{i=a}^b f(i)$ inside text.

The same product on display:

$$\prod_{i=a}^b f(i)$$

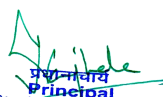
3 Limits

Limit $\lim_{x \rightarrow \infty} f(x)$ inside text.

The same limit on display:

$$\lim_{x \rightarrow \infty} f(x)$$

3.


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Equations

Prof. Naveen Kumar¹, Dr. Neeraj Kumar Sharma², and Sakeena Shahid³

¹Department of Computer Science, University of Delhi

²Ram Lal Anand College, University of Delhi

³SGTB Khalsa College, University of Delhi

November 15, 2022

1 Maxwell's Equations

"Maxwell's equations" are named for James Clark Maxwell and are as follow:

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0} \quad \text{Gauss's Law} \quad (1)$$

$$\vec{\nabla} \cdot \vec{B} = 0 \quad \text{Gauss's Law for Magnetism} \quad (2)$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \text{Faraday's Law of Induction} \quad (3)$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \left(\epsilon_0 \frac{\partial \vec{E}}{\partial t} + \vec{J} \right) \quad \text{Ampere's Circuital Law} \quad (4)$$

Equations 1, 2, 3, and 4 are some of the most important in Physics.

2 Matrix Equations

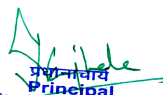
$$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix} \begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}$$

4.

List of mathematical functions:

- Trigonometric functions
 - sine
 - cosine
 - tangent
- Special functions
 - Beta function
 - Gamma function
 - Riemann zeta function

5. Add the following algorithm to the document.


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Algorithm 1: Example code

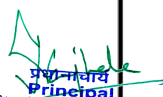
```
Input: Your Input
Output: Your output
Data: Testing set  $x$ 
1  $\sum_{i=1}^{\infty} := 0$  // this is a comment
  /* Now this is an if...else conditional loop */
2 if Condition 1 then
3   | Do something // this is another comment
4   | if sub-Condition then
5   |   | Do a lot
6 else if Condition 2 then
7   | Do Otherwise
  /* Now this is a for loop */
8   | for sequence do
9   |   | loop instructions
10 else
11   | Do the rest
  /* Now this is a While loop */
12 while Condition do
13   | Do something
```

6.

col1	col2	col3
Multiple row	cell2	cell3
	cell5	cell6
	cell8	cell9

7.

Country List		
Country Name or Area Name	ISO ALPHA 2 Code	ISO ALPHA 3
Afghanistan	AF	AFG
Aland Islands	AX	ALA
Albania	AL	ALB
Algeria	DZ	DZA
American Samoa	AS	ASM
Andorra	AD	AND
Angola	AO	AGO


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8. Insert four sub-figures as given below, and add captions. Also, refer to these sub-figures in the text.

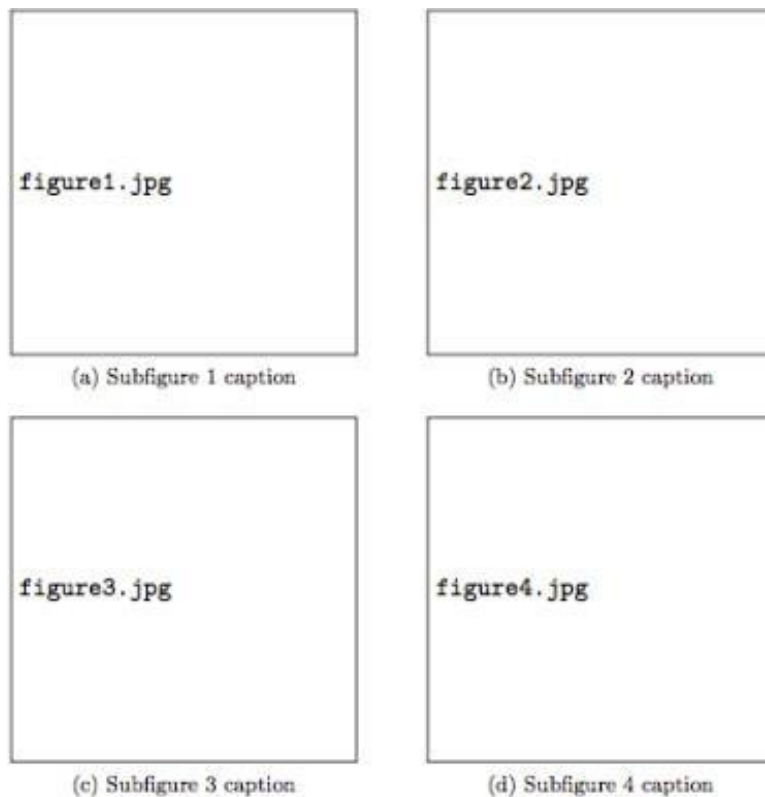


Figure 1: This is a figure containing several subfigures.

In the text, you can refer to subfigures of figure 1 as 1a, 1b, 1c and 1d and to the sub-index as (a), (b), (c) and (d).

9. Add a table of contents, a list of figures, and a list of tables in the document as given below.

Contents

Table of contents	1
1 First Section	2
2 Second Section	2

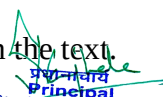
List of Tables

1 Just a table	2
--------------------------	---

List of Figures

1 This is an image	2
------------------------------	---

10. Add a list of references in the document as given below and cite them in the text.


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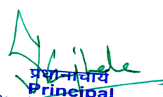
This document is an example of `natbib` package using in bibliography management. Three items are cited: *The L^AT_EX Companion* book [2], the Einstein journal paper Einstein [1], and the Donald Knuth's website [3]. The L^AT_EX related items are [2, 3].

References

- [1] A. Einstein. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921, 1905. doi: <http://dx.doi.org/10.1002/andp.19053221004>.
- [2] M. Goossens, F. Mittelbach, and A. Samarin. *The L^AT_EX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.
- [3] D. Knuth. Knuth: Computers and typesetting. URL <http://www-cs-faculty.stanford.edu/~uno/abcde.html>.

Examination scheme and mode:

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Front End Web Design and Development

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Front End Web Design and Development	2	0	0	2	Class XII	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To introduce the basic concepts and techniques of client-side web programming.
- To enable the students to develop simple, interactive, and stylish websites using HTML, CSS and JavaScript.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to build websites using the elements of HTML.
- After studying this course, students will be able to build interactive and stylish websites using client-side programming techniques with CSS and Javascript.
- After studying this course, students will be able to learn to validate client-side data.
- After studying this course, students will be able to define the structure and contents of the website using different features of CSS.

SYLLABUS

Unit-1: Introduction

(8 hours)

Introduction: Introduction to internet and web design. Basic concepts of web architecture.

Unit-2: HTML

(8 hours)

Introduction to hypertext mark-up language (html), creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames.

Unit-3: Cascading style sheet (CSS)

(8 hours)

Concept of CSS, creating style sheet, Importing style sheets, CSS properties, CSS styling (background, text format, controlling fonts), CSS rules, Style Types, CSS Selectors, CSS cascade, working with block

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elements and objects, working with lists and tables, CSS id and class, box model (introduction, border properties, padding properties, margin properties).

Unit-4: Basics of Javascript

(8 hours)

Document object model, data types and variables, functions, methods and events, controlling program flow, built-in objects and operators, validations.

Practical Exercise

(28 hours)

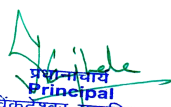
HTML

- Create an HTML document with following formatting – Bold, Italics, Underline, Colors, Headings, Title, Font and Font Width, Background, Paragraph, Line Brakes, Horizontal Line, Blinking text as well as marquee text.
- Create an HTML document with Ordered and Unordered lists, Inserting Images, Internal and External linking
- Create an HTML document for displaying the current semester's timetable.
- Create a website with horizontal and vertical frames. Top horizontal frame needs to show your college's name and logo. Bottom horizontal frame is to be split into two vertical frames. The left frame has hyperlinks to pages related to faculty, courses, student activities, etc. The right frame shows the corresponding webpage based on the link clicked on the left frame.
- Create a student registration form using HTML which has the following controls and make an interactive content presentation using CSS.:

I. Text Box II. Dropdown box III. Option/radio buttons

IV. Check boxes V. Reset and Submit button

- Create a webpage for your department with a drop-down navigation menu for faculty, courses, activities, etc.. Implement the webpage using styles, rules, selectors etc. learned in CSS
- Write event-driven programs in JavaScript for the following:
 - Enter a number and on click of a button print its multiplication table.
 - Print the largest of three numbers entered by the user.
 - Find the factorial of a number entered by the user.
 - Enter a list of positive numbers using the prompt terminated by a zero. Find the sum and average of these numbers.
- Create a student registration form using text, radio button, check box, drop down box, text field and all other required HTML elements. Customize the CSS and javascript to input and validate all data. Create functions to perform validation of each element, example:
 - Roll number is a 7-digit numeric value
 - Name should be an alphabetical value (String)
 - Non-empty and valid fields like DOB


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Essential/recommended readings

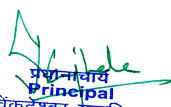
- Nixon, R., Learning PHP, MySQL & JavaScript with jQuery, CSS and HTML5, O'Reilly, 2018.
- Powell, T.A. HTML & CSS: The Complete Reference, 5th edition, Tata McGrawHill, 2017.
- Duckett, J., JavaScript and JQuery: Interactive Front-End Web Development, Wiley, 2014.

Suggested Readings

- Boehm, A., & Ruvalcaba, Z., Murach's HTML5 and CCS, 4th edition, Mike Murach & Associates, 2018.
- Ivan Bayross, Web Enabled Commercial Application Development Using Html, Dhtml, Javascript, Perl CGI, BPB Publications, 2010.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Back-End Web Development

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Back-End Web Development	2	0	0	2	Class XII	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To introduce the basic concepts and techniques of server-side web programming.
- To enable the students to apply the basic concepts and techniques of server-side web programming.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to build interactive and dynamic websites.
- After studying this course, students will be able to write the server side programming techniques with Django for accessing the contents to/from the server
- After studying this course, students will be able to learn to validate server-side/backend data
- After studying this course, students will be able to use GET and POST methods for sending data within client and server.

SYLLABUS

Unit-1

(15 hours)

Installation of Django, Introduction to Django; Model–view–controller(MVC) model; Django structure; HTML templates; URL dispatcher, Django Template System, Interacting with a Database

Unit-2

(15 hours)

The Django Administration Site , Wrapper Functions, Custom Views GET and POST methods;Deployment of Django; Automating tasks with Django; Building Web REST

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Project Work

(30 hours)

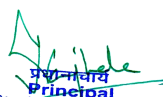
Build a website for student admission in a college/university.

Essential/recommended readings

<https://docs.djangoproject.com/>

Examination scheme and mode:

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APP Development using Flutter

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
APP Development using Flutter	2	0	0	2	Class XII	Basic knowledge of Python programming language is preferred.

Learning Objectives:

The Learning Objectives of this course are as follows:

- To enable the students for developing simple mobile applications that can run on Android, IOS and Web.
- To learn the fundamentals of Flutter platform.
- To enable the students to write cross-platform applications.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to Install and use flutter
- After studying this course, students will be able to use DART language
- After studying this course, students will be able to build a cross-platform AP
- After studying this course, students will be able to deploy application with single codebase.

Syllabus

Unit-1

(8 hours)

Introduction to Flutter, Flutter – installation, Widgets, Gestures(Title, Body, Columns, Root, Run app)

Unit-2

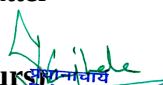
(8 hours)

State Management, Flutter – Introduction To Package, Build method, Dart packages, app bar, text widgets, Scaffold, Containers, Structuring flutter apps, Using GitHub repos of flutter

Unit-3

(8 hours)

Flutter – Accessing Rest API, Database Concepts, Testing (Widget Testing).


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Unit-4

(8 hours)

Deployment (Android Application On Play Store, IOS Application On APP Store)

Practical Exercises

(28 hours)

- Build a simple quiz app in flutter for android, ios, and web.
- Build a cross-platform app based on your own idea. Use as many features of flutter as you can.

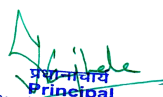
Essential/recommended readings

<https://docs.flutter.dev/>

<https://github.com/flutter>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Big Data Analytics - I

Credit Distribution, Eligibility and Pre-Requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Big Data Analytics-I	2	1	0	1	Class XII	Basic knowledge programming language (preferably Java), Shell scripting, SQL Query

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the Big Data platform and its uses.
- Provide an overview of Apache Hadoop.
- Provide HDFS concepts and Interfacing with HDFS.
- Provide an overview of Map Reduce Programming.

Learning Outcomes

The Learning Outcomes of this course are as follows:

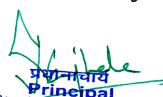
- After studying this course, students will be able to identify Big Data and its Business Implications.
- After studying this course, students will be able to list the components of Hadoop and Hadoop Eco-Systems.
- After studying this course, students will be able to access and process data on distributed file system.
- After studying this course, students will be able to manage job execution in Hadoop environment.

Syllabus:

Unit-1: Understanding Big Data

(2 hours)

Data Storage and Analysis-The process of data analysis, Characteristics of Big Data, Big Data Analytics, Typical Analytical Architecture, Requirement for new analytical architecture, Challenges in Big Data Analytics – Need of big data frameworks


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Unit-2: Foundations of Big Data Systems**(4 hours)**

Getting started with Hadoop, Requirement of Hadoop Framework, Design principle of Hadoop –Comparison with other system, Understanding Hadoop Ecosystem: Hadoop Components – Hadoop 1 vs Hadoop 2

Unit-3: HDFS (Hadoop Distributed File System)**(4 hours)**

The Design of HDFS, Hadoop Daemon's – HDFS Commands, HDFS Concepts, Command Line Interface, Hadoop file system interfaces-Loading data into HDFS, read/write process to HDFS

Unit-4: Introduction to Parallel Programming with Map Reduce**(5 hours)**

Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining Map Reduce jobs (Map Reduce Execution Pipeline)- Map, Shuffle and Sort, Reduce

Practical Exercises**(30 hours)**

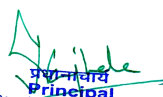
- Downloading and installing Hadoop.
- Understanding different Hadoop modes. Startup scripts, Configuration files.
- Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files.
- Run a basic word count Map reduce program to understand map reduce paradigm: To count words in a given file, to view the output file, and to calculate the execution time.
- Map Reduce Program to analyse time-temperature statistics and generate report with max/min temperature.

Essential/recommended readings

- Seema Acharya, Subhasini Chellappan, “Big Data Analytics” Wiley 2015.
- Tom White, “Hadoop: The Defective Guide”, O'Reilly, 4th Edition, 2015.
- Donald Miner, Adam Shook, “Map Reduce Design Pattern”, O'Reilly, 2012.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Big Data Analytics - II

Credit Distribution, Eligibility and Pre-Requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Big Data Analytics-II	2	1	0	1	Class XII	Big Data Analytics-I

Learning Objectives

The Learning Objectives of this course are as follows:

- Provide hands-on Hadoop Eco System.
- Provide an overview of Apache Spark.
- To understand Machine Learning with Big Data.
- Provide an overview of GPU Computing.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to develop Big Data Solutions using Hadoop Eco System.
- After studying this course, students will be able to use Spark for the effective analysis of the Big Data.
- After studying this course, students will be able to use Machine Learning Techniques with Big Data.
- After studying this course, students will be able to use GPU Computing for parallel computations.

Syllabus:

Unit-1: Big Data Systems- The Advances

(3 hours)

Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit-2: Introduction to Apache Spark

(3 hours)

Introduction, Architecture of Spark, Resilient Distributed Datasets, Spark Transformations, Spark Application - Spark Programming in Scala, Python, R, Java - Application Execution

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Unit-3: Machine Learning with Big Data**(3 hours)**

Introduction to machine learning, Supervised vs Unsupervised learning, Cluster analysis, understanding k means clustering, Implementation of k means clustering with Map Reduce.

Unit-4: Introduction to GPU Computing**(6 hours)**

Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix, Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features.

Practical Exercises**(30 hours)**

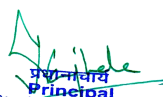
- Implementation of Matrix Multiplication with Hadoop Map Reduce.
- Implementation of K-means clustering using Map Reduce.
- To study and implement basic functions and commands in R/Python programming.
- To build Word cloud, a text mining method using R/Python for easy to understand and visualization than a table data.
- To implement clustering program using R/Python programming

Essential/recommended readings

- Seema Acharya, Subhasini Chellappan, “Big Data Analytics” Wiley 2015.
- Mike Frampton, “Mastering Apache Spark”, Packt Publishing, 2015.
- Tom White, “Hadoop: The Defective Guide”, O’Reilly, 4th Edition, 2015.
- Nick Pentreath, Machine Learning with Spark, Packt Publishing, 2015.
- Mohammed Guller, Big Data Analytics with Spark, Apress, 2015.
- Donald Miner, Adam Shook, “Map Reduce Design Pattern”, O’Reilly, 2012.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Introduction to Blockchain

Credit Distribution, Eligibility and Pre-Requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Blockchain	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the basic concept of blockchain.
- To make the students learn and implement blockchain technology.
- To learn about distributed organizations and distributed ledger.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand how Ethereum transactions are validated by miners.
- After studying this course, students will be able to understand Ethereum Blockchain.
- After studying this course, students will be able to learn Solidity programming language to develop Smart Contracts.
- After studying this course, students will be able to understand the key concepts like cryptography and public , private blockchain.
- After studying this course, students will be able to gain a deep insight into Ethereum, Hyperledger and its network.

Syllabus:

Practical

Unit-1

(16 hours)

Blockchain: Basics And Applications: Node Fundamentals, Blockchain Basics, Blockchain Features, Ethereum Fundamentals, Smart Contract Development In Ethereum, Dapp Development In Ethereum.

Building A Distributed Application On Hyperledger Fabric:

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Hyperledger Fundamentals,

Unit-2

(16 hours)

Fabric Network Setup, Chaincode Development,DAPP Development.

CAPSTONE PROJECT

(28 hours)

- Assignment/Project

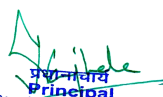
Suggested Web links

<https://ethereum.org>

<https://www.hyperledger.org/>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Introduction to Cloud Computing (AWS)

Credit Distribution, Eligibility and Pre-Requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Cloud Computing (AWS)	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about cloud computing through Amazon Web Services (AWS) platform.
- To learn about AWS cloud concepts, services, security and architecture to build an application.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to Understanding cloud computing platform
- After studying this course, students will be able to differentiate between on-premises, hybrid-cloud, and all-in cloud
- After studying this course, students will be able to describe the basic global infrastructure of the AWS Cloud
- After studying this course, students will be able to understanding the core AWS services, including compute, network, databases, and storage

Syllabus:

Practical

Unit-1

(12 hours)

Introduction to cloud computing, Creating AWS account, AWS Management Console, AWS Documentation overview, Availability Zones, AWS Global Infrastructure.

Unit-2

Compute in the Cloud :- Amazon EC2, instance types.

Unit-3

(10 hours)

Storage and Databases: - Amazon Simple Storage Service (Amazon S3), Amazon Relational Database Service (Amazon RDS), Amazon DynamoDB.

PROJECT

(28 hours)

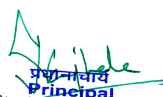
- Create an AWS account and implement AWS cloud for deploying any application.

Suggested Web links

<https://aws.amazon.com>

Examination scheme and mode:

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Biofertilizers

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biofertilizers	2	0	0	2	Class XII	NA

Learning objectives:

To help the students understand:

- the concept of biofertilizers and develop the skills for handling microbial inoculants.
- the growth and multiplication conditions of useful microbes and their role in mineral cycling and nutrition to plants.
- various methods of decomposition of biodegradable waste and their conversion to compost.

Learning outcomes:

After completion of this course, the learners will be able to:

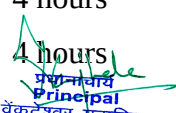
- describe the different methods of composting.
- assess quality of compost and its role in soil nutrition.
- apply methods of bio-control
- develop a composting unit for production of biofertilizers (generate employment)

SYLLABUS

Practical:

60 hours

1. Introduction to rhizobial symbiosis - Study of *Rhizobium* and its isolation from root nodules of leguminous plants by Gram staining method. 4 hours
2. Study of different bio-composting methods (microbes and earthworm). 8 hours
3. Compost quality assessment and its role in soil nutrition - Test for pH, NO³⁻, SO₄²⁻, Cl⁻ and organic matter of different composts. 8 hours
4. Introduction to Arbuscular mycorrhiza - Study of arbuscular mycorrhizal fungi from plant roots by staining methods. 4 hours
5. Isolation of arbuscular mycorrhizal spores from rhizosphere soil. 4 hours


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6. Study structure of *Anabaena* and *Azolla* structure - Isolation of *Anabaena* from *Azolla* leaf. 4 hours
7. Study various biocontrol methods and their application Pheromone trap, *Trichoderma*, *Pseudomonas*, Neem etc. 4 hours
8. Projects on any one of the following topics: *Rhizobium* technology, AMF technology, Organic farming, Bio composting, Vermicomposting, *Azolla* culture etc. The design of the project should be such that it includes a continuous work of at least 6 weeks and a dissertation submission/ presentation/ CE - continuous evaluation. 24 hours

Essential Readings:

1. Kumaresan, V. (2005). *Biotechnology*. New Delhi, Delhi: Saras Publication.
2. Sathe, T.V. (2004). *Vermiculture and Organic Farming*. New Delhi, Delhi: Daya publishers.
3. Subha Rao, N.S. (2000). *Soil Microbiology*. New Delhi, Delhi: Oxford & IBH Publishers.
4. Khosla, R. (2017). *Biofertilizers and Biocontrol Agents for Organic Farming* Kojo Press.

Suggestive Readings:

1. Azotobacter - Isolation and characterization -- <https://youtu.be/1Z1VhgJ2h6U>
2. Rhizobium -- Identification and characterization - <https://youtu.be/jELlo-pMvc4>.
3. 3-Days Online Workshop On Arbuscular Mycorrhizal Fungi_ Biodiversity, Taxonomy and Propagation 19-2 (2022-01-20 at 02_27 GMT-8) – <https://youtu.be/LKzK4IuSRc4>
4. Vayas, S.C, Vayas, S., Modi, H.A. (1998). *Bio-fertilizers and organic Farming*. Nadiad, Gujarat: Akta Prakashan.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Bioinoculants for Agriculture and Sustainable Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Bioinoculants for Agriculture and Sustainable Development	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students aware of the role of microorganisms in sustainable development and remediation.
- To develop their own biofertilizers and other kinds of bio-inoculants for use in agriculture and environment.
- Skill development in initiating a bioinoculant-based low cost startup.

Learning outcomes

After studying this course, the students will be:

- Able to identify the role of microbes in sustainable development and how microbes can be used in remediation of damaged environments.
- Skilled in isolating microorganisms from a variety of different sites. Will learn Selection, purification and preservation of useful cultures.
- Skilled in formulating bioinoculants and test its efficacy.

SYLLABUS

Practical

60 hours

Unit 1: Introduction and scope of bioinoculants

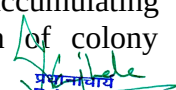
20 hours

Biofertilizers: success story – biofertilizer production under ICAR - How Biofertilizers for Corn Went Commercial. Biopesticides: success story of using biopesticides for nematode management in horticultural crops. Bioinoculants as a solution to the problem of parali (stubble) burning: case study of “PUSA Decomposer”. Bioinoculants for reforestation. Bioinoculants for the reclamation of waste lands having alkaline, acidic, heavy metal-contaminated soils. Bioinoculants for clearance of oil spills. Mycorrhizal inoculants. Some important commercially available bioinoculants.

Unit 2: Isolation of microorganisms for the preparation of bioinoculants

28 hours

Isolation of phosphate solubilizers, free-living nitrogen fixers, heavy metal-accumulating microbes, alkalophiles, acidophiles from suitable soil samples. Observation of colony


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morphology and microscopic structure of selected microbes and preservation of these cultures in slants and glycerol stocks.

Unit 3: Formulation of bioinoculant using selected microbes (student group project)

12 hours

Culturing of selected microbes from those isolated, and formulating them into a bioinoculant. Preparation of workflow for evaluating efficacy in potted plants and in fields, for determining shelf life, and stability.

Essential/Recommended readings

1. Microbiology: A Lab Manual by J. G. Cappuccino and C. T. Welson. 12th edition.
2. Pearson. 2020.
3. Bio-inoculants as prospective inputs for achieving sustainability: Indian Story by C. Gupta et al. Economic Affairs. Vol. 65, No. 1, pp. 31-41. 2020.
4. Bioinoculants for bioremediation applications and disease resistance: Innovative Perspectives by T. Chaudhary and P. Shukla. Indian J Microbiol. 59 (2): 129–136. 2019.
5. Remediation of metalliferous soils through the heavy metal resistant plant growth promoting bacteria: paradigms and prospects by M. Ahemad. Arabian Journal of Chemistry, 12 (7);1365-1377. 2019.
6. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2nd edition. Scientific International Pvt. Ltd., Delhi. 2018.
7. Online resource: <https://www.jaivikkheti.in/DMS/Waste-Decomposer%20Book-Eng.pdf>
8. Online resource: <https://www.iihr.res.in/success-story-using-biopesticides-nematode-management-horticultural-crops>.
9. Biofertilizer Production under ICAR All India Network Project on Soil Biodiversity Biofertilizers DOI: 10.13140/RG.2.2.26840.42244
10. Online resource: <https://blog.teamtrade.cz/the-story-of-how-biofertilizers-for-corn-went-commercial-part-one/>
11. Online resource: https://en.wikipedia.org/wiki/Microbial_inoculant

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Organic Farming

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Organic arming	2	0	0	2	Class XII	NA

Learning objectives:

- To create awareness among the students about organic farming and its importance in sustainable agriculture.
- To provide a skill set of Organic farming to students to help them become self-reliant.

Learning Outcomes:

After completion of this course the learners will be able to:

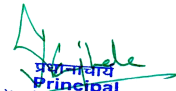
- practice organic farming along with application of indigenous knowledge.
- establish entrepreneurial ventures and generate employment (Organic Grower).
- evaluate the organic produce as per FSSAI standards (Government rules).

SYLLABUS

Practical:

60 hours

1. Study of Organic Farming as an integrated approach. 4 hours
2. Soil analysis-physical testing and assessment of soil types, weightment, water movement, soil conditioners, etc. 8 hours
3. Manure preparation and introduction to compost, composting and its value addition quality test. 4 hours
4. Study of Indigenous Technology Knowledge (ITK) for nutrient, insect, pest disease and weed management. 8 hours
5. Study of various agriculturally useful Biofertilizers. 4 hours
6. Biocontrol agents including Integrated Pest Management. 4 hours
7. Study of traditional organic input preparation/formulation of Biofertilizer, biopesticides, plant health promoters like *Panchgavya*, *Beejamrut* etc. 8 hours
8. Study of the system of organic certification and inspection. 4 hours


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9. Branding of rural products, FSSAI, marketing, packaging and handling of organic produce. 4 hours
10. Current Government schemes related to organic farming. 4 hours
11. Visit organic farms to study the various components and their utilization. 8 hours

Essential Readings:

1. Dhama, A.K. (2014). Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
2. Sharma, Arun K. (2013). A Handbook of Organic Farming, Agrobios (India), Jodhpur
3. Palaniappan, S.P. and Anandurai, K. (1999). Organic Farming – Theory and Practice. Scientific Pub. Jodhpur
4. Thapa, U and Tripathy, P. (2006). Organic Farming in India, Problems and prospects, Agritech, Publising Academy, Udaipur.
5. Jaivik Kheti Sahayak Pustika- National Centre for Organic and Natural Farming, Department of Agriculture & Farmers Welfare, GoI.

Suggestive Readings:

1. National Program for Organic Production-APEDA, Ministry of Commerce & Industry, GoI.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Horticulture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Horticulture	2	0	0	2	Class XII	NA

Learning objectives

- To acquaint students with the basic, principles, concepts and importance of Horticulture
- To train students in lawn designing, species selection for lawns, parks, home gardens and terrace gardens.
- To provide information about the employment and business opportunities and other avenues in the horticulture sector

Learning Outcomes

After completion of the course, learners will be able to:

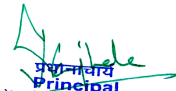
- design gardens and learn the art of landscape design.
- describe and implement methods of preparing soil, cultivation and propagation for growing hedges, climbers, vegetables, and fruit yielding plants
- create and maintain nurseries, green houses and implement innovative practices in maintenance, harvesting and storage of horticultural produce.
- apply the skills for enhancing the job opportunities (Horticulturist) as well as self-employment.

SYLLABUS

Practical:

60 hours

1. Introduction to Horticulture; Garden tools and safety. 4 hours
2. Lawn making and lawn care: recognizing soils and drainage systems, types of grasses. 4 hours
3. Choosing the appropriate plants (species selection) for plantation in different seasons and locations (Outdoor, roof-top, balcony, rock gardens); Flowering annuals, herbaceous


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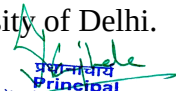
- perennials, vines and climbers, ornamental trees, bulbous and foliage plants, cacti and succulents. 4 hours
4. Vegetable Garden: Sowing, raising seedlings, transplantation methods; choosing the right vegetables for the season. 4 hours
 5. Seed germination, viability tests and comparison of other parameters of seeds (stored from different years/different temperatures). 4 hours
 6. Weeding, manuring, and irrigation methods used in lawns, parks, and vegetable gardens. 4 hours
 7. Propagation and plant care: propagation by layering, cutting and other methods. 4 hours
 8. Pruning: pruning roses, shrubs, and trees. 4 hours
 9. Supporting plants: bamboos, strings, and enclosures. 4 hours
 10. Maintenance and care of lawns and gardens: understanding diseases caused by pests and pathogens; protecting garden plants from infections, treating the plants with organic and biopesticides. 4 hours
 11. Bonsais: Art and craft. 4 hours
 12. One week internship on field or in a company/organisation (Landscape Design) that shall be facilitated by the college and report to be submitted. 8 hours
 13. Methods and plantation approaches in various garden designs: Japanese, Mughal, Buddhist, English and Indian Gardens. 4 hours
 14. Enhancing beauty of a garden using flowering plants, Garden walls, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Borders, aquatic garden with flowers; Case studies: Some selected gardens of India. 4 hours

Essential Readings:

1. Edmondson, J.L., Cunningham, H., Densley Tingley, D.O. et al. (2020). The hidden potential of urban horticulture. *Nat Food* **1**, 155–159.
2. Musser E., Andres. (2005). *Fundamentals of Horticulture*. New Delhi, Delhi: McGraw Hill Book Co. 2.
3. Sandhu, M.K. (1989). *Plant Propagation*. Madras, Bangalore: Wile Eastern Ltd.
4. Bird, C. (Ed.). (2014). *The fundamentals of horticulture: Theory and practice*. Cambridge University Press.
5. The Practical Gardener (1994). *Reader's Digest Special Volume*.

Examination scheme and mode:

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Floriculture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Floriculture	2	0	0	2	Class XII	NA

Learning Objectives

- To acquaint students with the basic principles and importance of Floriculture.
- To teach students about flowering plants that can be grown in different seasons in Delhi-NCR.
- To make students aware about exotic flowering plants of ornamental value and their propagation in laboratories and greenhouses.
- To provide information about employment, business opportunities and other avenues in the Floriculture sector (Floriculturist).

Learning Outcomes

After completion of this course learners will be able to:

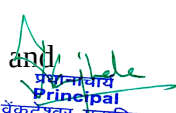
- identify and describe the ornamental flowering plants in Delhi-NCR.
- practice the methods of preparing soil and water, cultivation and propagation methods.
- design, prepare and apply appropriate combinations of plants and methods of cultivation for commercial setup.
- adapt to the job role of Floriculturist (employment/ entrepreneurship)

SYLLABUS

Practical:

60 hours

1. Introduction to floriculture, tools and equipments. 4 hours
2. Study of diversity in shape, size, and colour of flowers (including basic botany, nomenclature, common name and general uses). 4 hours
3. Identification and preparation of an inventory of herbaceous flowering plants, climbers, shrubs, and trees around the campus. 4 hours
4. Study the various physico-chemical soil properties for understanding different soils/soil-types. 8 hours
5. Methods of preparation of floral beds, soil preparation, greenhouse design and fumigation methods. 8 hours
6. Methods of seed sowing and raising flowering plants through seeds, bulbs and


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through vegetative methods in planters, containers and in outdoor environments. Role of light, plant growth regulators and nutrients in blooming and flowering. 8 hours

7. Bacterial and fungal diseases and pests of ornamental flowers and their management. 4 hours
8. Interior decoration methods, flower arrangements (Japanese, Western and Indian). 4 hours
9. Harvesting, methods to increase the shelf life of flowers, post-harvest care and marketing platforms for the floriculture industry. 8 hours
10. Field visit to nearby nursery/garden to understand basic aspects of Garden design. 4 hours
11. Project Report on any five flowering plants that are grown commercially, their share in the global market, methods used for selling the products and importance of the floriculture industry in job creation. 4 hours

Essential Readings:

1. Randhawa, G.S., Mukhopadhyay, A. (1986). Floriculture in India. New York, NY: Allied Publishers.
2. Larson, R. A. (Ed.). (2012). Introduction to floriculture. Elsevier.

Suggestive Readings:

1. Pal, S. L. (2019). Role of plant growth regulators in floriculture: An overview. J. Pharmacogn. Phytochem, 8, 789-796.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Hydroponic and Aeroponic Farming

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Hydroponic and Aeroponic Farming	2	0	0	2	Class XII	NA

Learning objectives:

- The objective of the course is to provide hands-on experience to students on various aspects of hydroponics and aeroponics.
- To make students self-reliant and employable by providing the necessary knowledge and experience to establish hydroponic and aeroponic systems.

Learning Outcomes:

After completing the course, learners will be able to:

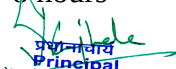
- develop basic hydroponics and aeroponics facilities at any given location (pilot scale and/or industrial scale).
- devise and implement a strategy for marketing of the product.
- apply the knowledge to fulfill certification rules and various government policies.
- establish themselves as entrepreneurs (Hydroponic cultivator).

SYLLABUS

Practical:

60 hours

1. Study of techniques used in hydroponics (Circulating methods such as Nutrient Film Technique (NFT), Deep Flow Technique (DFT), Dutch bucket; Non circulating methods such as Root dipping, Floating, Capillary action; Aeroponics such as root mist and fog feed techniques). 8 hours
2. Study of various instruments used in hydroponics (Pressure gauge, Filters, PVC Tanks, Venturi/Reciprocating Pump/Mixing tank, EC meter, pH meter, TDS meter, water pump, net cups, air pump, thermometer, lux meter, drip irrigation system. 8 hours
3. Construction of sustainable hydroponic and aeroponic units (including greenhouse facilities) 8 hours


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| 4. Preparation of growth media for Hydroponics. | 4 hours |
| 5. Estimation of NPK, DO, TDS, pH of growth media. | 4 hours |
| 6. Study of suitable conditions for Hydroponics-quality, light intensity, photoperiod and temperature. | 4 hours |
| 7. Growing a leafy vegetable/fruity vegetable/medicinal herb /aromatic plant in Hydroponics /Aeroponic solution. | 16 hours |
| 8. Study of safety measures, certification standards and government policies. | 4 hours |
| 9. Visit to Hydroponic/Aquaculture/Aeroponic farm/Institute. | 4 hours |

Essential Readings:

1. Meier Schwarz. (1995). Soilless Culture Management. Advanced Series in Agricultural Sciences, vol 24.Springer, Berlin.
2. Hasan, M.; Sabir, N.; Singh, A.K.; Singh, M.C.; Patel, N.; Khanna, M.; Rai, T.; and Pragnya, P. (2018). Hydroponics Technology for Horticultural Crops, Tech. Bull. TB-ICN 188/2018.Publ. by I.A.R.I., New Delhi.
3. Misra, R.L., Misra S. (2017). Soilless Crop production. Daya Publishing House, Astral

Suggestive Readings:

1. Goddek, S., Joyce, A., Kotzen, B., Burnell, G.M. (2019). Aquaponics Food Production Systems.Springer, Cham.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Green Belt Development for Smart Cities

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Green Belt Development for Smart Cities	2	0	0	2	Class XII	NA

Learning objectives:

- To introduce students with one of the key green skill development programs under the Skill India mission by the Government of India.
- To acquaint students with various methods and techniques used in development of green infrastructure for smart cities

Learning Outcomes:

After completion of the course, students will be able to:

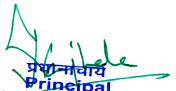
- measure factors (biotic and abiotic) contributing to sustainable, healthy environment.
- Assess, describe and use the appropriate plants for restoring polluted environment.
- use their skills enhancing for green infrastructure development (UN-SDG).

SYLLABUS

Practical:

60 hours

- Methods of vegetation sampling and calculation of importance value index 4 hours
- Measuring Tree Basal Area, Height and Canopy Cover to estimate green cover of an area. 8 hours
- Understanding of Instruments for measuring microclimatic variables viz., light, wind, temperature, humidity and precipitation 4 hours
- Estimation of Total Carbon stock of an area. 8 hours
- Understanding methods for selection of plants according to pollutant load of both air and water (includes field survey) 4 hours


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| 6. Assessing air pollution tolerance of plant species using APTI (Air pollution tolerance index). | 8 hours |
| 7. Use Open Source Softwares for mapping the GPS points and generating a cover map. | 4 hours |
| 8. Measurement of Dissolved Oxygen (DO) from treated wastewater. | 8 hours |
| 9. Measurement of BOD and TDS from tank and treated pond. | 8 hours |
| 10. Determination of total dissolved and suspended solids in water. | 4 hours |

Essential Readings:

1. Bell, J. R., Wheater, C. P., Cook, P. A., Bell, J. R., Wheater, C. P., Cook, P. A. (2011). Practical Field Ecology: A Project Guide. United Kingdom: Wiley.
2. Singh J.S., Singh S.P. & Gupta S.R. · 2014. Ecology, Environmental Science & Conservation. (2014). India: S. Chand Pvt. Limited.
3. Measurements for Estimation of Carbon Stocks in Afforestation and Reforestation Project Activities under the Clean Development Mechanism, A field Manual UNFCCC.
4. Slingsby, D., Cook, C., Slingsby, D., Cook, C. (2016). Practical Ecology. United Kingdom: Macmillan Education UK.
5. Mukerji, K. G. (2013). Laboratory Manual of Food Microbiology. India: I.K. International Publishing House Pvt. Limited.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Nursery, Gardening and Landscaping

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nursery, Gardening and Landscaping	2	0	0	2	Class XII	NA

Learning objectives

The program is aimed to teach students the basic knowledge required to develop entrepreneurship skills in the development of Nursery, Gardening and Landscaping. This course would train students to initiate a remunerative enterprise owing to a high demand of skilled professionals in this field.

Learning Outcomes

After completing this course, the learners will be able to:

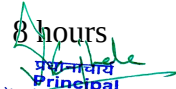
- describe and differentiate between the types of gardens.
- practice different methods for propagation of plants.
- execute several nursery and gardening operations.
- assess growing conditions of different horticultural plants, their general requirements and understand their role in landscaping.

SYLLABUS

Practical:

60 hours

1. Methods of preparation of nursery beds and sowing of seeds. Media for propagation of plants in Nursery Beds, Pots and Mist chamber. 12 hours
2. Study and practice of different propagation methods viz., cutting, layering, division, grafting and budding. 4 hours
3. Introduction and practicing Bonsai training, pruning and wiring. 4 hours
4. Study of different types of gardens (indoor and outdoor) and key features of gardens (Paths & Avenues, Hedges & Edges, Lawn, Flowerbeds, Arches & Pergolas, Fencing, Water bodies, Rock garden). 8 hours


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5. Methods for selection and enlisting of suitable plants for different locations and in different types of gardens. 4 hours
6. Identification of key horticultural plants, Herbs including different types of grasses – foliage and flowering, Shrubs including hedge plants - foliage and flowering, Avenue trees – foliage and flowering, Climbers, Lianas, Epiphytes, Creepers, Trailers, Aquatic plants, Succulents, Weeds. 8 hours
7. Study of important gardens of India (any five). 4 hours
8. Methods of Landscape designing of Residential areas and Public Gardens, Aquatic Garden, Rock Garden, Industrial gardens. 4 hours
9. Concept and Application of Computer aided Designing (CAD) for landscape designing/ Preparation of landscape designs for school and college using CAD technology. 8 hours
10. Demonstration of different composting methods for Biofertilizers. 4 hours

Essential Readings:

1. A handbook of Landscape: CPWD
2. Gopaldaswamiengar, K. S., Parthasarathy, G., Mukundan, P. (1991). Complete Gardening in India. India: Gopaldaswamy Parthasarathy, 'Srinivasa'.
3. Hartmann, H. T., Kester, D. E., Hartmann, H. T., Kester, D. E. (1975). Plant Propagation: Principles and Practices. India: Prentice-Hall.
4. Roy, R. K., Roy, R. K. (2013). Fundamentals of Garden Designing: A Colour Encyclopedia. India: New India Publishing Agency.
5. Littlepage, R., Littlepage, R. (2017). Fundamentals of Garden Design: An Introduction to Landscape Design. (n.p.): CreateSpace Independent Publishing Platform.

Suggestive reading:

1. Hodge, G., Hodge, G. (2014). Practical Botany for Gardeners: Over 3,000 Botanical Terms Explained and Explored. United Kingdom: University of Chicago Press.
2. The Royal Horticultural Society Gardening Manual. (2000). United Kingdom: Dorling Kindersley.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Mushroom Culture and Technology I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mushroom Culture and Technology I	2	0	0	2	Class XII	NA

Learning objectives

To make students aware about

- mushroom growing techniques.
- medicinal and nutritional value of mushrooms.

Learning Outcomes

After successful completion of the course, students will be able to:

- practice the techniques for cultivation of various edible mushrooms
- setup entrepreneurial small-scale units for self-employment
- apply the skills as Mushroom Grower in large scale industries.

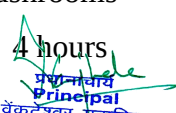
SYLLABUS

Practical**:

60 hours

** Specimens and examples studied may vary depending on seasonal factors and availability

1. To study the principle and operation of Autoclave, Incubator, Laminar Air Flow/ BSL 2 facility. 4 hours
2. To study edible mushrooms (*Agaricus*, *Pleurotus*, *Boletus*, *Lentinula*, *Calocybe*, *Volvariella*, *Morchella*). 4 hours
3. To study poisonous mushrooms (*Amanita*, *Cortinarius*, *Psilocybe*, *Coprinopsis*). 4 hours
4. To study medicinal mushrooms (*Ganoderma*, *Ophiocordyceps*, *Chaga*, *Hericium*). 4 hours
5. Preparation of various types of compost and media which can be used for cultivation of mushroom. 4 hours
6. To study the common fungal, bacterial, viral, and insect borne diseases of mushrooms (any 2 from each). 4 hours


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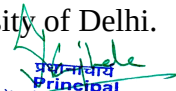
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| 7. To study the cultivation technique of <i>Agaricus</i> mushroom. | 4 hours |
| 8. To study the cultivation technique of <i>Pleurotus</i> mushroom. | 4 hours |
| 9. To study the cultivation technique of <i>Calocybe/ Volvariella</i> mushroom. | 4 hours |
| 10. To study the cultivation technique of <i>Ganoderma</i> mushroom. | 4 hours |
| 11. To study the nutritional value and market value of mushrooms, and post-harvest technologies like packaging and preservation. | 4 hours |
| 12. Various requirements for setting up a mushroom cultivation unit (“kuccha” or cemented house). | 4 hours |
| 13. Entrepreneurship in cultivation of mushrooms. | 4 hours |
| 14. Government policies related to the promotion of mushroom cultivation. | 4 hours |
| 15. Visit to an Institute or Center conducting mushroom cultivation (Report to be submitted). | 4 hours |

Essential Readings:

1. Bahl, N. (2015). Hand Book on Mushroom. Page no. 1-166. Oxford & IBH Publishing Company.
2. Russell, S. (2014). The Essential Guide To Cultivating Mushroom. Storey Publishing. North Adams, M.A. 01247.
3. Zied, D. C., Gimenez, A. P. (2017) Edible and Medicinal Mushroom page no. 1-585. John Wiley & Sons Ltd. UK.
4. Chang, S.T., Miles, P.G. (2004) Mushrooms Cultivation, Nutritional Value, Medicinal effect and Environmental Impact, CRC Press.
5. Fletcher, J.T., Gaze, R.H. (2007). Mushroom Pest and Disease Control. CRC Press.
6. Ahlawat, O.P., Tewari, R.P. (2007). Cultivation Technology Of Paddy Straw Mushroom (*Volvariella volvacea*). Pages 1-44 National Research Center for Mushroom (Indian Council of Agricultural Research) Chambaghat, Solan (HP).
7. Rai, R.D., Arumuganathan, Y. (2008). Post Harvest Technology of Mushrooms. National Research Center for Mushroom (Indian Council of Agricultural Research) Chambaghat, Solan (HP)
8. Singh, M., Vijay, B., Kamal, S., Wakchaure, G.C. (2011). Mushrooms Cultivation, Marketing and Consumption., Publishers Directorate of Mushroom Research (ICAR) Chambaghat, Solan.

Examination scheme and mode:

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Mushroom Culture and Technology-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mushroom Culture and Technology-II	2	0	0	2	Class XII	NA

Cultivation of Button mushroom and King oyster mushroom

Prerequisites:

Compost preparation for button mushroom would start around October-November and further cultivation steps will take place from January. Compost and spawn should be prepared before going to the next step.

Learning objectives:

- To develop skills for growing button and king oyster mushroom

Learning Outcomes:

After completion of this course, the learner will be able to:

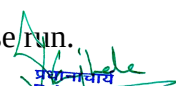
- prepare casing soil and apply over spawn-run compost bags.
- implement harvesting, packaging and marketing of produce as per FSSAI standards.

Syllabus

Practical**: 60 hours

** Specimens and examples studied may vary depending on seasonal factors and availability

- To add and mix spawn of button mushroom to pre-prepared compost (Spawning). 4 hours
- To set up ideal mushroom house for cultivation of button mushroom. 8 hours
- To maintain ideal environmental conditions for spawn run. 4 hours
- Preparation and sterilization of casing soil. 4 hours
- To apply casing soil over the spawn run compost bags and incubating for case run.


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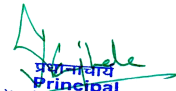
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| | 4 hours |
| 6. To maintain appropriate conditions for pin head formation and fruiting of button mushroom. | 8 hours |
| 7. Harvesting of first flush of button mushrooms. | 4 hours |
| 8. Post-harvest packaging and storage of button mushrooms. | 4 hours |
| 9. Maintaining the environmental conditions for the second flush of button mushroom. | 4 hours |
| 10. To prepare and sterilize substrate bags for cultivation of king oyster mushroom. | 4 hours |
| 11. To add the spawn of king oyster mushroom in the substrate bags under aseptic conditions and incubator under appropriate conditions. | 4 hours |
| 12. To induce fruiting of king oyster mushroom by scraping the mycelium from the edges and surface of spawn run bags. | 4 hours |
| 13. Harvesting, post-harvest packaging and storage of king oyster mushrooms. | 4 hours |

Essential Readings:

1. Aggarwal, A., Sharma, Y.P., Angra, E. (2021). A textbook on mushroom cultivation, Theory and Practices. Newrays Publishing House, 2021.
2. Tiwari, S.C. Kapoor, P. (2018). Mushroom Cultivation. Mittal Publications. ISBN - 978-8183249232.
3. Bahl, N. (2015). Hand Book on Mushroom. Page no. 1-166. Oxford & IBH Publishing Company. ISBN- 13:978-8120413993.
4. Russell, S. (2014). The Essential Guide To Cultivating Mushroom. Storey Publishing. North Adams, MA 01247 page no. 1-233. ISBN 978-1-61212-146-8.
5. Chang, S.T. Miles, P.G. (2004). Mushrooms Cultivation, Nutritional Value, Medicinal effect and Environmental Impact. Page no. 1-477, CRC Press.
6. Fletcher, J.T., Gaze, R.G. (2007). Mushroom Pest and Disease Control. CRC Press.
7. Rai, R.D., Arumuganathan, Y. (2008). Post harvest technology of mushrooms. Pages 1-72. National Research Center for Mushroom (Indian Council of Agricultural Research) Chambaghat, Solan-173 213 (HP)

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Plant Aromatics and Perfumery

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Aromatics and Perfumery	2	0	0	2	Class XII	NA

Learning objectives

- Provide the basic understanding of aromatic and medicinal plants including classification and methods of extracting essential oils.
- Practical demonstration of extraction and quality assessment of the product obtained.

Learning Outcomes

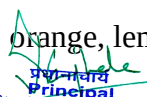
After completion of the course, learners will be able to:

- extract essential oils from a variety of plants and plant parts.
- develop strategy for promotion and marketing of the aromatic and essential oils.
- establish their own startup, become self-reliant and/or adapt to job roles in beauty and wellness sector.

SYLLABUS

Practical: 60 hours

1. Classification of essential oils on the basis of chemical composition, aroma and extraction methods. 4 hours
2. Principles, processing and techniques of extraction of essential oils. 4 hours
3. Cultivation practices of the common aromatic crops (any five) - Rose, Lavender, Peppermint, Spearmint, Basil, Citronella, Vetiver, Palmrosa, Lemongrass. 8 hours
4. Extraction process of essential oil from fruit/ fruit peel by steam distillation (e.g. orange, lemon). 4 hours


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5. Extraction of essential oil from bark by steam distillation (e.g. cinnamon). 4 hours
6. Extraction of essential oils from flower by steam distillation (e.g. clove, rose, jasmine, lavender, rosemary). 4 hours
7. Extraction of essential oil from leaves and stems by steam distillation (e.g. lemongrass, eucalyptus, citronella, bottlebrush). 4 hours
8. Extraction of essential oil from seeds by steam distillation (e.g. fennel, nutmeg). 4 hours
9. Extraction of essential oil from root (e.g. vetiver) and rhizome (e.g. ginger, curcuma) by steam distillation 4 hours
10. Determination of oil content in aromatic crop/material by Clevenger's method. 4 hours
11. Quality assessment of essential oils through *sensory evaluation* (odour, colour), physical tests (specific gravity, refractive index, optical rotation, solubility), chemical tests (determination of acid value, ester value). 8 hours
12. Demonstration/Illustration of Instruments and techniques quality assessment of Gas chromatography (GC) and Thin layer chromatography (TLC). 4 hours
13. Field Visit to essential oils and perfumery Institute/Industry. 4 hours

Essential Readings:

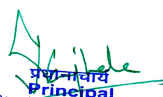
1. EIRI BOARD. (2008). Handbook of Essential Oils Manufacturing and Aromatic Plants 5/E edition, Engineers India Research Institute (India), New Delhi.
2. Kochhar, S.L. (2016). Economic Botany – A Comprehensive Study, 5th Edition. New Delhi, India: Cambridge University Press.

Suggestive Readings:

1. Başer, K.H.C., Buchbauer, G. (2020). Handbook of Essential Oils: Science, Technology, and Applications, 3rd edition, CRC Press.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Viewing and Capturing Diversity in Nature

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution Of The Course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Viewing and Capturing Diversity in Nature	2	0	0	2	Class XII	NA

Learning objectives

- Understand fundamentals of digital cameras and smartphone photography technology.
- Develop a working knowledge of digital image analysis and processing.
- Understand the importance and use of Nature photography in business and as career goal.
- Enhance appreciation for the tremendous aesthetics inherent in nature.

Learning Outcomes

On successful completion of this course, a student will be able to:

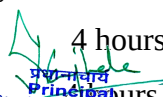
- Describe and use the digital camera and smartphone camera functions and their applications
- employ different photographic equipment to enhance their photographic skills and create digital resources.
- discriminate between the photographic variables with reference to weather and season.
- employ the photographic skills in various professions and for entrepreneurship.

SYLLABUS

Practical:

60 hours

1. To study the parts of a digital camera. 4 hours
2. To study the principle and working of digital camera/ smartphone camera. 4 hours
3. Working and handling of light microscopes (Dissection and Compound). 4 hours
4. Study of plant forms through microscopic lens (Single-celled, colonial forms, filamentous forms, multicellular and complex forms). 8 hours
5. To study techniques of capturing shots (using light and lenses effectively, macro and micro photography, wide angle and close-ups). 4 hours
6. Study of plant adaptations through photographs (Aquatic and desert plants).


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7. To capture and understand the Ecological Interactions. 8 hours
8. Identification of different plant life forms through online available tools/ search engines. 8 hours
9. Outdoor/ Campus Photography: Plants, Environment, Landscapes and Cityscape. 4 hours
10. Foldscope: The domestic microscope. Use the Foldscope to explore microscopic organisms in pond water. 4 hours
11. Project Work: To make a portfolio of diverse landscaping patterns/ selected themes through outdoor visits. 8 hours

Essential Readings:

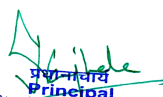
1. Ang., T. (2008). Fundamentals of modern Photography. London, Mitchell.
2. Freeman Patterson “The Art of Seeing” by Key Porter Books.
3. Tim Fitzharris “Landscape Photography” Firefly Books.
4. Kelby, S. (2012). The digital photography book. Peachpit Press.
5. Langford, M., Fox, A., and Smith, R.S. (2013). Langford basic photography: the guide for serious photographers. Amsterdam: Focal Press/Elsevier.
6. Peterson, B. (2016). Understanding exposure: how to shoot great photographs with any camera. AmPhoto Books.

Suggestive readings:

1. Sharma P.D. (2008) Ecology and Environment. Rastogi Publishers.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Apiculture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Apiculture	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To help the student to become familiar with the significance of beekeeping as an economically viable industry.
- To help the student to understand the different species of honeybees, their biology, behaviour and role in pollination.
- To train the students to learn the techniques of honey bee rearing, optimization of techniques based on climate and geographical regions, and various measures to be taken to maximize the benefits.
- To understand the significance of beekeeping in the diversification of agriculture for the rural communities to increase their income and create employment opportunities and at the same time to develop entrepreneurial skills required for self-employment in the beekeeping sector.

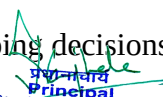
Learning Outcomes

After studying this course, the students will be able to:

- Comprehend the various species of honey bees in India, their social organization and its importance.
- Appreciate the opportunities and employment in apiculture – in public, private and government sector.
- Gain thorough knowledge about the techniques involved in bee keeping and honey production.
- Make various products and by-products obtained from beekeeping sector and their importance.
- Develop entrepreneurial skills necessary for self-employment in beekeeping sector.
- Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments and projects.

Skill development and job opportunities

- After completion of this course students would obtain the training in collection, identification, and various ways/aspects of bee rearing.
- The students can also take a job as an apiary worker, often called a beekeeper, manage colonies of honeybees for the production of honey as well as pollination services.
- The course would also provide a basic training to enable the students to construct hives and replace combs.
- Enhance entrepreneurial skills by collecting and packaging hive products including honey, beeswax and pollen.
- Make decisions on yards, treatment, splits, honey harvesting and all other beekeeping decisions.
- Identify and report hive health concerns.


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SYLLABUS (Practical)

Unit 1: Biology of Bees

16 hours

Historical background of apiculture, classification and biology of honey bees, Social organization of bee colony, behavioral patterns (bee dance, swarming).

Practical Exercises:

1. Study of the life history of honey bees: *Apis cerana indica*, *Apis mellifera*, *Apis dorsata*, *Apis florea*, *Melipona* sp. from specimen/ photographs - Egg, larva, pupa, adult (queen, drone, worker).
2. Study of morphological structures of honey bees through permanent slides/photographs–mouthparts, antenna, wings, sting apparatus and temporary mount of legs (antenna cleaner, mid leg, pollen basket).
3. Study of natural beehive and identification of queen cells, drone cells and brood.

Unit 2: Rearing of Bees

18 hours

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth; Bee Pasturage; Selection of bee species for apiculture –*Apis cerana indica*, *Apis mellifera*; Bee keeping equipment methods of extraction of honey (Indigenous and Modern) & processing; Apiary management - Honey flow period and lean period, effects of pollutants on honeybees.

Practical Exercises:

1. Distinguishing characters of workers of three bee species.
2. Importance of site selection for bee keeping.
3. Study of an artificial hive (Langstroth/Newton), its various parts and beekeeping equipment: draw diagrams of bee boxes proportionate to the body size and measure the body length and wing size.
4. Preparation of mount of pollen grains from flowers.

Unit 3: Diseases and Enemies

10 hours

Bee diseases control and preventive measures: enemies of bees and their control.

Practical Exercises:

1. Diagnosis of honeybee diseases: Protozoan diseases, Bacterial diseases, Viral diseases (one each)- symptoms, nature of damage and control.
2. Identification of honeybee enemies: Predators-Insects and non-insects.

Unit 4: Bee Economy

8 hours

Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses; Modern methods in employing artificial Beehives for cross pollination in horticultural gardens- stationary and migratory bee keeping.

Practical Exercises:

1. Video demonstration of wax extraction and preparation of comb foundation sheets.
2. Analysis of honey – purity, physical and biochemical parameters (any two constituents).
3. Study of bee pasturage – visit to fields/gardens/orchards for studying the bee activity (role in pollination, nectar collection, videography of honeybee activity) and preparation of herbarium of nectar and pollen yielding flowering plants (floral mapping).

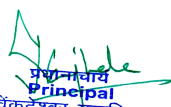
Unit 5: Entrepreneurship in Apiculture

8 hours

Bee keeping industries – Recent advancements, employment opportunities, economics in small and large-scale beekeeping, scope for women entrepreneurs in beekeeping sector, study of development programs and organizations involved in beekeeping in India.

Exercise:

1. Visit to an apiary/honey processing unit/institute and submission of a report

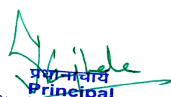

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Essential/Recommended readings

- Singh, S. (1962). Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
- Mishra, R.C. (1995). Honeybees and their management in India. Indian Council of Agricultural Research, New Delhi.
- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Rahman, A. (2017). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
- Gupta, J.K. (2016). Apiculture, Indian Council of Agricultural Research, New Delhi.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Formulation of Fish Feed

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Formulation of Fish Feed	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on identification of various indigenous ingredients for formulation of fish feed.
- To gather knowledge on the nutritional requirements of the cultivable species.
- To gain knowledge on the impact of formulated feeds on fish growth.
- To enhance the quality of aquacrops and increase the production.

Learning Outcomes

By the end of the course, the students will be able to:

- Identify the useful ingredients for fish feed formulation.
- Learn to prepare fish feed using locally available ingredients.
- Start the Fish feed production industry.
- Initiate entrepreneurship on Fish feed production.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own fish feed production industry.

SYLLABUS:

Practical

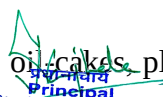
Unit I: Selection of ingredients

20 Hours

Identification of various types of non-conventional ingredients for fish feed formulation. Evaluation of their nutritional quality. Preparation of fish feed and feeding of the prepared feeds to the cultivable fishes and prawns. The study of impact of the prepared feeds on the performances of fishes and prawns.

Exercises:

1. Identification of various types of locally available ingredients (viz. macrophytes, oil-cakes, plants etc.) for fish feed formulation.


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2. Evaluation of the nutritional values (viz. protein, lipid, carbohydrates, ash, amino acids, fatty acids) of these ingredients.
3. Assay of presence of anti-nutritional factors (viz. tannin, saponin, phytic acid, oxalic acid etc.) in these ingredient

Unit II: Formulation of Fish Feed

20 Hours

Preparation of fish feed using traditional method and computerized soft ware. Evaluation of quality of prepared feed for the cultivable species.

Exercises:

1. Formulation of fish feed using “Pearson Square” method.
2. Formulation of fish feed using computerized soft ware.
3. The assay of biochemical composition of formulated feed: protein, lipid, carbohydrate, ash, amino acids, fatty acids.

Unit III: Feeding of Fish

20 Hours

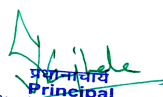
The feeding of the prepared feeds to the cultivable fishes and prawns. The study of impact of the prepared feeds on the performances of fishes and prawns. Evaluation of nutritional value of fishes for human consumption.

Exercises:

1. The feeding of the prepared feeds to the cultivable fishes and prawns.
2. Evaluation of impact of the prepared feeds on the survival, growth and production of fishes and prawns.
3. Assessment of Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of the feed.
4. Assay of nutritional value of the produced fishes/ prawns for human consumption.
5. Evaluation of impact of prepared feed on the water quality of the culture system.
6. Visit to a Fish feed preparation facility/ industry.

Recommended Readings:

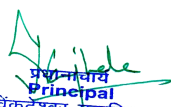
- AOAC, Association of Official Analytical Chemists. 2017. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.


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- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Fish Breeding and Larviculture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fish Breeding and Larviculture	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on various aspects of brood stock maintenance of carps and air breathing fishes.
- To understand the breeding techniques for carps and air breathing fishes.
- To understand the larviculture techniques for carps.
- To gain experience on the larviculture techniques of air breathing fishes.
- To gather knowledge in the management of optimum water quality for larviculture.
- To gather knowledge on the nutritional requirements of the cultivable species.
- To gain knowledge on the impact of live food in larviculture.

Learning Outcomes

By the end of the course, the students will be able to:

- Produce seeds of carps and air breathing fishes.
- Start the Fish hatchery business.
- Start fish-food production.
- Initiate entrepreneurship in fish seeds production.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own entrepreneurship in fish farming.

SYLLABUS:

Practical

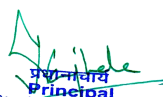
Unit I: Breeding of Economically Important Fishes

20 Hours

Breeding of various fishes in the captivity and production of quality fish seeds for aquaculture.

Exercises:

1. Management of brood stock units and breeding of carps.
2. Maintenance of brood stock units and breeding of air breathing fishes.


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3. Estimation of major water quality parameters viz., temperature, pH, dissolved oxygen, conductivity etc. in the fish breeding units.

Unit II: Culture of Important Live Food Organisms

15 Hours

Culture of various live food organisms using organic manures and feeding of different fish larvae produced.

Exercises:

1. Culture of live food organisms viz., rotifers, cladocerans, copepods, chironomid larva etc. using organic manures (like cattle manure, poultry wastes and mustard oil-cake).
2. Evaluation of major water quality parameters viz., temperature, pH, dissolved oxygen, ammonia etc. in the live food culture units.
3. The enrichment of live food organisms (with vitamin C, DHA, EPA etc.) to enhance the nutritional value of the live food for fish larvae.

Unit II: Larviculture

25 Hours

Culture of larvae of carps and air breathing fishes and production of healthy seeds for stocking ponds.

Exercises:

1. Culture of fish larvae in the static water/ Recirculating Aquaculture Systems (RAS).
2. Measurement of water quality parameters (viz., temperature, pH, dissolved oxygen, ammonia etc.) in the larvae culture unit regularly.
3. Feeding of fish larvae with live food thrice daily.
4. The study of morphological and physiological changes in the larvae during ontogenic development.
5. Visit to a fish farm.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2017. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi.

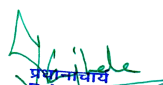

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Delhi, India.

- Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Ornamental Fish Culture: Opportunity and Scope

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ornamental Fish Culture: Opportunity and Scope	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on Aquarium preparation and decoration.
- To gain hands-on training on breeding and culture of various Ornamental fishes.
- To gain experience in the management of optimum water quality in the fish aquarium.
- To gather knowledge on the nutritional requirements of the cultivable species.

Learning Outcomes

By the end of the course, the students will be able to:

- Prepare and decorate ornamental fish aquarium.
- Identify the suitable and economically important Ornamental fish species.
- Initiate entrepreneurship on Aquarium making and Ornamental fish production.

Skill development and job opportunities

After completion of this course students will be

- Fully equipped to start own entrepreneurship in **aquarium making and its decoration.**
- Aware about the requirements to start their own **Ornamental fish industry.**

SYLLABUS:

Practical

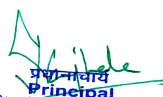
Unit I: Preparation of Aquarium and Its Decoration

20 Hours

Preparation of glass aquaria of various shapes and their decoration using locally available materials. The impact of aquatic plants in the maintenance of healthy environment in the aquarium.

Exercises:

1. Construction of glass aquaria of various shapes (rectangular, square, round etc.).
2. Identification and culture of useful aquatic plants for the decoration of fish aquarium.


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3. Decoration of aquarium with plants and locally available materials.

Unit II: Breeding of Ornamental Fishes and Culture of Plants

20 Hours

Identification of economically important cultivable Ornamental plants and fishes for culture.

Exercises:

1. Identification of economically important Ornamental fishes and their breeding.
2. Culture of young larvae and feeding them live food.
3. Regular monitoring of water quality parameters viz. temperature, pH, conductivity, dissolved oxygen, ammonia etc. in the fish aquarium.
4. Culture of zooplankton (rotifers, cladocerans, copepods etc.) using organic manures for the feeding of fish larvae.
5. Production of plants for the decoration of aquarium.

Unit III: Production of Marketable Ornamental Fishes

20 Hours

Culture of compatible fishes together and feeding them with live food and prepared diets. Keep them ready for local market.

Exercises:

1. Maintenance of aquarium.
2. Feeding of ornamental fishes with various natural foods and prepared diets.
3. Evaluation of their growth rate and colour development.
4. Development of marketing strategy for the produced ornamental fishes in well decorated aquaria.
5. Visit to any Aquarium Facility.

Recommended Readings:

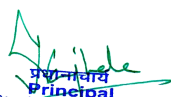
- AOAC, Association of Official Analytical Chemists. 2019. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.

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- Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.
- Swain, S. K., Sarangi, N. and Ayyapan, S. 2010. Ornamental Fish Farming. DIPAS, Indian Council of Agricultural Research, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Bio-floc Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Bio-floc Technology	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the basics of Bio-floc technology and it's important as a skill for self-sustainable and self-employment
- To learn production of fish in the larger scale with minimum use of water source and land to help in the total production of fish for human consumption in India.
- To learn about how to set-up the technology looking into the different conditions and availability of space and training.
- To teach fundamental concept of running this system with the biological knowledge of bacteria culture, water quality management
- To learn the types of fish species, types of feed and feeding, density of fish to be maintain in the particular volume of water etc.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to gain insight into fish culture using minimum amount of water, land, fish feed and with high biosecurity.
- After studying this course, students will be able to learn and explain about the bio-floc technology and they can set up bio-floc tanks for themselves and for others in the form of industries and entrepreneurship as well as for start-up with the help of existing Government funding and self funding.
- After studying this course, students will be able to understand and implement bio-floc system and this can be an alternative skill for earning, self-employment, job generation and contribute in large scale fish production which are hygienic, organic and good protein source for human health.

SYLLABUS:

Practical

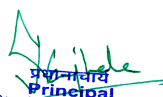
Unit-I

12 Hours

Introduction to basics of Bio-floc technology and its applications in aquaculture industry, Standard operating procedure, Microbial Role in Bio-floc System, Design Set-up and installation of Bio-floc system, Biosecurity, Advance over pond aquaculture, basic equipment's and necessary items.

Exercises

1. Inoculation of bacteria and its role in Bio-floc technology.
2. Plankton and microbial analysis of bio-floc.
3. Set-up and Installation of Bio-floc system.


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Unit-II

12 Hours

Optimum water quality parameters and its management. Floc water preparation and floc volume measurement. Monitoring and management of dissolved oxygen, pH, conductivity, temperature, salinity, ammonia, nitrate, nitrite, TDS. Measurement of floc volume and its control. Role of bacteria in management of water quality.

Exercises

1. Analysis of following water quality parameters in Bio-floc culture tanks using kits: temperature, pH, conductivity, salinity, TDS, ammonia, nitrate, nitrite.
2. Water preparation for Bio-floc system.
3. Measurement of floc volume using imhoff cone.

Unit-III

12 Hours

Suitable species selection, Pre-stocking and post stocking management, Food and feeding management, Production performance, Nursery rearing days, Survival (%), Average body weight at harvest, feed conversion ratio.

Exercise

1. Identification of suitable fish, feeding habits, stocking capacity, growth rate and duration of culture.
2. The study of Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE).

Unit-IV

12 Hours

C: N ratio management, Nutritional requirements and protein levels in the food.

Source of carbon, calculation of carbon and nitrogen ratio, suitable C:N ratio management in the initial floc preparation and during culture days. Selection of species-specific food with optimum protein level, food size, quantity of feed according to per cent body weight, feeding rate.

Exercise

1. Calculation of C: N ratio and its management from the TAN content in the floc water.
2. Mouth size and food size and growth study.

Unit-V

12 Hours

Disease management and prophylactic treatment, Economics values of fish and its marketing strategies. Common disease in bio-floc, identification of disease its causes, species-specific disease, stress management and treatment. Steps for prevention and protections of possible disease, possible control measures with setup systems by controlling light, temperature etc. Sludge management. Economics values of fish and its marketing strategies. Production capacity and requirements, start-up and entrepreneurship opportunities, funding and grants for setting up from Government.

Exercise

1. Fungal, bacterial, parasitic and viral disease commonly found in bio-floc fish culture system.
2. Identification and economically important fish species for culture in bio-floc system like prawn, other new economic species etc.
3. Write a Project for start-up or entrepreneurship and governmental grants.
4. Visit to hatcheries with super-intensive models.

Recommended Readings:

- Avnimelech, Y. 2015. Bio-floc Technology- a Practical Guidebook. 3rd ed. World Aquaculture Society, USA.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

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Aquaculture Entrepreneurship

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Aquaculture Entrepreneurship	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on traditional and technology-based Aquaculture.
- To understand the importance of different types of ponds required for aquaculture.
- To understand the requirement of advanced technology for sustainable development of aquaculture in India.
- To gain experience in the management of optimum water quality in the fish production systems.
- To enhance the quality of aquacrops and increase the production.

Learning Outcomes

By the end of the course, the students will be able to:

- Identify the useful aquaculture systems for sustainable aquaculture development.
- Recognize the suitable and economically important aquacultural species.
- Understand the importance of aquaculture in nutrition security, poverty elevation and employment generation.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own entrepreneurship in fish farming.

SYLLABUS:

Practical

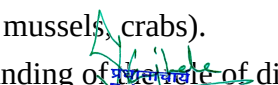
Unit I: Pond-based Traditional Aquaculture

20 Hours

Introduction to indigenous pond-based fish culture systems and identification of economically important cultivable finfishes and shellfishes. The impact of aquatic organisms in the production of aquacrops.

Exercises:

1. Designing (layout) and drawing of a self-sustainable Aquaculture farm showing different ponds.
2. Selection and identification of cultivable finfishes and shellfishes (prawns, mussels, crabs).
3. Collection and identification of various freshwater aquatic plants. Understanding of the role of different aquatic plants in aquaculture.


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4. Identification of harmful aquatic insects and their remedial measures.
5. The study of diurnal fluctuations of major water quality parameters (viz., temperature, pH, dissolved oxygen, ammonia etc.) in a pond.

Unit II: Recirculating Aquaculture System (RAS)

20 Hours

Application of advance technology like, Recirculating Aquaculture System (RAS) for the sustainable development of Aquaculture in India.

Exercises:

1. Designing of a land-based Recirculating Aquaculture System (RAS).
2. Evaluation of various types of filters like, mechanical, chemical and biological filters in the maintenance of water quality in the RAS.
3. The study of role of flow rate and duration of circulation in the maintenance of water quality in the RAS.
4. The monitoring of temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, phosphate etc. at different hours of water circulation.
5. Culture of various fishes and prawns in the RAS.
6. Visit to a Recirculating Aquaculture System.

Unit III: Aquaponics System

20 Hours

Application of Aquaponics System to grow multiple crops simultaneously and thereby, increases the production of aquacrops in per unit area in a sustainable manner. Thus, enhances the earning of Fish farmers.

Exercises:

1. Designing of an Aquaponics System.
2. Evaluation of role of various types of edible (lettuce, tomato, water spinach etc.) and ornamental plants in the maintenance of ammonia levels in the fish culture units.
4. Identification of microorganisms functioning in the Aquaponics System.
5. Culture of various fishes and prawns in the Aquaponics System.
6. The monitoring of temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, phosphate etc. in the fish culture units.
7. Visit to an Aquaponics System.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2019. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.

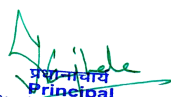
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.


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- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.
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Examination scheme and mode:

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Pearl Culture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pearl Culture	2	0	0	2	XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn the basics of Pearl culture and it's important as a skill for self-sustainable and self-employment.
- To impart a comprehensive knowledge regarding morphology, anatomy, physiology, food and feeding behaviour, related diseases and its control measures of the mother Pearl Oyster.
- To gather a comprehensive knowledge of various types of implantations in Oyster and also the technique of insertion of beads for the formation of Pearl.
- To gather experience of post-operative care.
- To learn the techniques of harvesting, processing, sorting and marketing of the Pearl produced.

The Learning Outcomes:

By the end of the course, the students will be able to:

- Gain overall idea about Pearl oyster - its biology, morphology especially the histology of mantle, pearl formation etc.
- Recognize the suitable species of oyster for pearl culture in India.
- Set up a pearl culture system in pond/ tanks.
- Start entrepreneurship on Pearl culture.
- Start-up with the help of existing Government funding.

Skill development and job opportunities

After completion of this course students may be

- Employed in various pearl farming related businesses.
- Fully equipped to start own entrepreneurship in **pearl farming**.
- Completely aware about the requirements to start their own **Pear processing industry**.

SYLLABUS:

Practical

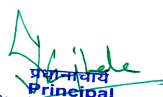
Unit-I

20 Hours

Introduction to pearl culture. Morphology and anatomy of pearl culture. Structure and histology of mantle. Origin of pearls, mussels producing pearls. Identification of species capable of producing pearl.

Exercises:

1. Set-up and Installation of culture system (sac culture, raft culture) for sustainable production.
2. Identification of suitable species capable to produce pearl.
3. The study of morphology and growth rate of the pearl oyster.
4. Measurement of major water quality parameters.
5. Feeding of the pearly oyster.


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Unit-II

20 Hours

Implantation of foreign particles for pearl formation and post operation care.

Exercise:

1. Preparation of the graft tissue for insertion.
2. Pearl oyster surgery and insertion technique of bead.
3. Post-operational care.
4. Culture of the pearl oyster using natural food .
5. Regular monitoring of the water quality parameters.

Unit-III

20 Hours

Harvesting of Pearl and its processing. Sorting of Pearl. Marketing and economics concerned.

Exercises:

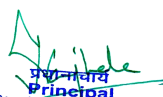
1. Bleaching and collection of pearls.
2. Cleaning of pearls.
3. Sorting of pearls.
4. Marketing of pearl.
5. Visit to a pear production site.

Recommended Readings:

- Srivastava, C.B.L. 2014. Fishery Science and Indian Fisheries.
- Far, A. E. 1986. Pearls. Butterworth Heinemann publications.
- Beveridge, M.C.M. 1987. Cage aquaculture. Fishing News.
- Bardach, J.E.W . 1972. Aquaculture farming and husbandry of freshwater and Sorting of Pearl. Marketing and economics concerned with Pearl Culture. Generation marine organisms
- Dobilet, D. 199. Pearl Farming. Australia: Nat Geographic Mag publication.

Examination scheme and mode:

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Sericulture I: Mulberry Silkworm Rearing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture I: Mulberry Silkworm Rearing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

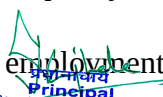
Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

1. Sericulture is multi-disciplinary activity consists of mulberry leaf production, silkworm rearing (cocoon production), silkworm egg production, silk reeling (yarn production), twisting, Warp and weft making, printing and dyeing, weaving, finishing, garment designing, marketing etc.
2. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth.
3. This course will generate entrepreneurs in this field. Sericulture offers gainful employment not only the rural masses but also for the educated youth in semi-urban and urban areas.


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4. Effective utilization of waste generated in the industry will help in making the sericulture sector more viable, stable and create more employment opportunities.
5. Sericulturists fall under the category of primary activities. They usually find employment in sectors like government and research development centres.

SYLLABUS

Introduction to sericulture. Life cycle of silkworm and its characteristic features, Rearing of mulberry silk worm
(60 hours)

Practical

1. Study of models of rearing houses, appliances used in silkworm rearing
2. Preparation and application of disinfectants in rearing house and appliances
3. Technique for hot and cold acid treatment of silkworm eggs, its advantages and disadvantages
4. Rearing Techniques: Harvesting and preservation technique; leaf selecting for different instants; mulberry leaf estimation; Identification of moulting larva, care during moulting, mounting and mounting density, types of mountages; Harvesting of cocoons, assessment of cocoons.
5. Selection of moth, pairing and despairing, preparation of eggs (loose and sheet, surface sterilization of eggs)
6. Visit to seed cocoon markets, commercial grainage and cold storage centre to know activities of cocoon markets, preparation of laying and cold storage of eggs.
7. Mulberry Crop Cultivation: Preparation of nursery beds, Different propagation methods – grafting and layering, Planting System and Intercultural Operations: - pit and row system, mulching, irrigation.
8. Visit to Sericulture research institute

Essential Readings

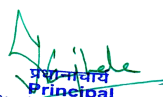
- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yip-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.

Examination scheme and mode:

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Sericulture II: Eri Silkworm Rearing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture II: Eri Silkworm Rearing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

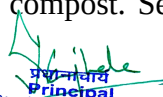
Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

Sericulture mainly focuses on silkworms rearing with the main aim of silk production. There are several applications of this:

1. The demand for silk is bound to increase in the coming years. This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth. This course will generate entrepreneurs in this field.
2. Sericulture by-products have remarkable application in the preparation of compost. Sericulture waste upon enrichment can be converted to high value manures.
3. Silk consists of two types of proteins, silk fibroin and sericin.


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- a. Sericin contributes about 20-30 per cent of total cocoon weight. It is characterized by its high content of serine and 18 amino acids, including essential amino acids. Sericin has wide applications in pharmaceuticals and cosmetics such as, wound healing, bioadhesive moisturizing, antiwrinkle and antiaging properties.
- b. Silk fibroin, has a variety of applications in pharmaceutical, food, and fodder industries. Silk fibroin is used for bone formation, silk thread in surgery, and drug delivery system. Silk fibroin has unique properties including good adherence with flexibility to wound bed, absorption of exudates, biocompatibility, biodegradability, minimal inflammatory reaction and in skin grafting due to its outstanding mechanical properties.
4. Mulberry, the sole food plant of silkworm has also the potential to be used in pharmaceutical and food industry.

SYLLABUS

Introduction to non-mulberry sericulture (Eri, Tassar, Muga). Morphology of Eri silkworm, Propagation of host plant. **(60 hours)**

Practical

1. Propagation of castor food plant
2. Study of models of rearing houses, appliances used in Eri silkworm rearing
3. Preparation and application of disinfectants in rearing house and appliances
4. Rearing techniques of Eri silkworm, Eri mother moth examination, mounting method and storage of cocoons.
5. Incubation of eri eggs and its egg hatching ratio

Essential Readings

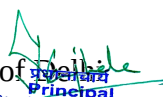
- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yip-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.
- Hisao Aruga, Principles of Sericulture, Oxford & IBH Publications
- Eikichi Hiratsuka, Silkworm Breeding, Oxford & IBH Publications
- P.K. Pandey, S.K. Sharan, Silk Culture, APH Publishing Corp.
- Dr. P.K. Rajan, Silkworm Rearing Technology, Central Silk Board
- R.K. Goel, Laboratory Techniques in Sericulture, APH Publishing Corp.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Sericulture III: Silk Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture III: Silk Technology	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

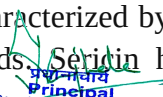
Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

Sericulture mainly focuses on silkworms rearing with the main aim of silk production. There are several applications of this:

1. The demand for silk is bound to increase in the coming years. This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth. This course will generate entrepreneurs in this field.
2. Sericulture by-products have remarkable application in the preparation of compost. Sericulture waste upon enrichment can be converted to high value manures.
3. Silk consists of two types of proteins, silk fibroin and sericin.
 - a. Sericin contributes about 20-30 per cent of total cocoon weight. It is characterized by its high content of serine and 18 amino acids, including essential amino acids. Sericin has wide


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applications in pharmaceuticals and cosmetics such as, wound healing, bioadhesive moisturizing, antiwrinkle and antiaging properties.

- b. Silk fibroin, has a variety of applications in pharmaceutical, food, and fodder industries. Silk fibroin is used for bone formation, silk thread in surgery, and drug delivery system. Silk fibroin has unique properties including good adherence with flexibility to wound bed, absorption of exudates, biocompatibility, biodegradability, minimal inflammatory reaction and in skin grafting due to its outstanding mechanical properties.
4. Mulberry, the sole food plant of silkworm has also the potential to be used in pharmaceutical and food industry.

SYLLABUS

Introduction to Silk Technology

(60 hours)

Practical

1. Introduction to different textile fibres.
2. Cocoon stifling- different methods and determination of degree of drying.
3. Determination of commercial characters of cocoon: average cocoon weight, shell weight, shell percentage, average filament length, reelability, raw silk recovery percentage, renditta and denier.
4. Identification of silk, cotton, wool and synthetic fibres by various tests.
5. Raw silk testing and grading by mechanical tests like winding test, seriplane test and cohesion test.
6. Study of silk manufacturing unit.

Essential Readings

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yip-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.
- Hisao Aruga, Principles of Sericulture, Oxford & IBH Publications
- Eikichi Hiratsuka, Silkworm Breeding, Oxford & IBH Publications
- P.K. Pandey, S.K. Sharan, Silk Culture, APH Publishing Corp.
- Dr. P.K. Rajan, Silkworm Rearing Technology, Central Silk Board
- R.K. Goel, Laboratory Techniques in Sericulture, APH Publishing Corp.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Sericulture IV: Application of Sericulture in Therapeutic and Cosmetic Industry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture IV: Application of Sericulture in Therapeutic and Cosmetic Industry	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

1. Sericulture is multi-disciplinary activity consists of mulberry leaf production, silkworm rearing (cocoon production), silkworm egg production, silk reeling (yarn production), twisting, Warp and weft making, printing and dyeing, weaving, finishing, garment designing, marketing etc.

2. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth.
3. This course will generate entrepreneurs in this field. Sericulture offers gainful employment not only the rural masses but also for the educated youth in semi-urban and urban areas.
4. Effective utilization of waste generated in the industry will help in making the sericulture sector more viable, stable and create more employment opportunities.
5. Sericulturists fall under the category of primary activities. They usually find employment in sectors like government and research development centres.

SYLLABUS

Sericulture as a tool for rural development. Uses of different by-products of sericulture in pharmaceuticals and Cosmetics **(60 hours)**

Practical

1. Identify and collection of different waste materials of mulberry, silkworm rearing and silk reeling
2. Prepare different useful products of mulberry leaf waste and sticks.
3. Silkworm sericin in- medical textiles, regenerative drugs, and tissue engineering, cosmeceuticals, food additives, and manufacturing of valuable biomaterials.
4. Silkworm pupa in the field of therapeutics, cosmetics, animal feed, fertilizer, etc.
5. Sericulture wastes in sustainable applications for biofuels generation.
6. Entrepreneurial ideas to convert waste material of sericulture into raw material for other industries.
7. IT/ non IT based projects of sericulture.

Essential Readings

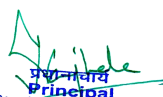
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- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yip-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Chemistry Lab Operations and Safety Measures

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry Lab Operations and Safety Measures	2	0	0	2	Class XII with Science	NIL

Learning Objectives

- To cultivate efficient working skills among the students to work in a chemistry laboratory
- To create a trained workforce which can responsibly learn imbibe and explore verticals on structured knowledge safely.
- To make students aware of different chemicals and their properties being used in the chemistry laboratory.

Learning outcomes

After studying this course, the student will be:

- Able to design and implement safe working practices in chemistry laboratory.
- Able to safely handle different glass apparatus
- Able to handle the chemicals and equipment safely and properly.
- Able to design working protocols related to various methods and instruments in chemistry laboratory.

SYLLABUS

Practicals/ Hands-on Training:

60 hours

Part A: Safety Measures

- 1) Design an illustrative chart exhibiting creativity at transaction of Do's and Don'ts instructions for working in a chemistry laboratory.
- 2) i. Carry out Classification and labeling of the given set of chemicals based upon Globally Harmonized System.
ii. Carry out detailed survey of the Chemical Abstract Service (CAS) Registry Number and identify the given set of CAS RN and explain the different sections of CAS RN.
- 3) Carry out preparation of the indicative MSDS (Material Safety Data Sheet) of given set of chemicals as per Standard MSDS format.
- 4) Design an illustrative chart exhibiting creativity at transaction of Common Safety Symbols along with its description. Associate appropriate safety symbol with each of the given set of chemicals.

- 5) Draw and elucidate the National Fire Protection Association Hazard Labels.
- 6) i. Identify and enlist the Incompatible Chemicals from a given set of chemicals available in the laboratory.
ii. Carry out investigations on Labeling and storage of Chemical in laboratory.
- 7) i. On the basis of MSDS analysis, identify the required storage conditions for the given set of chemicals.
ii. Describe procedure for the storage, maintenance and handling of compressed gas cylinders.
iii. Explore guidelines for the Storage of shelf chemicals and reagents.
- 8) i. Carry out a brief review of common pathways by which working Chemicals can enter the Body.
ii. Carry out a detailed study of the Limits of Exposure of given Chemicals.
- 9) i. Classify the Hazard based on storage, handling, and disposal of chemicals.
ii. Identification and describe handling protocols for Substances with Greater Hazardous Nature.
- 10) Carry out detailed investigations on procedural protocols for safe Disposal of Chemicals.
- 11) i. Carry out study on recommended Safety and Emergency Equipment essential for the safe practices in a Chemistry Laboratory.
ii. Study the guidelines in the Event of a Chemical Accident or Spill.
- 12) i. Write detailed description on Fire Safety in the laboratory.
ii. Carry out investigations of the data regarding Institute Safety Policies: Safety Audits / Inspections.

Part B: Chemistry Lab Standard Operations

- 1) Carry out exploration on Holding, Handling and use of Common Laboratory Apparatus as per given list of laboratory apparatus (Appendix A).
- 2) Carry out investigations of various types of apparatus in labs based on material they are made of such as Pyrex Glass (borosilicate Glass) Apparatus, Fused Silica Apparatus: Corning Vycor Glass, Porcelain apparatus, Plastic Apparatus, Metal Apparatus.
- 3) Understanding the protocol of Cleaning and drying and polishing of Glassware apparatus.
- 4) Carry out detailed investigations on Identification, diagrammatic representation, set up of Apparatus assemblies and details exploration on operational procedural protocols for glassware apparatus with Interchangeable ground glass joints: Typical Assemblies.
- 5) i. Carry out calibration of Volumetric/ Graduated Glassware Apparatus along with description on Temperature Standards.
ii. Carry out Calibration of thermometers.
- 6) i. Carry out exploration and investigations of working protocol for various heating equipment in laboratory: Burners, Hot Plates, Electrical Heating Mantles, Electric Oven,

- Microwave Oven, Muffle Furnace, Infrared lamps, Crucible and Beaker Tongs and Emersion heaters.
- ii. Carry out exploration and investigations of working protocol for various Stirring apparatus in laboratory: Stirring rods; Policeman, Boiling rods, Use of Mechanical agitation-Magnetic Stirrer and Mechanical Shaker.
 - iii. Carefully analyze the Glass, Cork and Rubber Stoppers and investigate their preparation and appropriate applications.
- 7) i. Carry out detailed investigations of Heating and Cooling Bath, and determine their working ranges and working protocols.
 - ii. Explore and differentiate between different forms of water for Laboratory Use: Distilled (Grade I to III), De-ionized and tap water, and carry out conductance measurement /other analytical investigations for the differentiation purpose.
- 8) i. Differentiate among Various types of Filter Paper and explore their applications.
 - ii. Preparation of a fluted filter paper and its advantages.
 - iii. Classification of reagents as AR/ GR grade.
- 9) i. Care and Use of Analytical Balance: Mass and Weight, Two-Pan Balance and Electronic Balance.
 - ii. Carry out Calibration of weighing balances and accuracy in measurement.
- 10) Introduction to Chromatographic adsorption: Paper and Thin Layer Chromatography. Preparation of Thin Layer Chromatography (TLC) Plates.
- 11) i. Use of melting point apparatus. Experimental determination of the melting point using various methods.
 - ii. Experimental determination of the boiling point using various methods.
- 12) To Purify given organic solvents.
- 13) i. Hand on training for working with typical assemblies of apparatus for distillation and refluxing.
 - ii. Assessment of Fire hazards attending the distillation of inflammable solvents.
- 14) i. Purification of given solid organic compounds by crystallisation method.
 - ii. Recrystallization of given non-volatile organic solids and outline the Difficulties encountered in recrystallization process.
- 15) Removal of traces of colouring matter and use of decolourising carbon.
- 16) i. Carry out exploration and investigations of working and working protocol for Filtration Apparatus: Filtration with suction.
 - ii. Explore and imbibe knowledge about types of Vacuum Pump; Water and Oil Pump and their applications.
- 17) Investigate Conventions for Drying of the recrystallized material.
- 18) i. Introduction to Gas absorption traps and their importance.
 - ii. Recrystallization in an atmosphere of inert gas.

- 19) i. Performing Evaporation of the solvent in the laboratory.
 ii. Preparation of anhydrous liquids or solutions of organic compounds in organic solvents.
- 20) i. Various procedures for the precipitation and washing of the precipitates.
 ii. Application of various methods and instruments for drying of solid organic compounds.
- 21) i. Incineration of Filter paper with precipitate.
 ii. Differentiate between various types of centrifugation methods, principle, uses and application of centrifugation method.
 iii. Calculation of yields for different chemical processes.
- 22) In-depth Understanding and Preparation of Chemical Laboratory Reagents.
- 23) Explore methodologies of Preparation and Storage of Standard Solutions.

Important Instruction Note on working approach:

A minimum of 5 exercises from Part A and 10 exercises from Part B is required to be discussed/performed/investigate. Moreover, exercises related to MSDS, CASRN safety symbols identification is required to be performed mandatorily.

Mandatory exercises:

Part A Exercise No.: 2, 3, 4, 5 and 9

Part B Exercise No.: 1 to 10.

The exercises mentioned above will be performed by the student strictly in accordance with the instructions received and only under the supervision of the teacher concerned.

Essential Readings:

1. Skoog D.A., West D.M., Holler F.J., Stanley R.C., **Fundamentals of analytical chemistry**, 9th Edition, Cengage Learning.
2. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), **Vogel's Quantitative Chemical Analysis**, 6th Edition, Prentice Hall.
3. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; **Vogel's Text Book of Practical Organic Chemistry**, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
4. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.
5. <https://iupac.org/>
6. <https://edu.rsc.org/resources/practical/experiments>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Basic Analytical Techniques

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Analytical Techniques	2	0	0	2	Class XII with Science	NIL

Learning Objectives

- To make students aware of the importance and the concepts of chemical analysis of water and soil samples collected from different sources
- To make them learn few techniques like chromatography, analytical techniques and instrumentation techniques, for example: spectrophotometry and flame photometry.

Learning Outcomes

After studying this course, the student will be able to:

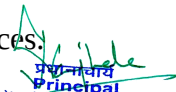
- Handle analytical data
- Determine the pH and conductance of soil samples, which can be useful in agriculture sector
- Do quantitative analysis of metal ions in water samples
- Separate ions using chromatographic techniques
- Estimate macronutrients using Flame photometry.

SYLLABUS

Practical:

60 hours

1. Determination of pH of soil samples collected from college nursery, sports ground and the soil collected from Yamuna River Bank.
2. Determination of conductance of soil samples collected from college nursery and sports ground.
3. Determination of pH of different types of aerated drinks and fruit juices.
4. Estimation of Calcium and Magnesium ions as Calcium carbonate (total hardness) by complexometric titration.
5. Determination of pH, acidity, and alkalinity of water samples collected from different water body/supply sources like Yamuna water, MCD supply water, Groundwater, water samples collected from water sewage treatment plants (Delhi /NCR).
6. Determination of dissolved oxygen (DO) of a water sample collected from different sources (at least two sources).
7. Determination of BOD of water sample collected from different water sources.


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8. Paper chromatographic separation (*ascending and circular both*) of the mixture of metal ion (Ni^{2+} and Co^{2+}) and (Cu^{2+} and Cd^{2+}).
9. To study the use of phenolphthalein in trap cases.
10. Estimation of macro-nutrients: Potassium, calcium and magnesium in soil samples by flame photometry.
11. Spectrophotometric determination of Iron in vitamin / dietary tablets / different solutions of iron.
12. Spectrophotometric identification and determination of caffeine and benzoic acid in soft drink.
13. Spectrophotometric determination of cadmium and chromium in the given water sample.
14. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).
15. Visit STP plants and different chemical industries.

Essential Readings:

- Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
- Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), **Vogel's Quantitative Chemical Analysis**, 6th Edition, Prentice Hall.
- De, A. K. (2021), **Environmental Chemistry**, 10th edition. New Age International Pvt. Ltd.

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Lab Testing and Quality Assurance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Lab Testing and Quality Assurance	2	1	0	1	Class XII with Science	NIL

Learning Objectives:

The objective of this course is:

- To introduce the concept of quality check and quality control in chemical industries.

Learning Outcomes:

By the end of the course, the students will be able to:

- Describe role of quality control chemist
- Discuss and demonstrate analytical and separation techniques
- Carry out sample preparation
- Illustrate fundamentals of quality check
- Describe and use safety procedures

SYLLABUS

Unit 1: Introduction

2 hours

Industry and sub-sectors, standards for manufacturing in life-sciences, drug regulatory agencies, role of quality control chemist, quality management systems

Unit 2: Modern Analytical methods and separation techniques

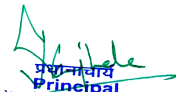
5 hours

Gravimetric methods, volumetric methods, electroanalytical methods, spectroscopic methods, chromatographic techniques

Unit 3: Sample preparation

2 hours

Basics of sample preparation, preservation and storage, standards and guidelines for sample handling, good storage practices


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Unit 4: Quality check

6 hours

Overview, productivity concept, statistical analysis of laboratory data, measurements, calibrations, validation, reference standards and materials, requirements of a calibration lab, fundamentals of advanced QC approaches, Trouble shooting in QC, documentation, audit/ process related query, Quality certifications, Government regulations in industries like pharmaceuticals, food supplements, cosmetics.

Practicals/Hands-on-Training

30 hours

1. Calibration of glassware
2. Weighing of samples, accuracy of measurements
3. Preparation of TLC plates and separation of amino acids
4. Working protocols of various laboratory instruments-oven, pH-meter, conductivity meter, water baths, muffle furnace, spectrophotometer.
5. Calibration of instruments like colourimeter, pH-meter, conductivity meter, spectrophotometer using reference standards or reference materials.

Suggested exercise: Visit some industries to study the validation of simple procedures.

Essential readings:

- Skoog D.A., West D.M., Holler, F.J., Crouch S.R., **Fundamentals of Analytical Chemistry**, 9th Edition, Cengage learning.
- **Quality control chemist participant manual** prepared by LSSSDC in collaboration with NSDC India.
- iso.org

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Essential Food Nutrients

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical /Practice		
Essential Food Nutrients	2	1	0	1	Class XII with Science	NIL

Learning Objectives

- To develop a basic understanding of the components of food, their source, properties and interactions as well as changes that occur during processing, storage, and utilization

Learning Outcomes

After studying this course, the student will be able to:

- Account for chemistry of foods: composition of food, role of each component
- Recognize some of the reactions and changes in individual food components which occur during processing, handling and storage

SYLLABUS

Theory:

Unit 1: Carbohydrates

3 hours

Introduction, sources, functions, deficiencies, Structures of monosaccharides and disaccharides: glucose, fructose, galactose; lactose, maltose, sucrose, maltitol, concept of reducing and non-reducing sugars; role of carbohydrates as sweeteners in food; lactose intolerance, galactosemia, dental plaque, overview of carbohydrate metabolism.

Unit 2: Lipids

5 hours

Introduction, sources, functions, deficiencies, classification (fatty acids, phospholipids, fats & oils, waxes), common fatty acids present in oils and fats, Omega- 3,6,9 fatty acids, trans fats, chemical properties: iodine value, saponification value, effect of frying on fats, changes in fats and oils-rancidity, lipolysis, flavor reversion, auto-oxidation and its prevention.

Unit 3: Proteins

5 hours

Introduction, sources, functions, deficiencies, protein structure (primary, secondary and tertiary), physico-chemical & functional properties of proteins, food proteins: animal and plant proteins.

Unit 4: Vitamins & Minerals

2 hours

Vitamins: Introduction, classification: fat-soluble vitamins & water-soluble vitamins.
Minerals: Introduction, classification: macrominerals (Ca, P, Mg) & microminerals (Se, Fe, I, Co, Zn, Cu, Se, Cr). Role of vitamins and minerals in food chemistry.

Practicals/Hands-on Training

30 hours

1. Determination of moisture in food products by hot air oven-drying method.
2. Colorimetric determination of iron in vitamin/dietary tablets.
3. Estimation of Vitamin C in a given solution/lemon juice/chillies by 2, 6 Dichlorophenol indophenol method.
4. Estimation of total soluble sugar content by ferricyanide method (volumetric analysis).
5. Determination of saponification value of the given fat/oil.
6. Determination of iodine value of the given fat/oil.
7. Qualitative tests for proteins and carbohydrates.
8. Qualitative Estimation of cholesterol by Liebermann Burchard method.

Essential Readings:

Theory:

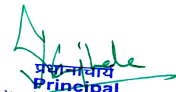
- deMan, J.M., Finley, J.W., Hurst, W.J., Lee, C.Y. (2018), **Principles of Food Chemistry**, 4th Edition, Springer.
- Msagati, T.A.M. (2013), **Chemistry of Food Additives and Preservatives**, Wiley-Blackwell.
- Fennema, O.R. (2017), **Food Chemistry**, 5th Edition, CRC Press.
- Attokaran, M. (2017), **Natural Food Flavors and Colorants**, 2nd Ed., Wiley-Blackwell.
- Potter, N.N., Hotchkiss, J.H. (1995) **Food Science**, 5th Ed., Chapman & Hall.
- Brannen, D., Davidsin, P.M., Salminen, T. Thorngate III, J.H. (2002), **Food Additives**, 2nd Edition, CRC Press.
- Coultate, T. (2016), **Food: The Chemistry of its Components**, 6th Edn., Royal Society of Chemistry.
- Belitz, H. D.; Grosch, W. (2009), **Food Chemistry**, Springer.
- Course: FOOD CHEMISTRY (iasri.res.in)

Practicals:

- Ranganna, S. (2017). **Handbook of analysis and quality control for fruits and vegetable products**, 2nd Edn., McGraw Hill Education
- Sawhney, S.K., Singh, R. (2001), **Introductory Practical Biochemistry**, Narosa Publishing House

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Chemistry of Food Flavors and Colourants

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical /Practice		
Chemistry of Food Flavors and Colourants	2	1	0	1	Class XII with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To provide introduction to quality attributes of food such as appearance and flavour.
- To impart an understanding of the chemistry of the flavour as well as colour constituents of foods.

Learning Outcomes:

By the end of the course, the students will be able to:

- Describe mechanisms of flavor perception
- Demonstrate various mechanisms of flavor formation
- Discuss the chemical dimension of flavour.
- Recognize off-flavor defects in foods and strategies to control it.

SYLLABUS

Unit 1: Flavors

9 hours

Introduction and importance of flavors in food.

Taste & Odour: Structure and physiology of taste organs- tongue, papillae, taste buds, salivary glands, Mechanism of taste and odour perception

Basic Types of taste : Salty, Sweet, Bitter, Sour, Umami taste, Chemical dimensions of basic tastes (sweet, salt, sour, bitter and umami), odour and other sensations (like astringency, coolness, pungency/pungency), Non-nutritive and nutritive sweeteners (including structures of aspartame, saccharin, sucralose, Stevioside), Molecular Theory of Sweetness, Taste Inhibition and enhancement, Chemical dimension of Flavors (peppers, peppermint, coriander, cinnamon, onion), Chemistry of food flavorings: Maillard browning, enzymic browning reactions, caramelisation browning, Off-Flavour in Food (Rancidity in Fats/Oils, Non Enzymic Browning), Control of enzymic browning (acidulants, chelating agents, heat treatment etc)

Unit 2: Food Colours

6 hours

Introduction, importance, classification: Natural food colourants (Anthocyanins, Carotenoids, Chlorophyll), Examples of Pigments in common food (turmeric, tomato, carrot, orange); Nature-identical colourants (β -Carotene, Canthaxanthin and Riboflavin); Artificial/synthetic colourants: Azo dyes (e.g. amaranth dye, tartrazine, citrous red); Quinoline (e.g. quinoline yellow); Phthalein (e.g. erythrosine); Triarylmethanes and indigoid (e.g. indigo carmine), FD&C Dyes and Lakes.

Practicals/Hands-on-Training

30 hours

1. Determination of the taste threshold for the different sensations – sweet, salty, sour.
2. Extraction of limonene from orange peels using supercritical carbon dioxide.
3. Quantitative determination of food dyes in powdered drink mixes by spectrophotometric method.
4. Extraction and separation of pigments present in spinach by Thin Layer Chromatography (TLC).
5. Experiment to demonstrate the enzymic browning and its prevention.
6. Determination of rancidity of edible oils by Kriess Test.
7. Estimation of carotenoids in sample by colorimetric method.

Essential readings:

Theory:

- DeMan, J.M., Finley, J.W., Hurst, W.J., Lee, C.Y. (2018), **Principles of Food Chemistry**, 4th Edition, Springer.
- Msagati, T.A.M. (2013), **Chemistry of Food Additives and Preservatives**, Wiley-Blackwell.
- Fennema, O.R. (2017), **Food Chemistry**, 5th Edition, CRC Press.
- Attokaran, M. (2017), **Natural Food Flavors and Colorants**, 2nd Ed., Wiley-Blackwell.
- Potter, N.N., Hotchkiss, J.H. (1995) **Food Science**, 5th Ed., Chapman & Hall.
- Brannen, D., Davidsin, P.M., Salminen, T. Thorngate III, J.H. (2002), **Food Additives**, 2nd Edition, CRC Press.
- Coultate, T. (2016), **Food: The Chemistry of its Components**, 6th Edn., Royal Society of Chemistry.
- Belitz, H. D.; Grosch, W. (2009), **Food Chemistry**, Springer.
- Course: FOOD CHEMISTRY (iasri.res.in)

Practicals:

- Ranganna, S. (2017). **Handbook of analysis and quality control for fruits and vegetable products**, 2nd Edn., McGraw Hill Education
- Sawhney, S.K., Singh, R. (2001), **Introductory Practical Biochemistry**, Narosa Publishing House

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Chemistry of Cosmetics and Hygiene Products

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical /Practice		
Chemistry of Cosmetics and Hygiene Products	2	0	0	2	Class XII with Science	NIL

Learning Objectives

- To introduce the concept of cosmetics in terms of chemistry and their formulation.
- To make students understand the role of each ingredients in the preparation of the cosmetic products.
- To give an idea about the role of herbal ingredients in the making of any cosmetic product.

Learning Outcomes

After studying this course, the student will:

- Be familiar with the basic principles of various cosmetic formulations
- Be aware of different ingredients and their roles in cosmetic products.
- Appreciate the role of herbal ingredients in various cosmetic products
- Use safe, economic and body-friendly cosmetics
- Prepare new innovative formulations to achieve the aimed efficacies and effects

SYLLABUS

Practicals/Hands-on-training

60 hours

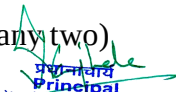
1. Definition, History and Classification of cosmetic & cosmeceutical products.

Skin Care Products: Basic structure and function of skin. Principles of formulation of skin care products. Role of herbs in Skin Care: Aloe and turmeric. General Ingredients and preparation of

(a) Preparation of Talcum powder (chemical based and herbal)

(b) Face cream/ vanishing cream/ cold cream/ suntan cream/lather shaving cream (any two)

(c) Body lotion


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2. Hair Care Products: Basic structure of hair and classification of hair. Principles of formulation of Hair care products. Types of shampoo and conditioners. Role of herbs in Hair care: Henna and amla. Role of primary and secondary surfactants in shampoo. General Ingredients and preparation of

(a) Shampoo (chemical based and herbal)

(b) Conditioners

3. Hand Care and hygiene Products: Principles of formulation of hand sanitizers and hand wash. General Ingredients and preparation of:

(a) Hand wash

(b) Hand sanitizer

4. Nail preparation: Structure of nail, Nail lacquers, Nail polish remover. General Ingredients and preparation of:

(a) Nail polish and nail polish remover

5. Personal hygiene products: Total fatty matter, alkali content and pH of soaps. Bathing soap and toilet soap. Antiperspirants and deodorants. General Ingredients and preparation of

(a) Soaps

(b) Cream Soaps

6. Oral hygiene products: Common problem associated with teeth and gums. Role of herbs in oral care: Neem and clove. Principles of formulation of Oral hygiene products. Flavours and essential oils. General Ingredients and preparation of

(b) Tooth powder (chemical based and herbal)

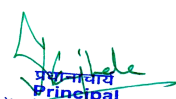
(c) Tooth paste

Essential Readings

- Barel, A.O.; Paye, M.; Maibach, H.I. (2014), **Handbook of Cosmetic Science and Technology**, CRC Press.
- Garud, A.; Sharma, P.K.; Garud, N. (2012), **Text Book of Cosmetics**, Pragati Prakashan.
- Gupta, P.K.; Gupta, S.K. (2011), **Pharmaceutics and Cosmetics**, Pragati Prakashan
- Butler, H. (2000), **Poucher's Perfumes, Cosmetic and Soap**, Springer

Suggestive Readings:

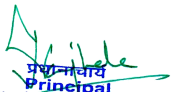
- Flick, E.W. (1990), **Cosmetic and toiletry formulations**, Noyes Publications / William Andrew Publishing.
- Natural Ingredients for Cosmetics; EU Survey 2005
- Formulation Guide for cosmetics; The Nisshin OilliO Group, Ltd.


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- Functional Ingredients & Formulated Products for Cosmetics & Pharmaceuticals; NOF Corporation

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi


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Green Methods in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical /Practice		
Green Methods in Chemistry	2	0	0	2	Class XII with Science	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To create awareness about the chemistry that is good for human health and the environment.
- To provide thorough knowledge of the green chemistry principles, and new remediation technologies for the cleaning up of hazardous substances.
- To develop basic skills to be able to design, develop and run chemical processes in a sustainable way.

Learning Outcomes:

After studying this course, the student will be able to:

- Design and develop materials/ processes that reduce the use and generation of hazardous substances in industry.
- Describe how injudicious use of chemicals can have an adverse/potentially damaging effect on humans and the environment.
- Propose ideas for innovative approaches to environmental and societal challenges.
- Critically analyse the existing traditional chemical pathways/processes and creatively think about bringing environmentally benign reformations in these protocols.
- Convert biomass into valuable chemicals through green technologies.

SYLLABUS

Practicals/Hands-on Training

60 hours

1. Definition and Importance of green chemistry. Introduction to the prevention of waste/ by products and waste/ pollution prevention hierarchy. Provide the scheme for the traditional as well as green method for the synthesis of ibuprofen and ask students to compare the amount and hazards of waste generated in both the processes.

2. Principle and calculation of atom economy. Use of molecular model kit to stimulate the reaction

to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Hoffman elimination

(II) Dehydration of propanol

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy

3. Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard x exposure.

(a) Nitration of salicylic acid using green method $\text{Ca}(\text{NO}_3)_2$

(b) Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.

(c) Preparation of dibenzalacetone by cross aldol condensation reaction using base catalysed green method

(d) Acetylation of primary aromatic amine using the green method.

4. Use of Green solvents and comparison of greenness of solvents:

(a) Explain about supercritical fluids with special reference to carbon dioxide. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice

(b) Introduction to water as a solvent for chemical reactions. preparation of Manganese (III) acetylacetonate using green method

(c) Advantages and application of solventless processes in organic reactions.

(i) Benzil- Benzilic acid rearrangement in solid State under solvent-free Condition.

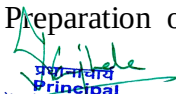
(ii) Mechanochemical solvent free, solid–solid synthesis of azomethine using *p*- toluidine and *o*-vanillin/*p*-vanillin

5. Energy requirements for reactions – alternative sources of energy: use of microwaves and photochemical energy.

(a) Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

(b) Microwave assisted ammonium formate-mediated Knoevenagel reaction: *p*-anisaldehyde, ethyl cyanoacetate, ammonium formate.

6. Selection of renewable starting material rather than depleting, Illustrate with few examples such as biodiesel and polymers from renewable resources (such as green plastic). Preparation of biodiesel from waste cooking oil and characterization.


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7. Importance of using catalytic reagents in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

(a) Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

(b) Rearrangement of diazoamino benzene to *p*-aminoazo benzene using K10 montmorillonite clay

8. Students should be asked to prepare a presentation/project based on any of the following topics:

- Bhopal Gas Tragedy and safer route to carbaryl synthesis
- Flixiborough accident and safer route to cyclohexanol
- Use of Surfactants for SC-CO₂ for precision cleaning and dry cleaning of garments replacing PERC.
- A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards)
- Healthier Fats and oils by Green Chemistry: Enzymatic Interesterification for production of No Trans-Fats and Oils.
- Synthesis of anti-tuberculosis drug Paramycin from waste water stream
- Syntheses of vitamin D₃ using photochemical energy
- Greener Manufacturing of Sitagliptin Enabled by an Evolved Transaminase
- Microwave assisted solvent free synthesis of aspirin
- Synthesis of 6-Aminopenicillanic Acid (6-APA) from penicillin G using biocatalyst.

Essential Readings:

Theory:

- Anastas, P.T., Warner, J.C. (2014), Green Chemistry, Theory and Practice, Oxford University Press.
- Lancaster, M. (2016), Green Chemistry: An Introductory Text, 3rd Ed., RSC Publishing.
- Cann, M.C., Connely, M. E. (2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.
- Matlack, A.S. (2010), Introduction to Green Chemistry, 2nd Ed., CRC Press.
- Alhuwalia, V.K.; Kidwai, M.R. (2012), New Trends in Green chemistry, Kluwer Academic Publishers, Springer.
- Sidhwani, I.T; Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India Pvt Ltd.
- [Etzkorn](#), F. A . (2019), Green Chemistry: Principles and Case Studies, Royal Society of Chemistry.

Practicals:

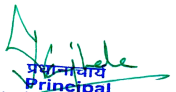
- Kirchoff, M., Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
- Sharma, R.K., Sidhwani, I.T., Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
- Pavia, D.L., Lamponam, G.H., Kriz, G.S.W. (2006), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
- Sidhwani, I.T. ; Saini, G.; Chowdhury, S. **Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from**

waste further generated. University of Delhi, Journal of Undergraduate Research and Innovation, Volume 1, Issue 1, February 2015, ISSN: 2395-2334.

- Sharma, R. K., Gulati, S., Mehta, S. (2012), **Preparation of Gold Nanoparticles Using Tea: A Green Chemistry Experiment**, Journal of Chemical Education, 89 (10), 1316-1318.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Forensic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical /Practice		
Forensic Chemistry	2	1	0	1	Class XII with Science	NIL

Learning Objectives

- To introduce students to this fascinating branch of science and familiarize them with important concepts like fingerprints, explosives/arson, drugs and their detection.

Learning outcomes

After studying this course, the student will be able to:

- Describe latent fingerprints, various methods of detection of latent fingerprints, explosive analysis in forensic science, collection and preservation of evidence from crime scene etc

SYLLABUS

Theory:

Unit 1: History of Development of Forensic Science in India

2 hours

Definitions, Scope and Need of forensic science, Ethics in forensic science, History of forensic science, Basic principles of forensic science, Organizational structure of forensic science laboratories, Different branches in forensic science

Unit 2: Fingerprints

5 hours

Definition, History of fingerprint identification, Fingerprint as forensic evidence, Visible Finger marks, Latent Finger marks, ten-digit classification, Methods of Development of latent fingerprints using conventional methods—Powdering (Black and grey, fluorescent and magnetic), Methods of development of latent fingerprint using chemical method (iodine fuming, silver nitrate, Ninhydrin, Vacuum metal deposition), Automated Fingerprint identification system (AFIS), Poroscopy and Edgescopy

Unit 3: Forensic Chemistry

8 hours

Scope & significance of Forensic Chemistry, Types of cases/exhibits received for analysis. Trap Cases: Collection, and Preliminary analysis of evidence in trap cases.

Alcoholic Beverages: Types of alcohols, country made liquor, illicit liquor, denatured spirits, Indian made foreign alcoholic and non-alcoholic beverages.

Dyes: Scope & Significance of dyes in crime investigation, analysis of ink by TLC and UV visible spectrophotometry. Petroleum products and their adulterations: Chemical composition of various

fractions of Petroleum Products, Analysis of petrol, kerosene, diesel.

Fire/Arson and Explosives Fire: Introduction to Fire & Arson, origin of fire, Chemistry of Fire, Fire tetrahedron, Firefighting operations, preservation of fire scene, collection of evidences, Seat offire, cause of fire, motives, Analysis of fire debris, Case studies related to fire and Arson. Explosive and Explosion: Scope & significance of explosive analysis in forensic science, Types of explosives, deflagration and detonation, explosive trains, collection, preservation and forwarding of exhibits, preliminary analysis of explosives. Dos and Don'ts. Case studies related to explosives.

Drugs of abuse: Classification, including designer drugs. Ill effects of drugs of abuse, Preliminary and conformatory tests.

Practicals/Hands-on Training

30 hours

1. Development of fingerprint through conventional powder method.
2. Development of fingerprint through chemical methods.
3. To check the alcohol presence in different liquor.
4. Phenolphthalein test for trap cases.
5. Identification of Handwriting Individual Characteristics.
6. Study of Disguise in handwriting.
7. TLC of amino acids

Essential/recommended readings

- Saferstein, R. (1990) Criminalistics, Prentice Hall, New York.
- Basic Principles of Forensic Chemistry by JaVed I. Khan • Thomas J. Kennedy
Donnell
R. Christian, Jr.
- Fundamentals of FINGERPRINT ANALYSIS Hillary Moses Daluz
- Clarke's Analysis of Drugs and Poisons 3rd Ed.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENTAL IMPACT AND RISK ASSESSMENT	02	0	0	02	Class XII with Science	NA

Learning Objectives

- To gain insights into the concepts of environmental impact assessment (EIA) and its relevance for sustainable development
- To acquire knowledge of the socio-ecological and economic perspectives of any developmental project.
- To evaluate methodologies to conduct and analyze EIA acceptable per prevalent regulations

Learning outcomes

The Learning Outcomes of this course are as follows.

After studying the course, the students will be able to:

- Conduct EIA of any developmental project and analyze its environmental and other implications
- Serve as consultant to different agencies working on EIA and a developmental plan
- Evolve strategies to ensure development and conservation hand-in-hand
- Formulate sustainable development strategies for any development plan varying in scale
- Identify and classify different development projects based on their sales and impacts on the environment

SYLLABUS

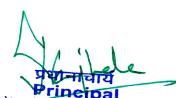
Practical

(02 Credits: 60 hours)

- Based on the given project details, classify them as Category A and Category B1 and B2 projects.
- Prepare the scope of any recent developmental project of Category A which received Environmental Clearance.
- To prepare a questionnaire and compilation of primary data to study the scope of the project based on public participation.
- Identify the impacts due to a Mining Project using the checklist method.
- Based on the impacts identified in Activity 4, formulate mitigating measures for the project.
- Determine the impacts due to a large-scale hydropower project in a given state using the matrix method and geo-spatial data,
- Prepare an environmental management plan for a mining project.
- To conduct a public hearing for any project and prepare a draft for the process.
- Prepare a brief life cycle assessment of a smartphone.
- Prepare a brief EIA report of a River Valley Project.

Teaching learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f)


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demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective Sectors:

As per the Ministry of Environment, Forests, & Climate Change (MoEF&CC), Govt. of India, ~30 sectors require EIA for Environmental Clearance before any project activity. Some of them include Mining, Oil and gas exploration, development & production, River valley, hydel, drainage and irrigation projects, thermal Power plants, Nuclear power projects, Coal washeries, Mineral, Metallurgical industries, Cement plants, Petroleum industry, Coke oven plants, Asbestos milling, Chlor-alkali industry, Soda ash Industry, Chemical fertilizers, Pesticides industry, Synthetic organic chemicals industry, Distilleries, Integrated paint industry, Pulp & paper industry, Induction/arc furnaces, Air ports, All ship breaking yards, Industrial estates, Common hazardous waste treatment, storage and disposal facilities, Highways, railways, transport terminals, mass rapid transport systems, Building and large construction projects, Townships, and area development projects.

Essential/recommended readings

- EIA 2020. Ministry of Environment, Forest and Climate Change, Draft Environment Impact Assessment Notification, 2020, <http://environmentclearance.nic.in/writereaddata/om/6998FGGHOI_Gaztte_EIA2020_Comments.pdf>.
- Glasston, J. and Therivel, R., 2013. Introduction to Environmental Impact Assessment. Routledge.
- MacKinnon, A.J., Duinker, P.N. and Walker, T.R., 2018. The Application of Science in Environmental Impact Assessment. Routledge.
- Mareddy, A.R. (2017) Environmental Impact Assessment Theory and Practices, Butterworth Heinemann.

Suggested readings

- Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
- Lawrence, D.P., 2013. Impact assessment: practical solutions to recurrent problems and contemporary challenges. John Wiley & Sons.
- Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
- Petts, J. (1999). Handbook of Environmental Impact Assessment. Vol. 1, Blackwell Science.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

SUSTAINABILITY REPORTING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
SUSTAINABILITY REPORTING	02	0	0	02	Class XII	NA

Learning Objectives

- To gain insights into the step-by-step process of writing a sustainability report using internationally acceptable standards.
- To evolve a holistic view of sustainability and understand the carrying capacity of ecosystems for human needs.
- To acquire skills to address sustainability challenges in a global context.
- To evaluate industrial/organizational processes/programmes based on the interconnections among economic, environmental, and social activities

Learning outcomes

The Learning Outcomes of this course are as follows.

After studying the course, the students will be able to:

- Develop a multi-disciplinary and holistic perspective of sustainability and identify key factors determining sustainability and associated benefits
- Write sustainability reports using universal, sector, and topic standards
- Explain sustainability challenges and effective methods to communicate it to different stakeholders
- Apply sustainability concepts, and GRI Standards for sustainable industries
- Serve as environmental consultants to different industries
- Advise governments on sustainable environmental policies

SYLLABUS

Practical/Hands-on Exercises

(02 Credits: 60 hours)

1. Investigate the framework for sustainability reporting outlined by global reporting initiatives (GRI)
2. Analyse universal, sector, and topic standards given by GRI
3. Develop sustainability reporting of your institute
4. Examine and report the sustainability of your residential society or residential area around your College
5. Compare and contrast sustainability reporting of the market in your neighbourhood and the selected mining industry
6. Visit a thermal power plant in and around your city and write its sustainability report

7. Using appropriate standards, evaluate the sustainability of a Cement Factory in your city
8. Field survey of a waste treatment facility in your city, assess their sustainability and give recommendations if required.
9. Analyze the potential and limitations of certified tools and software recommended by the GRI for sustainability reporting
10. Examine and evaluate sustainability reports available on different sectors and topics worldwide and give appropriate recommendations, if any.

Teaching learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective Sectors:

All Multi-National Companies, (b) Environmental and Sustainability Consultancies, (c) Environmental NGOs, (d) World Bank, and (e) UNDP

Essential/recommended readings

- Bini, L. and Bellucci, M., 2020. Integrated Sustainability Reporting: Linking Environmental and Social Information to Value Creation Processes. Springer.
- A Short-Introduction to GRI Standards. <https://www.globalreporting.org/media/wtaf14tw/a-short-introduction-to-the-gri-standards.pdf>
- Evaluating National Policies on Corporate Sustainability Reporting <https://wedocs.unep.org/handle/20.500.11822/9435>
- Gutterman, A.S., 2021. Sustainability Reporting and Communications. Business Expert Press.
- Sustainability Reporting in the Financial Sector: A Governmental Approach <https://wedocs.unep.org/handle/20.500.11822/17375>
- United Nations Environment Program (UNEP), 2015. Raising the bar: Advancing environmental disclosure in sustainability reporting.

Suggested readings

- Greiling, D., Traxler, A.A. and Stötzer, S., 2015. Sustainability reporting in the Austrian, German and Swiss public sector. International Journal of Public Sector Management.
- <https://www.globalreporting.org/reporting-support/reporting-tools/certified-software-and-tools/>

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

ENVIRONMENTAL AUDITING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENTAL AUDITING	02	0	0	02	Class XII	NA

Learning Objectives

- To gain an understanding of the fundamental principles and components of environmental auditing
- To train in conducting an environmental audit in any organization/ institution
- To implement critical thinking toward environmental problems and formulate local solutions for their mitigation

Learning outcomes

After studying the course, the students will be able to:

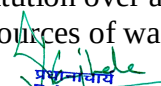
- Conduct an environmental audit in a scientific manner
- Recommend organizations to adopt specific sustainable strategies
- Serve as catalyst to evolve sense of ownership and responsibility among organizations/industries towards solving local environmental problems.
- Pursue environmental auditing for higher studies and a future career.

SYLLABUS

Practical/Hands-on Exercises

(02 Credits: 60 hours)

1. Prepare a working plan (in the form of a flowchart/ graphical abstract) for the environmental audit of any organization/ institution focusing on pre-audit, on-site and post-audit objectives and activities
2. Prepare a brief profile of any selected organization/ institution (Area, land use, green cover, organizational setup, demography etc.) and discuss its environmental policy and the environmental management systems
3. Prepare an interpretive electricity consumption report of the organization/ institution over a five-year period (both actual or arbitrary data can be used).
4. Prepare an interpretive water consumption report of the organization/ institution over a five-year period (both actual or arbitrary data can be used). Also, identify the sources of wastewater discharge and its management, if any.
5. Survey the campus and prepare a list of the plant/ animal (or both) diversity highlighting its importance and threats faced.


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6. Prepare a monthly air quality level dataset nearest to the institution's location, extracting data from the National Air Quality Index (CPCB) website. Prepare a report on causes of variation and measures taken by an organization to improve air quality levels
7. Prepare a comprehensive assessment report of Solid Waste Management at the organization/ institution highlighting compliance to Solid Waste Management Rules, 2016.
8. Formulate a scientifically sound protocol for identifying and disposing of e-waste and hazardous waste at any organization based on E-waste (management) rules, 2016 and Hazardous waste (management) rules, 2016.
9. Examine various environment-related practices and activities of the organization/ institution that have impacted the neighbouring communities and prepare a social audit questionnaire for studying the impact.
10. Compile the data, results, and analysis of all previous practicals and prepare a detailed environmental audit report of your selected organization/ institution.

Teaching learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective Sectors:

- (a) Universities/Colleges, (b) Environmental Consultancies, (c) Environmental NGOs, and (d) Indian Audit & Revenue Departments

Essential/recommended readings

- Cahill, L.B (2017). Environmental Health and Safety Audits: A Compendium of Thoughts and Trends, 2nd Edition, Bernan Press.
- Council, N.C., Britain, G. and Unit, E.F., 2011. Handbook for Phase 1 Habitat Survey: A Technique for Environmental Audit. Nature Conservancy Council.
- Ho G, Anda, M., Brennan, J., 2015. Water Auditing and Water Conservation. IWA Publishing
- Pain, S.W., 2010. Safety, Health, and Environmental Auditing: A Practical Guide. CRC Press.
- Thuman, A., Niehus, T., Younger, W.J., 2012. Handbook of Energy Audits, 9th ed. Routledge, Taylor and Francis
- Van Guilder, C.V., 2014. Environmental Audits. Mercury Learning & Information.

Suggested readings

- Barton, H., and Bruder N., 1993. A Guide to Local Environmental Auditing. Routledge, Taylor and Francis

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

PROSPECTING E-WASTE FOR SUSTAINABILITY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Prospecting E-Waste for Sustainability	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide in-depth knowledge on the effective mechanisms to regulate the generation, collection, and storage of e-waste
- To gain insights into the internationally/nationally acceptable methods of transport, import, and export of e-waste within and between countries
- To develop a holistic view on recycling, treatment, and disposal of e-waste and related legislative rules.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to holistically analyze the environmental impacts of e-waste
- After studying this course, students will be able to apply the skills and various concepts for sustainable management of e-waste
- After studying this course, students will be able to decipher the role of various national and international regulations for e-waste management
- After studying this course, students will be able to provide specific recommendations for improved methods for handling e-waste at different stages such as generation, collection, storage, transport, and recycling

SYLLABUS

Practical/Hands-on Exercises

(02 Credits: 60 hours)

- Identification of e-waste and its types
- Composition of e-waste and segregation- from the material provided
- Dismantling of e-waste and handling process
- Visit a nearby e-waste handling facility
- Environmental protection laws and producer's responsibility for e-waste management
- Build an understanding of how regulatory mechanisms can be utilized in the management of e-waste in educational institutions.
- Discussion on plausible ways and implementation of e-waste reduction at the source
- Evaluation of the status of e-waste handling at your institution and suggest remedial solutions as per the existing norms of E-Waste (Management) Rules, 2016 and beyond.

9. Estimate how recycling of e-waste in metro cities will go in sync with the circular economy
10. Develop an understanding and itinerary of the process for procuring e-waste import permissions.
11. Inventory of the e-waste disposal mechanisms.
12. Study the evolution of e-waste management rules and its implementation- Hazardous Waste Rules, 2008, E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016
13. Study the international laws on e-waste management- the international legislations: The Basel Convention; The Bamako Convention; The Rotterdam Convention; Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union; Restrictions of Hazardous Substances (RoHS) Directive

Teaching and learning interface for practical skills:

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective sector(s):

- Electric and electronic industries,
- E-waste Recycling Unites,
- Private entrepreneurs,
- Environmental consultancies,
- Pollution Boards, and
- Environmental NGOs

Suggested Readings:

- Hester, R.E. and Harrison, R.M., 2009. Electronic Waste Management: Design. Analysis and Application. Royal Society of Chemistry Publishing. Cambridge, UK.
- Fowler, B.A., 2017. Electronic Waste: Toxicology and Public Health Issues. Academic Press.
- Gaidajis, G., Angelakoglou, K. and Aktsoglou, D., 2010. E-waste: environmental problems and current management. Journal of Engineering Science and Technology Review, 3(1), pp.193-199.
- Janyasuthiwong, S., 2020. Metal Removal and Recovery from Mining Wastewater and E-waste Leachate. CRC Press.

Examination scheme and mode:

Evaluation scheme and mode II be as per the guidelines notified by the University of Delhi.

DEVELOPING SUSTAINABILITY PLANS FOR A BUSINESS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developing Sustainability Plans for a Business	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To assess the status of integration of social and ecological values into business practices
- To determine strengths and weaknesses in linkages between people, planet, and profit during business practices
- To correlate the changes in ecological footprint with growth in corporate responsibility
- To recommend strategies to improve current CSR practices for environmental conservation and enhance the return on investment of the organization

Learning outcomes

The Learning Outcomes of this course are as follows:

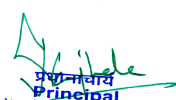
- After studying this course, students will be able to develop CSR plans to balance ecological security with economic success.
- After studying this course, students will be able to evolve methods for the financial stability of different organizations/companies
- After studying this course, students will be able to develop a framework to reduce energy consumption, adopt renewable resources and integrate waste management strategies among employees
- After studying this course, students will be able to design sustainable business plans having major positive impacts on plant and next-generation business setting

SYLLABUS OF SEC

Practical/Hands-on Exercises

(02 Credits: 60 hours)

- Determine strategies to reduce carbon footprint and improve supply chain efficiency of an organization
- Assess the current status of renewable energy use and investment and develop strategies to become carbon negative in the next decade.
- Identify opportunities for sustainable alternatives for an environmental cause that aligns well with the organizational goal and areas of philanthropic investments


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- Analyze material use at different stages of organizational process based on a set of sustainable principles and suggest environment-friendly alternatives to reduce waste
- Calculate the water footprint of the organization and develop methods for mindful water consumption to improve human health and reduce the economic cost
- Examine the current status of infrastructure with respect to the energy-efficient lighting system and evolve strategies for shifting to 100% renewable energy
- Determine the ecological impact of current infrastructure using guiding principles of LEED (Leadership in Energy and Environmental Design) Certification and identify areas for biophilic design, green spaces, and work conditions
- Optimize to reduce waste by improved methods of handling and disposing of waste
- Develop guidelines for eco-friendly transportation to reduce fuel usage and maximize route efficiency
- Eco-innovation in developing energy alternatives and providing solutions to complex environmental challenges
- Document the biological wealth (especially plants, insects, and birds) of an organization and develop the green design to maintain and enrich the biological wealth

Teaching and learning interface for practical skills:

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Prospective sector(s):

(a) Environmental Consultancies, (b) Sustainability Advisors, (c) All Multi-National Large-Scale Industries, and (d) Environmental NGOs

Suggested readings

- Calkins, M., 2012. The Sustainable Sites Handbook: A Complete Guide to the Principles, Strategies, and Best Practices for Sustainable Landscapes (Vol. 39). John Wiley & Sons.
- Daniels, T., 2017. The Environmental Planning Handbook: For Sustainable Communities and Regions. Routledge.
- Davoudi, S., Cowell, R., White, I. and Blanco, H. eds., 2019. The Routledge Companion to Environmental Planning. Routledge.
- Quaddus, M.A. and Siddique, M.A.B. eds., 2013. Handbook of Sustainable Development Planning: Studies in Modelling and Decision Support. Edward Elgar Publishing.
- USEPA, 2012. Planning for Sustainability: A Handbook for Water and Wastewater Utilities.

Examination scheme and mode:

Evaluation scheme and mode II be as per the guidelines notified by the University of Delhi.

PCB Designing and Fabrication

CREDIT DISTRIBUTION, ELIGIBILITY AND PREREQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PCB Designing and Fabrication	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of the course are as follows:

- To give a comprehensive understanding and hands-on exposure to the various processes, industrial tools, protocols, and design specifics which are involved in PCB Designing
- To enable the students to design an electronic printed circuit board for a specific application using industry-standard software after going through the complete procedural steps of developing circuit schematic, board files, image transferring, assembly, soldering, and testing.

Learning Outcomes

After Studying this course, the student will be able to:

- Identify the various types of devices/components that may be mounted on PCB
- Understand the PCB layout techniques for optimized component density and power saving.
- Perform design and printing of PCB with the help of various image transfer and soldering techniques
- Understand the current trends and scope of the PCB industry

Syllabus

Practical

Unit 1: PCB Fundamentals

12 hours

PCB Advantages, components of PCB, Electronic components, Microprocessors and Microcontrollers, IC's, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer, and flexible boards, Manufacturing of PCB, PCB standards.

Unit 2 : Schematic & Layout Design

16 hours

Schematic diagram, General, Mechanical, and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for a library, Tracks, Pads, Vias, power plane, grounding.

Unit 3: PCB Design Processes

20 hours

Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper-clad laminates materials of copper-clad laminates, properties of laminates (electrical & physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing.

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techniques, Etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing, and quality controls.

Unit 4 : PCB Technology

12 hours

Introduction of PCB prototyping machines, Schematic Entry, PCB Parts creation, Auto Routing, Post Design, Brief overview of various models available, Recent Trends, and environmental concerns in the PCB industry.

Exercises

PCB Designing, Fabrication, Component Mounting and Testing using Standard Procedures (Hardware)

A. Analog Electronic Circuits

1. Verification of Thevenin theorem
2. Designing of RC Low Pass Filter and High Pass Filter circuits
3. To study current-Voltage characteristics of a p-n junction diode (forward bias and reverse bias)
4. Designing of Centre tapped full wave rectifier – without and with shunt capacitance filter.
5. Simple circuit to glow an LED
6. Design, fabrication, and testing of a 9 V power supply with Zener regulator
7. Design and study of voltage divider biasing.
8. Designing of a CE based amplifier of given gain

B. Digital Electronic Circuits

1. To verify and design AND, OR, NOT and XOR using NAND gates
2. Design a Half adder and Full Adder
3. Design a Half Subtractor and Full Subtractor

PCB Design Softwares recommended

- KiCAD (Open Source Electronics Design Automation Suite) <https://www.kicad.org/>
- EasyEDA (Online PCB Design Tool) <https://easyeda.com/>
- PADS - Siemens EDA (PCB Design Software) <https://eda.sw.siemens.com/en-US/pcb/pads/>
- Any other similar PCB designing software

Essential/recommended readings

- Printed Circuit Board – Design & Technology, Walter C. Bosshart, Tata McGraw Hill, 2008.
- Printed Circuit Board –Design, Fabrication, Assembly & Testing, R.S. Khandpur, First Edition, Tata McGraw-Hill Education Pvt. Ltd., 2005.
- Printed Circuit Board Design Using Autocad, Chris Schroeder, Newnes Publisher, 1998.
- Printed Circuits Handbook, Clyde F. Coombs, Jr, Happy T. Holden, Sixth Edition, Publisher: McGraw-Hill Education, 2016.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Electronic Product Testing

CREDIT DISTRIBUTION, ELIGIBILITY AND PREREQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Product Testing	2	0	0	2	Class XII	NIL

Course Learning Objectives

The Learning Objectives of the course are as follows:

- To enable students for testing of various electronic and electrical components and instruments such as diode, transistor, transformer, switches, fuses, cables, CRO, multimeters, voltmeter, ammeters etc.
- To give an insight upon the SMD and its soldering and de-soldering, EDS.
- To help students to have insight knowledge of SMPS, UPS and batteries along with maintenance of consumer electronics gadgets like computers, Audio Amplifiers, Induction Top, Solar Panel etc.
- To enhance their capabilities of assembling, fault diagnosis and rectification in a systematic way. To enrich students about reliability and quality control standards of equipment.

Course Learning Outcomes

After studying this course, the student will be able to:

- Test different types of electronic and electrical components and instruments.
- Practice soldering and de-soldering processes with correct methods.
- Testing of SMPS, UPS, Inverters and batteries.
- Identify faults in consumer electronics gadgets such as audio amplifiers, computers, Induction top, Microwave, solar panel.

Syllabus

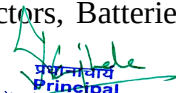
Practical

Unit 1 : Introduction

16 hours

Overview of Basic Measuring Instruments: CROs, Multimeter, Power supplies, LCR meter, Signal Generator and Power Analyzer.

Testing of various Devices: a) Semiconductor Devices: Single and Two junction Devices, Thyristor b) Electrical Devices: Transformers, relays, switches and fuses, cables and connectors, Batteries, Idea about ICs, PCBs, Sensors.


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Unit II : Soldering and Power Sources

16 hours

Basics of soldering: Soldering tools and materials (solder, flux), Types of soldering irons (Wattage, temperature, Tips), Soldering/ disordering station. Concept of ESD (Electrostatic discharge). The SMD (surface mounted Devices) and its soldering and de-soldering

Basics of SMPS (Switch Mode Power Supply), UPS (Uninterrupted power supply), batteries and Inverters along with their block diagram and Pin configuration of some important ICs used in it. Touch current and touch voltage.

Unit III : Appliance Testing and Computer Assembling

12 hours

Testing of Induction cook Top, microwave, Solar panel; Installation and Requirements, stand alone and Grid connected PV system.

Basics of computer assembling and testing. Brief description about its specifications and costing Factors.

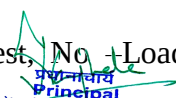
Unit IV : Reliability and Quality Standards

16 hours

Concept of Reliability: Scope, objectives and factors influencing equipment effectiveness, Acceptance Testing, Type Testing , Safety Testing, Identification of legends, symbols, color codes, Safety, safety standards, safety certificates (CE, UL and VDE), General awareness of quality standards, quality management systems & documentation, Idea of ISO 17025, ISO 9001, Calibration and Uncertainty of measurements, Effect of environmental testing(refer to IEC60068-1 for guidance), Awareness on disposal of Electronic waste

Exercises

1. An overview of testing of basic electronic / electrical components (BNC cable, switches and fuses, Capacitors, Inductors, Transformers, Relays, diodes, transistor, Thyristor, IC, Potentiometer etc.); Design a curve tracer on CRO for component testing.
2. Control the intensity and color of bi-Color LED with the help of POT, SPDT switch and 9V battery.
3. Soldering and De-soldering processes; SMD
4. Safety testing of SMPS (Applicable Standard: IS 14886).
 - a. Safety Testing (Earth Leakage current Test, Dielectric Test, Short Circuit Protection)
 - b. Performance Testing (Line Regulation, Load Regulation for a variation of Load Min to Max load and vice versa, Efficiency at nominal input and rated load)
5. Tubular Batteries (Applicable standard: IS 1651) Test for Capacity, Test for voltage during discharge
6. Personal Computer (Applicable Standard: IS 14896)
 - a. Safety Testing (Earth Leakage current Test, Dielectric Test) Performance Testing (Microprocessor used,
 - b. RAM expansion Capacity, Clock Rate and RAM Capacity, Effect of Power Supply variations)
7. Inverter (Applicable Standard: IS 13314)
 - a. Visual Inspection, High Voltage Test, Insulation Resistance Test, No -Load Test, Output Test


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8. UPS (Applicable Standard: IEC 62040-3)
 - a. Steady State Input Voltage Tolerance, Output-Normal Mode – No Load, Output-Normal Mode – Full Load, Output-Stored Energy Mode – No Load, Output- Stored Energy Mode – Full Load, Output-Normal Mode – Over Load, Output-Stored Energy Mode – Over Load Output-Normal Mode – Short Circuit, Output- Stored Energy Mode – Short Circuit, Efficiency and Input Power factor
9. Audio Amplifier (Applicable Standard: IEC 60065)
 - a. Audio frequency response at various power levels, Response to various inputs sources like DVD player, IPOD, CD player, etc., audio output power, Power Consumption, Voltage range
10. Solar Panel system: Testing and Efficiency

Suggested Readings

- Nutan Kala Joshi and Swati Nagpal, Basic Electronics with Simulations and Experiments, Khanna Publishers (2021)
- Jestine Yong, Testing Electronic Components (2007)
- Mark de Vinck, Make Getting Started with Soldering; A Hands-on Guide to Making Electrical and Mechanical Connections, Maker Media (2017)
- Mike Judd and Keith Brindley, Soldering in Electronics Assembly, Second Edition, Elsevier (1999)
- Jestine Yong, Troubleshooting Repairing Switch Mode Power Supplies (1995)
- David Griffith, Uninterruptible Power Supplies, CRC Press (1989)
- Thomas Reddy, Lindens Handbook of Batteries, 4th Edition, McGraw Hill
- Kevin Wilson, Essentials Computer Hardware; The Illustrated Guide to Understanding Computer Hardware, Elluminet Press (2018)
- N.S. Reddy, PC Hardware Maintenance and Troubleshooting, NEO Publishing House (2016)
- Handbook of Induction Heating Second Edition Valery Rudnev, Don Loveless, Raymond L. Cook, CRC Press Taylor & Francis Group (2017)
- R. G. Gupta, Audio and Video systems, Tata McGraw Hill (2004)
- A.R. Jha, Solar Cell Technology and Applications, CRC Press (2009)
- Statistical Applications in Process Control (Quality and Reliability), J. Bert Keats, Douglas C. Montgomery, CRC Press (1996)
- Reliability and Quality Management , Ankitsandilya (Author), R.C.Mishra , New Age International Private Limited. (2009)
- E-Waste Management Challenges and Opportunities in India, Varsha Bhaga Ganguly, Routledge India (2021)

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Radiation Safety

Course Title and Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Radiation Safety	2	1	0	1	Class XII pass with Physics and Mathematics as main subjects	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To focus on the applications of nuclear techniques and radiation protection.
- To not only enhance the skills towards the basic understanding of the radiation but also provide the knowledge about the protective measures against radiation exposure.
- To impart all the skills required by a radiation safety officer or any job dealing with radiation such as X-ray operators, jobs dealing with nuclear medicine: chemotherapists, operators of PET, MRI, CT scan, gamma camera etc.

Learning Outcomes:

After studying this course, the student will be able to:

- Understand and use the applications of nuclear techniques and radiation protection to guard against nuclear radiation hazards.
- Understand and use the units of radiations and their safety limits, the devices to detect and measure radiation.
- Understand and use radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards,
- Use the devices which apply radiations in medical sciences, such as X - r a y, MRI, PET, CT-scan with the required safety measures.

SYLLABUS

THEORY COMPONENT

Unit 1:

6 hours

Radiation and its interaction with matter: Basic idea of different types of radiation electromagnetic (X-ray, gamma rays, cosmic rays etc.), nuclear radiation and their origin.

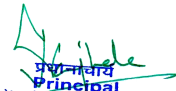
Nuclear Radiation: Basic idea of Alpha, Beta, Gamma neutron radiation and their sources (sealed and unsealed sources).

Interaction of Charged Particles (including alpha particles): Heavy charged particles (e.g. accelerated ions) - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling.

Interaction of Beta Particles: Collision and Radiation loss (Bremsstrahlung).

Interaction of Photons: Linear and Mass Attenuation Coefficients.

Interaction of Neutrons: Collision, slowing down and Moderation.


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Unit 2:**4 hours**

Radiation detection and monitoring devices: Basic concepts and working principle of gas detectors, Scintillation Detectors, Solid State Detectors and Neutron Detectors, Thermo- luminescent Dosimetry.

Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, annual limit of intake (ALI) and derived air concentration (DAC).

Unit 3:**2 hours**

Radiation Units, dosage and safety management: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, annual limit of intake (ALI) and Derived air concentration (DAC).

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards, its evaluation and control: radiation protection standards.

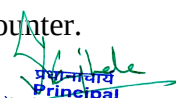
Unit 4:**3 hours**

Application of radiation as a technique: Application in medical science (e.g., basic principles of X-rays, MRI, PET, CT scan, Projection Imaging Gamma Camera, Radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterilization, Food preservation.

PRACTICAL**30 hours**

Minimum five experiments need to be performed from the following, graphs to be plotted using any graphical plotting software

- 1) Estimate the energy loss of different projectiles/ions in Water and carbon, using SRIM/TRIM etc. simulation software, (different projectiles/ions to be used by different students).
- 2) Simulation study (using SRIM/TRIM or any other software) of radiation depth in materials (Carbon, Silver, Gold, Lead) using H as projectile/ion.
- 3) Comparison of interaction of projectiles with $Z_P = 1$ to 92 (where Z_P is atomic number of projectile/ion) in a given medium (Mylar, Carbon, Water) using simulation software (SRIM etc).
- 4) SRIM/TRIM based experiments to study ion-matter interaction of heavy projectiles on heavy atoms. The range of investigations will be $Z_P = 6$ to 92 on $Z_A = 16$ to 92 (where Z_P and Z_A are atomic numbers of projectile and atoms respectively). Draw and infer appropriate Bragg Curves.
- 5) Calculation of absorption/transmission of X-rays, γ -rays through Mylar, Be, C, Al, Fe and $Z_A = 47$ to 92 (where Z_A is atomic number of atoms to be investigated as targets) using XCOM, NIST (<https://physics.nist.gov/PhysRefData/Xcom/html/xcom1.html>).
- 6) Study the background radiation in different places and identify the source material from gamma ray energy spectrum. (Gamma ray energies are available in the website <http://www.nndc.bnl.gov/nudat2/>).
- 7) Study the background radiation levels using Radiation meter.
- 8) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
- 9) Study of counting statistics using background radiation using GM counter.
- 10) Study of radiation in various materials (e.g. KSO₄ etc.). Investigation of possible radiation in different routine materials by operating GM counter at operating voltage.
- 11) Study of absorption of beta particles in Aluminum using GM counter.
- 12) Measurement of gamma ray attenuation co-efficient of aluminium using GM counter.
- 13) Estimation of half thickness for aluminium using GM Counter.


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Essential Readings:

- Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999.
- Nuclear Physics by S N Ghoshal, First edition, S. Chand Publication, 2010.
- Nuclear Physics: Principles and Applications by J Lilley, Wiley Publication, 2006.
- Fundamental Physics of Radiology by W J Meredith and B Massey, John Wright and Sons, UK, 1989.
- An Introduction to Radiation Protection by A Martin and S A Harbisor, John Willey and Sons, Inc. New York, 1981.

Suggestive Readings:

- Radiation detection and measurement by G F Knoll, 4th Edition, Wiley Publications, 2010.
- Techniques for Nuclear and Particle Physics experiments by W R Leo, Springer, 1994.
- Thermoluminescence dosimetry by A F Mckinlay, Bristol, Adam Hilger (Medical Physics Hand book 5
- Medical Radiation Physics by W R Hendee, Year book Medical Publishers, Inc., London, 1981.
- Physics and Engineering of Radiation Detection by S N Ahmed, Academic Press Elsevier, 2007.
- IAEA Publications: (a) General safety requirements Part 1, No. GSR Part 1 (2010), Part 3 No. GSR Part 3 (Interim) (2010); (b) Safety Standards Series No. RS-G-1.5 (2002), RS-G-1.9 (2005), Safety Series No. 120 (1996); (c) Safety Guide GS-G-2.1 (2007).

References (for Laboratory Work):

- Schaum's Outline of Modern Physics, McGraw-Hill, 1999.
- Schaum's Outline of College Physics, by E. Hecht, 11th edition, McGraw Hill, 2009.
- Modern Physics by K Sivaprasath and R Murugesan, S Chand Publication, 2010.
- AERB Safety Guide (Guide No. AERB/RF-RS/SG-1), Security of radioactive sources in radiation facilities, 2011
- AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed Radioactivity Sources., 2007.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Healthy and Sustainable Food Choices

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Healthy and Sustainable Food Choices	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To identify healthier food options
- To understand portion control for foods
- To demonstrate skill for preparing healthy and nutritious dishes
- To link sustainability with healthy food choices

Learning Outcomes

After studying this course, the student will be able to:

- Select and prepare healthier food options
- Relate the influence of food environment on food choices
- Comprehend the importance of sustainable food choices

SYLLABUS

Unit 1: Healthy food choices

12 hours

Identification of healthy and unhealthy foods and Understanding the immediate food environment

- Food labels and basics of nutrient profiling models to classify foods as HFSS
- Nutrient profiling of commonly consumed food items
- Exploring the food environment by mapping the food outlets and food available near home and college

Unit 2: Food portion sizes and related factors**12 hours**

Understanding food portion sizes and its relation to nutrient density

- The concept of portion/serving sizes and portion control
- Estimation of energy and nutrient density of selected food products using nutrient composition database

Unit 3: Basics of food preparation**20 hours**

Planning and preparation of healthy and nutritious dishes

- Planning and preparation of the following:
 - Snacks
 - Soups and Salads
 - Desserts
 - Meal combinations

Unit 4: Sustainability and healthy food**16 hours**

Linking the concept of healthy eating with sustainability

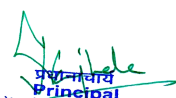
- Identification of nutritious food sources which have minimal impact on the environment
- Case study on understanding food supply chain and carbon footprints of any commonly consumed foods

Essential/Recommended readings

- Chadha R and Mathur P (2015). Nutrition - A Lifecycle Approach. New Delhi: Orient Blackswan Pvt Ltd.
- Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K (2017). Indian Food Composition Tables. National Institute of Nutrition, Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India, Hyderabad.
- Khanna K, Gupta S, Seth R, Mahna R, Rekhi T (2004). The Art and Science of Cooking: A Practical Manual, Revised Edition. New Delhi: Elite Publishing House Pvt Ltd.
- Raina U, Kashyap S, Narula V, Thomas S, Suvira, Vir S, Chopra S (2010). Basic Food Preparation: A Complete Manual, Fourth Edition. Hyderabad: Orient Black Swan.

Suggestive readings

- HLPE. 2017. Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. <https://www.fao.org/3/i7846e/i7846e.pdf>
- Agarwal P and Mathur P (2021). Eat Right - A Food Systems Approach . New Delhi: Food Future Foundation
- NIN-ICMR. Food Based Dietary Guidelines for Indians

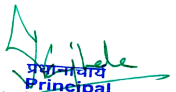


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Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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CHOCOLATE CRAFTS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chocolate Crafts	2	1	0	1	Class XII	NIL

LEARNING OBJECTIVES:

This Skill Enhancement Course enables student to understand the basic principles, hygiene and precautions of chocolate cookery. The emphasis of this will be to develop the skill required for preparation of various chocolates and its packaging and marketing.

The learning objectives of the course are:

- To learn the skill to craft different types of chocolates
- To learn the basic principles, hygiene and precautions of chocolate crafting and entrepreneurship in chocolate industry.

LEARNING OUTCOMES

After studying this course, the student will be able to:

- Have the understanding of different chocolates and acquire the skill to handle them.
- Develop the abilities and showcase skills for preparation of molded, center filled, free hand cluster, chocolate accessories, garnishes and ancillary chocolate recipes
- Get acquainted with techniques of packaging, costing and marketing of chocolates.
- Gain knowledge and skill to start small scale chocolate enterprise

SKILL DEVELOPMENT AND JOB OPPORTUNITIES':

Employment Opportunities:

- Apprentice in Small Catering units/ Kiosk/ Restaurant
- Entrepreneurship in chocolate industry
- Food Stylist / Designer

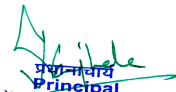
SYLLABUS

Credits: 2

Total lectures (45): 45 Hours/ 15 weeks

Theory: 30%, Credit – 1 (Lectures – 15)

Practical/ Field work/ Hands on learning: 70%, Credit – 1 (Lectures – 30)


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THEORY

Unit 1: Introduction to Chocolates

(7 hours)

Description: The focus of this unit is on chocolates, various aspects of chocolate processing and learning the precautions to make good chocolates.

Subtopics:

- Chocolates: history and types of compound and couverture chocolates.
- Processing of cocoa bean to manufacture chocolate liquor, cocoa butter, cocoa powder, chocolate and chocolate chips.
- Precautions and hygiene practices while handling chocolate.

Unit 2: Applications of Chocolates

(8 hours)

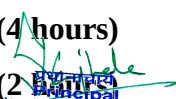
Description: The focus of this unit is on using the chocolates to make different products, understanding and rectifying the faults.

Subtopics:

- Molded, center filled, free hand clusters, garnishes and accessories.
- Recipe development, costing and packaging of chocolates.
- Faults in chocolates like sugar bloom and fat bloom, their reasons and correction. temperature and moisture control while handling chocolate.

PRACTICALS

1. Introduction to different kinds of chocolates: Compound and Couverture; their sensory analysis and mouth feel. (2 hours)
2. Market survey of Indian and Internationally made chocolates with respect to label reading (ingredients). (2 hours)
3. Equipment's (molds, scrapers, piping bags, nozzles, cooking thermometers, microwave, double boiler) and precautions to be used in handling chocolate. (2 hours)
4. Making molded compound chocolate. (2 hours)
5. Variations of molded chocolates. (2 hours)
6. Making center filled chocolate. (2 hours)
7. Variations of center filled chocolate (2 hours)
8. Making free hand chocolate clusters. (2 hours)
9. Making chocolate accessories and garnish. (4 hours)
10. Ancillary chocolate recipes like chocolate sauce, ganache and hand (2 hours)


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rolled truffles.

- | | |
|--|-----------|
| 11. Tempering of couverture chocolate. | (2 hours) |
| 12. Packaging and labeling of chocolates. | (2 hours) |
| 13. Visit to chocolate factory or chocolate exhibition and sale trial. | (4 hours) |

ESSENTIAL READINGS

- Afoakwa E.O. (2013). Chocolate Science and Technology, Wiley India Pvt Ltd, 978-8126545735.
- Beckett S.T. (2018). The Science of Chocolate, Royal Society of Chemistry, 978-1788012355.
- Minifie B.W. (1999). Chocolate, Cocoa and Confectionary, Aspen Publication. 978-0834213012.
- Manay, S. & Shadaksharaswamy, M. (2020). Foods: Facts and Principles, New Age Publishers. 978-8122422153.
- Panda, H. (2012). Technology of Confectionery, Chocolates, Toffee, Candy, Chewing & Bubble Gums, Lollipop and Jelly Products with Formulations, Engineers India Research Institute publisher. 978-9380772165.

SUGGESTED READINGS:

- Hodge N. (2018). The Art and Craft of Chocolate, Quarry Books, 978-1631594663.
- Perry S. (2008). Deep Dark Chocolate, Chronicle Books. 978-0811860895.
- Panda, H. (2017). Start Your Own Confectionery and Chocolate Products with Manufacturing and Formulations Hand Book, Bio-Green Books publisher. 978-9380772844.
- Greweling, P.P. (2012). Chocolates and Confections: Formula, Theory, and Technique for the Artisan Confectioner, The Culinary Institute of America (CIA), Wiley; 2nd edition, 978-0470424414.
- Shaffer, K. (2019). Chocolate for Beginners: Techniques and Recipes for Making Chocolate Candy, Confections, Cakes and More, Rockridge Press Publishers, 978-1641528887.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

PASTA AND PATISSERIE TECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pasta And Patisserie Technology	2	1	0	1	Class XII	NIL

Learning Objectives

This Skill Enhancement Course is about developing an understanding and skill about the types, role of ingredients, processing/production, innovations, sensory attributes and quality assessment of Pasta and Patisserie. The student can also study SEC on Bakery Enterprise, Food Business and Cafeteria Management to enhance scope of work opportunities.

The learning objectives of the course are:

- To provide students with basic knowledge of pasta technology.
- To familiarize students with patisserie technology/ skill.

Learning Outcomes

After studying this course, the student will be able to:

- Develop understanding of the pasta and patisserie technology.
- Acquire skill to prepare different pasta and patisserie.
- Work in specialized pasta and patisserie outlets such as restaurants, food courts, kiosks, fast food centers as well as in large institutions such as hotels, hospitals and food processing units.

SKILL DEVELOPMENT AND JOB OPPORTUNITIES’:

Employment Opportunities:

- Apprentice in Small Catering units/ Kiosk/ Restaurant
- Entrepreneurship in pasta and patisserie technology
- Food Stylist / Designer for pasta and patisserie

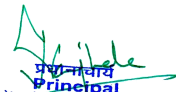
SYLLABUS

Credits: 2

Total lectures (45): 45 Hours/ 15 weeks

Theory: 30%, Credit – 1 (Lectures – 15)

Practical/Field work/Hands on learning: 70%, Credit – 1 (Lectures – 30)


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THEORY

Unit 1: Introduction to Pasta

(7 hours)

Description: This unit will include history of pasta , types of pasta, pasta making tools and equipment and understanding different sauces for preparing pasta dishes

Subtopics:

- History and types of pasta: packaged and handmade.
- Types: names and shapes of pasta.
- Tools and equipment commonly used for manufacturing pasta and preparing pasta dishes.
- Different types of sauces used for preparing pasta dishes: Tomato sauce, Béchamel, Bolognese, pesto and aglio olio.

Unit 2: Introduction to Patisserie

(8 hours)

Description: This unit is about different types of Patisserie like short crust pastry, choux pastry, puff pastry, sponge cake, shortened travel cakes, cheese cakes, cookies, brownies and biscotti.

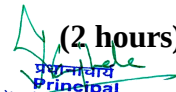
Subtopics:

- Short crust Pastry: Tarts and Pies
- Choux Pastry: Eclairs, Profiteroles.
- Puff Pastry: Patties, French Hearts, Vol au vents.
- Sponge cake and its decoration techniques.
- Shortened travel cakes and its variations.
- Cheesecakes with different toppings.
- Cookies, Brownies and Biscotti.

PRACTICALS

30 hours

1. Market survey of Packaged Pasta and patisserie. (2 hours)
2. Orientation and handling of the tools and equipment used in Pasta making (mechanical pasta roller and cutter, rolling pins, serrated knives, ravioli cutters, drying rack and drying trays, stock pots, pans). (2 hours)
3. Making the Pasta dough, shaping Pasta (Fettuccine, Farfalle, Macaroni, Noodles, Spaghetti, Vermicelli), drying and storage. (4 hours)
4. Making Stuffed Pasta: Ravioli with fillings like spinach and Ricotta Cheese; herbed cream cheese. (2 hours)
5. Making Sauces: Tomato, Bechamel, Pesto and preparing Pasta dishes with them. (2 hours)


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6. Making Baked Pasta: Mac n cheese and Lasagna. (2 hours)
7. Preparation of short crust pastry: Tarts or Pies (2 hours)
8. Preparation of Choux pastry: Eclairs or Profiteroles. (2 hours)
9. Preparation of Puff pastry: Patties/ Vol au vents/ French Hearts (4 hours)
10. Preparation of cakes (sponge cake/shortened cake) and their variations/decoration with whipped cream frosting. (4 hours)
11. Preparation of Cheesecake with fruit compote topping. (2 hours)
12. Preparations of Brownies or biscotti (2 hours)

ESSENTIAL READINGS:

- Karr, N. (2016). Handmade Pasta Workshop & Cookbook: Recipes, Tips & Tricks for Making Pasta by Hand, with Perfectly Paired Sauces. US : Page Street Publishing .<https://amzn.eu/d/6skTmuM>(ISBN 10-1624143229, ISBN 13-978-1624143229)
- Donnelly, K. (2021). The Artisan Pasta Cookbook: The Step by Step Guide with Flavorful Recipes for Mastering Handmade Pasta, Noodles, Gnocchi and Risotto at Home. Oksana Ali Aleksandrova . <https://amzn.eu/d/dFir9Zx>(ISBN 10-195460503X , 13-978-1954605039)
- Juillet, C. (1998). Classic Patisserie: An A-Z handbook. CBS publishers and distributors pvt. Ltd. <https://amzn.eu/d/5RC7hja>(ISBN 10-075063815X, ISBN 13-978-0750638159)
- Rippington, N. Baker, C. Burke, M (2013). Professional Patisserie: For Levels 2, 3 and Professional Chefs. Hodder Education; UK <https://amzn.eu/d/352HVZy>
(ISBN-10: 1444196448, ISBN-13: 978-1444196443)

SUGGESTED READINGS:

- Dubey, S. C. (2016). Basic Baking - Science and Craft. Delhi: Society of Indian Bakers.
- Dubey, S. C. (2009). Bakery Vigyan. Delhi: Society of Indian Bakers
- Ketrapaul, N., Grewal, R.B., & Jood, S. (2005). Bakery Science and Cereal Technology. Delhi: Daya Publishing House.
- Edward, W. P. (2007). The Science of Bakery Products. Cambridge: RSC Publishing.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

FROZEN DESSERT TECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Frozen Dessert Technology	2	1	0	1	Class XII	NIL

LEARNING OBJECTIVES

This course will help learners be equipped with the skills of developing, packaging, innovating and marketing of frozen desserts like ice creams, sorbets, ice popsicles, yoghurts, traditional *kulfi*, etc. During the past decade, the frozen food industry has grown, with an array of innovations in ice-creams, frozen yogurt, gelato and traditional desserts such as *shrikhand*. There is vast scope for the development of lower-fat, reduced-sugar products which may lead to increased sales. This course will equip the students with knowledge and skills necessary to work in the frozen food industry.

The learning objectives of the course are:

- To learn basic concepts on processing, distribution and storage of frozen desserts
- To develop the skill of preparing various types of frozen desserts

LEARNING OUTCOMES

After studying this course, the student will be able to:

- Prepare/ process/pack/handle/sell different types of frozen desserts
- Work in frozen food industry or start own business – manufacturing, distribution and retail.

SKILL DEVELOPMENT AND JOB OPPORTUNITIES’:

Employment Opportunities:

- Apprentice, supervisor, processor in frozen food manufacturing units/ distribution and retail outlets
- Entrepreneurship in frozen food industry
- Food Stylist / Designer for frozen desserts

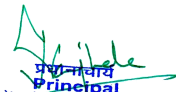
SYLLABUS

Credits: 2

Total lectures (45): 45 Hours/ 15 weeks

Theory: 30%, Credit – 1 (Lectures – 15)

Practical/Field work/Hands on learning: 70%, Credit – 1 (Lectures – 30)


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THEORY

Unit 1: Food Freezing

(7 hours)

Description: This unit will give an introduction to the concept of frozen foods/industry, their properties. It will also include the various equipments, freezing systems/methods which can be used to process, store and maintain cold chain during distribution.

Subtopics:

- Background, description and properties of frozen foods
- Freezing time
- Equipment and Freezing systems (direct and indirect contact)
- Act, regulations and standards

Unit 2: Frozen Desserts

(8 hours)

Description: This unit will focus on salient types of frozen desserts; both milk based as well as water based. It will include the composition, physical properties, processing, storage, freezing, common defects, packaging.

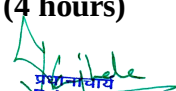
Subtopics:

Subtopics:

- Definitions and important terminology
- Ice-cream – composition, physical properties, processing, storage, freezing, common defects, packaging
- Ice based sherbets, sorbets, ice candies, popsicles
- Other frozen desserts – frozen yogurt, *shrikhnad*, mellorine, parevine, ice-cream sandwiches
- Future trends (novelties)

PRACTICALS

1. Market survey of frozen desserts and accessories and basics of working in food lab. (2 hours)
2. Preparation, packaging, labeling and sensory evaluation of vanilla ice cream (4 hours)
3. Preparation, packaging, labeling and sensory evaluation of any fruit based ice cream (mango, strawberry, pineapple etc.) (4 hours)
4. Preparation, packaging, labeling and sensory evaluation of Kulfi or nuts and fruit ice cream (4 hours)
5. Preparation, packaging, labeling and sensory evaluation of ice cream with egg or gelato or frozen custard (4 hours)
6. Preparation, packaging, labeling and sensory evaluation of ice cream sandwich or novelties (4 hours)
7. Preparation, packaging, labeling and sensory evaluation of ice-lolly/ popsicles/ ice-candies (4 hours)
8. Preparation, packaging, labeling and sensory evaluation of *Shrikhand* or frozen yogurt (4 hours)


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ESSENTIAL READINGS

- Raina, U., Kashyap, S., Narula, V., Thomas, S., Suvira, Vir, S., & Chopra, S. (2005). Basic Food Preparation – A Complete Manual. Delhi: Orient Longman.
- Khanna, K., Gupta, S., Seth, R., Mahana, R., & Rekhi, T. (2004). The Art and Science of Cooking. Delhi: Phoenix Publishing House Private Limited.
- Migoya, MJ. (2008). Frozen Desserts. First Edition. John Wiley and Sons Inc.
- Food Safety and Standards Authority of India (FSSAI). (2011). Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011. Compendium on Food Additives Regulations. Elite Publishers. Pgs. 877.
- Food Safety and Standards Authority of India (FSSAI). (2019). FSSAI regulations on frozen desserts.

Website: https://www.fssai.gov.in/upload/media/FSSAI_News_Ice_FNB_22_05_2019.pdf.

SUGGESTED READINGS:

- Clarke, C. (2004). The Science of Ice Cream. The Royal Society of Chemists.
- De, S. (2001). Outlines of Dairy Technology. First Edition. Oxford Publishing House.
- Francis, F.J. (2010). Encyclopedia of Food Science and Technology. Volume 2. Second Edition. John Wiley & Sons.
- Goff, H.D. & Hartel, R.W. (2008). Ice Cream. Seventh Edition. Springer.
- Himadri, P. (2010). Handbook on Frozen Food Processing and Freeze Drying Technology. First Edition. Engineers India Research Institute.
- Jana, A., Pinto, S. & Moorthy, P.R.S. (2016). Ice Cream and Frozen Desserts. AgriMoon.com Publishing. Website: <https://www.agrimoon.com/wp-content/uploads/Ice-cream-Frozen-Dessrt.pdf>.
- Rorer, S.T. (2005). Ice Creams, Water Ices, Frozen Puddings Together with Refreshments for All Social Affairs. First Edition. Project Gutenberg. Website: <https://www.gutenberg.org/ebooks/8501>.
- Stogo, M. (2018). Ice Cream and Frozen Desserts: A Commercial Guide to Production and Marketing. John Wiley & Sons.
- Tharp, B.W. & Young, L.S. (2012). Tharp and Young on Ice Cream: An Encyclopedic Guide to Ice Cream Science and Technology. First Edition. DEStech Publications Inc.
- Weinstein, B. (2010). The Ultimate Ice Cream Book. First Edition. Perfect Bound Publishing House. Website: <https://www.pdfdrive.com/the-ultimate-ice-cream-book-over-500-ice-creams-sorbets-granitas-drinks-and-more-e184459836.html>.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Early Child Care and Education Settings

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Early Child Care and Education Settings	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the significance of early childhood years and the importance of ECCE
- To understand developmental milestones and delays in development
- To plan, organize and create care facilities and developmentally appropriate material for infants and young children.
- To be acquainted with the ECCE centre, its daily routine, requirements, functioning and evaluation of the programme.
- To trace the progression of children in early childhood setting

Learning outcomes

After studying this course, the student will be able to:

- Explain the significance of early childhood development and ECCE
- Become familiar with developmental milestones and learn to assess children in early years.
- Understand, plan and organize care activities for young children
- Prepare activities and aids for fostering development in the early years
- Learn about evaluation of an ECCE programme

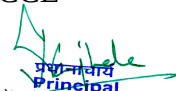
SYLLABUS

Unit 1: Importance of early years and significance of ECCE

20 hours

The unit will help to develop an understanding on the concept and importance of ECCE

- Meaning and objectives of ECCE and importance of early years


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- Norms and developmental milestones of infants and young children
- Observations, developmental checklists and developmental delays
- Nurturing care framework and early childcare practices
- Review of existing ECCE programmes and policies in India

Unit 2: Developmentally appropriate activities for young children

20 hours

The unit will focus on ways to promote development during early years through play and exploratory activities.

- Care and stimulation activities for infants and young children
- Plan and prepare multi-sensory materials and activities to promote development across domains: Physical motor, socio-emotional, cognitive and language development
- Use of music, dance, drama, storytelling, puppetry, rhymes/poems and art and craft
- Importance of- Indoor and outdoor activities; individual and group activities; free play and guided play; circle time
- Activities for school readiness

Unit 3: Components of ECCE Programme

20 hours

The unit will focus on the understanding of infrastructure, materials and equipment, curriculum development and assessing the development of children.

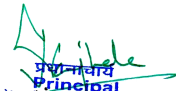
- Daily routines in child care and preschool centres
- Creating safe spaces for children: Organizing indoor and outdoor material and equipment
- Understanding the ECCE curriculum: Developing daily, weekly and monthly plans
- Assessing children's development across domains
- Indicators of a quality ECCE centre

Essential/Recommended Readings

- ECCE National Curriculum Framework-
https://wcd.nic.in/sites/default/files/national_ecce_curr_framework_final_03022014%20%282%29.pdf
- Managing Children's Programmes: Some Perspectives. Indira Gandhi National Open University DECE Study Material. <http://www.ignouhelp.in/ignou-dece-study-material/>
- Morrison, G. S. (2018). Early Childhood Education Today. Pearson
- National Education Policy 2020-
education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- Organizing a Child Care Centre. Indira Gandhi National Open University DECE Study Material
- Soni, R. (2015). Theme Based Early Childhood Care and Education Programme: A Resource Book. National Council of Educational Research and Training.
- Swaminathan, M. (1998). The First Five Years. Sage Publications

Suggestive Readings

- Aggarwal, J. C. (2007). Early Childhood Care and Education: Principles and Practices


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Shipra: New Delhi.

- Arni, K. and Wolf G. (1999). Child Art with Everyday Materials. TARA Publishing.
- Mohanty, J. Mohanty, B. (1996). Early childhood care and Education. Deep and Deep Publication, New Delhi.
- Morrison, G. S. (2003). Fundamentals of early childhood education. Merrill/Prentice Hall:
- Play Activities for Preschoolers – 1 and 2. Indira Gandhi National Open University DECE Study Material
- Virginia Singh, A. (1995). Playing to Learn: A training manual for Early Childhood Education. M. S. Swaminathan Research Foundation.

Note: Learners are advised to use the latest edition of readings

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Image Styling

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Image Styling	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To strengthen the student's hands on experience in using different tools of improving the visual and non-visual appearance
- To train the students with technical and professional ways of understanding wardrobe needs and their development
- To develop skills in understanding fashion trends for planning personal shopping .

Learning Outcomes

After studying this course the student will be able to:

- Demonstrate the practical ways to strengthen physical image based on body type, face shape and personal style analysis.
- Understand the effect of elements and principles of design on visual appearance.
- Explain the fashion trends of apparel and accessories.
- Identify wardrobe elements and the processes of planning and organization.
- Plan personal shopping of apparel and accessories based on physical traits, personal style and budget.

SYLLABUS

Practical

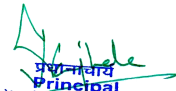
Unit 1: Physical traits and analysis

16 hours

Learning the first step in styling by developing skills to analyze individual characteristics such as body type, proportions, face shapes etc.

Subtopics:

- Body types
- Body proportion
- Face shapes
- Personal colour analysis


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Unit 2: Application of elements and principles of design for image styling

16 hours

Understanding the basics of design by learning about the various elements and principles of design, their role in the success of a design, and their importance in personal styling.

Subtopics:

- Effects of design elements and principles on clothing and visual appearance
- Effect of garment components on visual appearance

Unit 3: Wardrobe planning

12 hours

Learning the skills of wardrobe planning, analysis and management as per apparel and accessory needs.

Subtopics:

- Wardrobe analysis
- Wardrobe essentials
- Organization and categorization of wardrobe
- Elements of a basic wardrobe
- Optimising wardrobe and budgeting

Unit 4: The business of styling

16 hours

Understand the working of styling business. Developing the art of styling. Analyzing the present market trends.

Subtopics:

- Dress vs Style
- Analysis of trends of apparels and accessories
- Survey of apparel and accessory stores/ brands with respect to style, size and price.
- Types of stylists: Freelance stylists, Celebrity stylists, Editorial stylists
- Marketing your business
- Forms and Contracts

Essential Readings

- Constantine, S. & Woodall, T. *The Body Shape Bible: Forget Your Size Discover Your Shape Transform Yourself*, published by Weidenfeld & Nicolson (1977), ASIN: B01K14NWB8
- Funder, D.C. 2001, *The Personality Puzzle (2nd ed)*, New York: W.W. Norton
- Phares, J.E. 1991, *Introduction to Personality (3rd ed)*, New York: Harper Collins
- Rasband, J. *Wardrobe Strategies for Women*, published by Fairchild Books; Student edition (September 18, 2001), ISBN-10: 1563672596

Suggested Readings

- Baumgartner, J. *You are What You Wear*, Da Capo Press (2012)
 - Mc Call, *Sewing in Color*, Hamlyn Publishing Group 11th edition (1975)
 - Romano, C. *Plan your Wardrobe*, New Holland Publishers (1998)
- Vega, L. *The Image of Success*, American Management Association (2010)

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Content Development and Media for Children

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Content development and Media for Children	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To explore and review current trends in media and content for children
- To plan developmentally appropriate media and content for children
- To create culturally appropriate content for learning

Learning Outcomes

After studying this course, the student will be able to:

- Identify forms of content and media available for children
- Understand the impact of content and media on thoughts, attitudes and values of children
- Create age-appropriate content and media for children

SYLLABUS

Unit 1: Content for children: Relationship and interaction

20 hours

This unit will cover the different forms of content available to children and will create a linkage between children, content and context

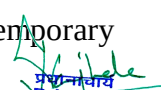
- Exploring different forms of content for children (exposure to history and folk forms)
- Children's usage and significance of print, audio visual content
- Review and analysis of available content for children
- Enabling parents/caregivers to be able to use content appropriately with children

Unit 2: Media for Children

20 hours

This unit will discuss the different forms of media available to children in the contemporary context and also focus on advances in media technology

- Different media forms available for children


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- Children's use and significance of media forms
- Assessing the portrayal of children in media; assessing the quality of Print, App or TV program, website, film
- Media literacy for children, parents and caregivers

Unit 3: Developing content and media for children

20 hours

This unit will enable students in developing content and media for children.

- Scripting for children: content and structure; Literature for and by children; Writing stories/poems for children (significance of humour, wonder, logic)
- Music/ Dance/Theatre/puppetry as sources for content development and dissemination
- Creating age-appropriate content for:
 - Developmental and domain specific needs
 - Children activity box/ Preschool Kit
 - Interactive Mobile applications/Digital content

Essential readings

- Condry, J. (1989). *The Psychology of Television*. Lawrence Erlbaum, Associates, Inc.
- Daniel, A.K. (2012). *Storytelling across the Primary Curriculum*. London: Routledge.
- Engel, S. (1999). *The Stories Children Tell: Making Sense of the Narratives of Childhood*. USA: W.H.. Freeman and Company.
- Honig, A. (1983). *Television and young children*. Young children 38(4).
- Joshi, P. & Shukla, S. (2019). *Child development and education in the twenty-first century*. Singapore: Springer International.
- Livingstone, S. (2002). *Young People and New Media*. New Delhi: Sage
- Prakash, S. & Mathur, P. (2000). *Children and TV*. NCERT,
- Real, M. R. (1996). *Exploring Media Culture*. New Delhi: Sage
- Singer D.G. & Jerome L. (2012). *Handbook of Children and Media*. California: Sage.

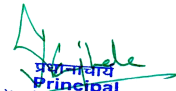
Suggestive Readings:

- Calvert, S.L. & Wilson, B.J. (2008). *The Handbook of Children, media and Development*. United Kingdom: Blackwell Publishing.
- Jordan, A.B. & Romer, D. (2014). *Media and the Well-Being of Children and Adolescents*. New York: Oxford University Press.

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Small Scale Catering

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Small Scale Catering	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To comprehend fundamentals of menu planning through management of resources in a food service establishment.
- To develop insight for recipe standardization and to apply acquired skills in menu planning and quantity food production.
- To use knowledge of preliminary steps for starting a small-scale catering unit.

Learning Outcomes

After studying this course, the student will be able to:

- Comprehend fundamentals of menu planning through management of resources in a food service establishment.
- Develop insight for recipe standardization.
- Apply acquired skills in menu planning and quantity food production
- Use the knowledge of preliminary steps for starting a small-scale catering unit.

SYLLABUS

Unit 1: Introduction to Food Service

12 hours

Kinds of food service establishments, kinds of food service outlets

- Market survey of various food products raw and processed in different kinds of markets.
- Survey of a nearby small-scale catering unit

Unit 2: Food Production

32 hours

- Menu planning: Importance of menu, factors affecting menu planning, types of menus, menu planning for different kinds of food service units, features of good menu card
- Basics of food purchase, receiving and storage
- Quantity food production: standardization of recipes, quantity food preparation techniques, recipe adjustments and portion control
- Hygiene and Sanitation

- Planning menus within specified budget for the following:
 - Menu for a birthday party/ nursery school.
 - Packed tiffin lunch for MNC employees.
 - Cyclic menu for catering breakfast, lunch and dinner for PG/ hostel girls.
 - Evaluation of menu card
 - Visit to a small-scale catering unit
 - Use of computers in inventory and billing
 - Standardization of a recipe
 - Scaling up of recipe for large number of customers (75)
 - Food stall/ event catering
 - Demonstration of specific dishes for entrepreneurial set up
 - Use of checklist to assess implementation of good hygiene and sanitation practices in a small-scale catering unit

Unit 3: Planning of a Food Service Unit

16 hours

- Preliminary planning: survey of types of units, identifying clientele, menu, operations and delivery
- Planning the set up:
 - Identifying resources (money, manpower, time, facilities, equipment, utilities, types of kitchen areas, flow of work and work area relationship), types of services and delivery system, business registration
 - Basics of Finance (Components of cost and factors affecting them, determining the selling price)
- Market survey/visit for equipment
- Development of a business plan

Essential/Recommended Readings

- Desai V. (2011) The Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House Pvt. Ltd., Mumbai.
- Mohini, S. (2005) Institution Food Management New Age International Publishers.
- West, B.B. & Wood, L. (1988) Food Service in Institutions 6th Edition Revised By Hargar FV, Shuggart SG, & Palgne Palacio June, Macmillan Publishing Company New York.

Suggested Readings

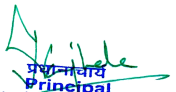
- Knight, J.B. & Kotschevar, L.H. (2000) Quantity Food Production Planning & Management 3rd edition John Wiley & Sons.
- Payne-Palacio, J. & Theis, M. (2011) Foodservice Management: Principles and Practice 12th edition.

- Taneja, S. & Gupta, S. L. Entrepreneur Development- New Venture Creation. Galgotia Publishing Company

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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CULINARY SCIENCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Culinary Science	2	1	0	1	Class XII	NIL

Learning Objectives:

Culinary science skill paper is about the cuisine arts of food preparation, cooking, and presentation of food. Students will be equipped with knowledge of various tools and equipments used for cooking, different cooking techniques, working in establishments such as restaurants and relatively large institutions such as hotels and hospitals, standardized cooking practices and recipes.

The learning objectives of the course are:

- To develop cuisine arts of food preparation, cooking, and presentation of food.
- The practical exercises aim to provide hands-on training to develop the skill of various cooking techniques and knowledge about various tools and equipment used for cooking

Learning Outcomes

After studying this course, the student will be able to:

- Develop different cooking and presentation skills.
- Get hands-on training to develop the skill to prepare Indian traditional and nutritious recipes.
- Develop the ability to work in establishments such as restaurants, food courts, kiosks, fast food centers large institutions such as hotels and hospitals.

SKILL DEVELOPMENT AND JOB OPPORTUNITIES’:

Employment Opportunities:

- Apprentice in Small Catering units/ Kiosk/ Restaurant
- Food Supplier
- Food Storekeeper
- Food Stylist / Designer

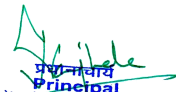
SYLLABUS

Credits: 2

Total lectures (45): 45 Hours/ 15 weeks

Theory: 30%, Credit – 1 (Lectures – 15)

Practical/ Field work/ Hands on learning: 70%, Credit – 1 (Lectures – 30)


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Unit 1: Basic Culinary Concepts**(8 hours)**

Description: This unit is an introductory unit about the culinary science and basic food ingredients, importance of hygiene to serve safe food.

Subtopics:

- Culinary Terms
- Basic Safety and Hygiene
- Basic food ingredients
- Recipe Evaluation: Sensory evaluation scales

Unit 2: Kitchen Techniques and Technology**(7 hours)**

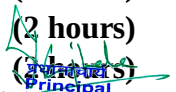
Description: This unit is about methods of cooking, storage and organizing the storage and imparting knowledge about various kitchen equipment and accessories.

Subtopics:

- Methods: Moist heat, Dry heat, Frying, Microwave Cooking
- Basic Equipment: Gas stove/Cooking range, Refrigerator, Oven, Microwave, Electrical Blenders, Air Fryer
- Kitchen Aids: Cooking Equipment, Measuring Equipment, Baking Equipment, Assorted Knives, Assorted tools, Service Equipment.
- Storage and organization of work area

PRACTICALS**30 hours**

1. General Instructions: Working in Food Lab/ Kitchen, Weight of edible portion, Temperature, Abbreviations used in recipes **(2 hours)**
2. Basic Indian Gravies: White, Makhani, Salan, Red gravies, Kadi **(2 hours)**
3. Beverages: Tea, Coffee, Cold Coffee, Smoothies, Milk Shakes, Fruit Punch, Iced Tea, Panna, Mojito. **(2 hours)**
4. Indian Breads: Chapatti, Paratha, Naan, Kulcha, Bhatura, Bedmi Puri, Sandwich (open, grilled, rolled), Puranpoli, Kathi roll. **(2 hours)**
5. Indian Rice Cooking: Boiled, Curd, Tomato, Lemon, Fried, Pulao, Tamarind, Biryani, Poha **(2 hours)**
6. Soups: Stock, Clear soups, Cream soups **(2 hours)**
7. Salads and Salad cuts/ craft: Coleslaw, Quinoa salad, Corn & Walnut, Exotic seeds salad, Salad vegetable cuts and crafts **(2 hours)**
8. Vegetables Preparations: Dry veg, Koftas, Stuffed veg, Baked veg preparations. **(2 hours)**
9. Indian Dry Snacks with Dips: Dhokla, Idli, Uttapam, Kachori, Khandvi, Chilla, Dumplings, (Momos/Dim sums/ wontons) **(4 hours)**
10. Indian Savory Snacks: Assorted Pakoras, Dahi Bhalla, Cutlets, Samosa, Tikki, Paneer Tikka **(4 hours)**
11. Traditional Deserts 1: Halwa, Kulfi, Kheer, Gulab Jamun **(2 hours)**
12. Traditional Deserts 2: Rasmali, Ladoo, Burfi, Jalebi, Gujia, Rasgulla **(2 hours)**
13. Baking: Tea cake, Muffins


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ESSENTIAL READINGS

- Raina, U., Kashyap, S., Narula, V., Thomas, S., Suvira, Vir, S., & Chopra, S. (2005). Basic Food Preparation – A Complete Manual. Delhi: Orient Longman.
- Khanna, K., Gupta, S., Seth, R., Mahana, R., & Rekhi, T. (2004). The Art and Science of Cooking. Delhi: Phoenix Publishing House Private Limited.
- Arora, K. (2011). New Delhi: Theory of Cooking. Frank Bros & Co.

SUGGESTED READINGS:

- Kumar, B. (2021). Theory of Culinary Arts. Rudra Publications
- Sethi, P. & Lakra, P. (2015). Aahar Vigyan, Poshan Evam Suraksha. Delhi: Elite Publishing House Pvt. Ltd.
- Suri, S. & Malhotra, A. (2014). Food Science Nutrition and Safety. Delhi: Pearson India Ltd.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

DAIRY PROCESSING

Credit Distribution, Eligibility and Pre-Requisites of The Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Dairy Processing	2	0	0	2	XII (PCM/PCB)	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the processing of milk products

Learning Outcomes

After studying this course, the student will be able to:

- Gain skills in dairy product development and hands-on training for the processing of different milk products.
- Establish a food industry/start up based on their learnings in the subject.
- Start providing 3rd party manufacturing to premier dairy-based industries.
- Work in any dairy based industry.

Syllabus

Practical Exercises:

60 hours

The learners are required to perform the following:

- Processing of Flavoured milk
- Preparation of Dahi
- Preparation of Ghee
- Preparation of milk based traditional Indian sweet
- Preparation of Ice cream
- Preparation of milk based instant mix
- Preparation of whey based drink
- Milk based new product development
- How to plan a startup, budgeting, marketing / case study/ entrepreneur (anyone of the above)
- Regulations, Licensing and registration of a startup

Essential/recommended readings

- De, Sukumar. (2007). Outlines of dairy technology. Oxford University Press.
- Webb B.H. & Alford (2005). Fundamentals of dairy chemistry. CBS Publisher
- P.F. Fox, T. Uniacke-Lowe and J.A.O' Mahony (2005). Dairy Science and Technology. Taylor & Francis.
- P. Walstra, Jan T.M. Wouters and Tom J. Geurts (2015). Dairy chemistry and Biochemistry. Springer

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Skill progression

India is indisputably the largest milk producer in the world. Overall, dairy industry in India engages about 80 million households in rural area. The course 'Skills in Dairy Processing' provides valuable skills to the candidates required to be in a dairy industry. The course is planned to provide a hands-on training experience to the students in relevance to the dairy product preparation and setting up an enterprise. The other courses like Technology of Milk and milk products, Food Quality Management, Agri-business management, Sensory science, Food standards and regulations in the upcoming semesters will provide a deeper insight to the subject and will help students to improve their skill set.

FRUITS & VEGETABLE PROCESSING

Credit Distribution, Eligibility and Pre-Requisites of The Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Fruits and Vegetable Processing	2	0	0	2	XII (PCM/PCB)	NIL

Learning Objectives

- To provide hands-on training to students for the entire process of selection, preparation, packaging, & presentation of variety of fruits & vegetable products.
- To impart skills of scale-up production of fruits & vegetable products & by products for setting their own enterprise.

Learning Outcomes

After studying this course, the student will be able to:

- Create variety of value-added products of consumer's choice & need.
- Enhance the level of processing, level of value addition, share in global food trade & employability.

Skill Development and Job Opportunities: Justification

The food processing sector is one of the largest sectors in India in terms of production, growth, consumption, and export. However, there exists a definite lack in processing and storage infrastructure and skilled manpower, which are essential to reducing the waste and enhancing the value addition and shelf life of the farm products. The government has ambitious plans to increase the level of processing, value addition and share in global food trade. This will have a spike in the requirement for qualified and trained fruits & vegetable processing professionals. The main objective of having this paper is to impart knowledge of processing various value added fruits & vegetable products which is ultimately used to enhance the employability of any candidate studying the paper including food technology graduates.

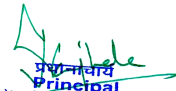
Syllabus

Practical

60 hours

Practicals based on different processing/ preservation techniques.

1. Preparation of canned fruits /vegetables
2. Preparation of chips from potato/bittergourd/apples etc.
3. In bottle pasteurization of fruit juices, nectars, purees etc.
4. Preparation of fruit squashes


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5. Preparation of fruit cordials
6. Preparation of fruit jams/jellies
7. Preparation of fruit nectars
8. Preparation of mango/chilli/ lime pickle
9. Preparation of Tomato puree & product
10. How to plan a startup, budgeting, marketing / case study/ entrepreneur (anyone of the above)
11. To study the Regulation, Licensing & registration of particular

Essential Readings

- Girdharilal., Siddappaa, G.S and Tandon, G.L.(2009). Preservation of fruits & vegetables. ICAR, New Delhi.
- Thompson, A.K., (2003). Fruits and vegetables; Harvesting, handling and storage. Blackwell Publishing.

Suggested Readings:

- Cruse, W.B. (2004). Commercial Unit and Vegetable Products. W.V. Special Indian Edition. Agrobios India.
- Manay, S. and Shadaksharaswami, M. (2004). Foods: Facts and Principles. New Age Publishers.
- Ranganna S.(2007). Handbook of analysis and quality control for fruits and vegetable products. Tata Mc Graw-Hill publishing company limited, Second edition.
- Srivastava, R.P. and Kumar, S. (2006). Fruits and Vegetables Preservation- Principles and Practices. 3rd Ed. International Book Distributing Co.
- Somogyi, L.P., Ramaswamy, H.S. and Hui, Y.H. (1996). Biology, Principles and Applications. Volume 1. Technomic Publishing Company, Inc.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

MINIMAL FOOD PROCESSING

Credit Distribution, Eligibility and Pre-Requisites of The Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Minimal Food Processing	2	1	0	1	XII (PCM/PCB)	NIL

Learning Objectives

- To provide the best combination of health, nutrition and convenience based on minimal food processing
- To impart skills in food processing for extending the shelf life with minimal processing that results in minimum changes to sensory characteristics and nutritional qualities, yet imparting convenience to the consumer.
- To make students aware of the various novel technologies being developed and used for minimal processing across the world.

Learning Outcomes

After studying this course, the student will be able to:

- Have skills and knowledge of methods of preservation by minimal processing of food.
- Do minimal processing of different food samples.

Job/Employment Opportunities:

- Students can establish his/her start-up specialized in minimal food processing of foods.
- Students can help in Research and Development in food industries to explore various novel technologies for minimal processing.
- Students can either collaborate or join with any Food Industry and help in developing various thermal and non-thermal techniques in food processing.

Syllabus

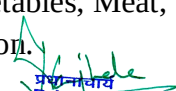
THEORY

Total Lecture (Nos): 15 Hours

Unit 1: Basic minimal processing

(8 Hours)

Introduction and importance of minimal processing, Preparation and pre-treatments, Minimal processing of foods by thermal, refrigeration and freezing methods, MAP (Modified Atmosphere Packaging) and CAP (Controlled Atmosphere Packaging). Physiological responses and biochemical changes during minimal processing of fruits and vegetables, Meat, Fish, poultry and Dairy products. Role of minimal processing in economic creation.


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Unit 2: Advanced technologies in minimal processing of foods (7 Hours)

Principle and applications of; irradiation, pulsed electric field processing, high pressure processing, pulsed light, ultrasound, ohmic heating, sous vide.

PRACTICALS

(30 Hours)

1. To study basic hygiene and sanitation requirements for minimal processing
2. Preparation and pre-treatment method for minimal processing of fruits and vegetables.
3. Minimal processing of Meat products.
4. Minimal Processing of fish and Poultry.
5. Minimal processing by Vacuum/ MAP/CAP/ edible coating.
6. Minimal Processing of Dairy Products.
7. To study the shelf life and quality characteristics of minimally processed foods available in the market
8. To study the effect of packaging material on shelf life of different minimally processed foods.
9. To determine the cost of minimally processed food.

Essential Readings:

- Fellows, P. J. (2009). Food processing technology: principles and practice. Elsevier
- Rahman, M. S. (Ed.). (2007). *Handbook of food preservation*. CRC press.
- Tewari, G., & Juneja, V. (Eds.). (2008). *Advances in thermal and non-thermal food preservation*. John Wiley & Sons.

Suggestive Readings:

- Barbosa-Canovas, G. V., Tapia, M. S., & Cano, M. P. (Eds.). (2004). *Novel food processing technologies*. CRC press.
- Bansal, V., Siddiqui, M. W., & Rahman, M. S. (2015). Minimally processed foods: overview. *Minimally processed foods*, 1-15.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Food Waste and By-product Utilisation

Credit Distribution, Eligibility and Pre-Requisites of The Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Food Waste and By-product Utilisation	2	0	0	2	XII (PCM/PCB)	NIL

Learning Objectives

Environment sustainability is a key area of interest to government, scientist, environmentalist, researchers, and students. The present course is designed to address the issues of food waste and further their utilization into value added products. It's a multidisciplinary subject which can be taken by students of varied background. The objectives of the course are as follow:

- To improve students' understanding of basic food industry waste and by-product.
- To provide students an opportunity in understanding the significance of treating and utilizing food waste and by-products.
- To study effluent treatment plant.
- The practicals provide hands-on training in different type of food waste and by-products, further their utilization.
- After completion of course students can apply for courses specific to any category of food waste and further specialize in it.

Eligibility: Being interdisciplinary in its nature and scope, the course will be equally engaging and beneficial for students of all subject streams.

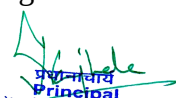
Learning Outcomes

After Studying this course, the student will be able to:

- Identify waste produced from different sectors of the food industry.
- Utilise waste from the food industry.
- Understand waste water treatment.

Skill Development and Job Opportunities:

- Students are eligible to handle the processing and operations at effluent treatment plant running in food and chemical-based industries.
- Students can provide consultancy to waste industries.
- Students can also start with hands-on training to students and industrialist on handling and utilizing the waste from industries.
- Students can work with Ministry of Agriculture to devise ways of utilizing the food waste.


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- Students can start his/her own start-up by providing waste water treatment services to food industries.
- The course will provide basic training enabling students to apply to advanced food waste management courses.

Syllabus

Practical

60 hours

2. Identification of waste from agriculture and food processing (Dairy/ Meat/ Fruits Vegetables / Alcoholic beverages/ cereals)
3. Study and layout of waste water treatment system (ETP)
4. Identification of co-products from F&V industry, estimation and utilization to develop value added products (pectin, banana fibre, lycopene from tomato waste, watermelon/ pumpkin rind).
5. Identification of waste from animal industry and utilisation to develop value added products (gelatin, egg shell).
6. Identification of various co-products from dairy industry, estimation and utilization to develop value added products (utilisation of ghee residue, buttermilk beverage, whey).
7. Identification of co-products from cereal industry, estimation and utilization to develop value added products (cereal husk, wheat fibre).
8. Determination of physico-chemical properties of wastewater.
9. Production of alcohol/ acetic acid from waste material.

Essential readings

- Marriott, N. G., Gravani, R. B., & Schilling, M. W. (2006). Principles of food sanitation(Vol. 22). New York: Springer.
- Sadasivam, A, & Manickam, A. (2021). Biochemical Methods. New Age InternationalPublishers.
- Green, J. H., & Kramer, A. (1979). Food Processing. Waste Management. Avi PublishingCompany, 629.
- Herzka, A. and Booth, R.G. Food Industry and Trade: Recycling Waste. Applied SciencePublishers, 1981.
- Tegge, G., Green, J. H., and A. Kramer. Food Processing Waste Management; AVIPublishing, 1979

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

INDIAN SNACK INDUSTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Indian Snack Industry	2	1	0	1	Class XII	NIL

LEARNING OBJECTIVES

With changing lifestyles and rising income levels, the processed Indian Snack industry has grown exponentially in recent years due to a massive upsurge in the demand for snack (ready to eat/ ready to cook) products in India. This course will equip our students with knowledge and skills necessary to work in the snack industry, contribute to the growth and after gaining some experience start-up their own micro/macro enterprises.

The learning objectives of the course are:

- To provide students with the basic knowledge of Indian snack industry.
- To familiarize students with different types of Indian snacks.

LEARNING OUTCOMES

After Studying this course, the student will be able to

- Describe various aspects of Indian snacks industry and regional snacks.
- Identify various types of snacks and their processing
- Prepare traditional, regional and healthy snacks.

SKILL DEVELOPMENT AND JOB OPPORTUNITIES':

Employment Opportunities:

- Apprentice in Small Catering units/ Kiosk/ Restaurant
- Start-up of micro/macro enterprises
- Able to set up home based/ small scale food catering units
- Work in Cloud Kitchen
- Food Stylist / Designer

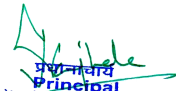
SYLLABUS

Credits: 2

Total lectures (45): 45 Hours/ 15 weeks

Theory: 30%, Credit – 1 (Lectures – 15)

Practical/ Field work/ Hands on learning: 70%, Credit – 1 (Lectures – 30)


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Theory

(6 hours)

Unit 1: Indian Snack Industry Current Scenario

Description: This unit is an introductory unit about what is a snack food, the history and current trends of snacks industry and regional snacks of India.

Subtopics:

- Definition and history of snack foods in India.
- Current scenario of Indian snack industry.
- Indian regional snacks and their salient features.

Unit 2: Processing of Snacks

(9 hours)

Description: This unit is about different types of Indian snacks and common packaging materials and techniques used in snack industry.

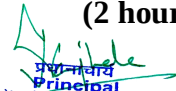
Subtopics:

- Packed Snacks of India: Classification of packaged snacks, common packaging materials and techniques
- Ready to cook (RTC) snacks, Instant snacks, Freshly prepared snacks, Extruded snacks.
- Usage of oils for frying and various seasonings
- Healthy snacks preparations (innovations in snack preparation)
- FSSAI License and regulations

PRACTICALS

30 hours

1. Weights, Measures and Food hygiene practices (2 hours)
2. Basic cooking terminologies and techniques of preparation (2 hours)
3. Pakoras/ fritters: Assorted pakoras, Bondas and its variations (2 hours)
4. Cutlets and Tikkis – Mixed Veg cutlets, Sago cutlets, Aloo tikki, Vegetable tikki, (2 hours)
5. Dough snacks: Kachori, Samosa, Spring rolls, Mathri, Kathi rolls, Pani puri (4 hours)
6. Vadas: Dahi vada, Masala vadas, Medu vada and accompaniments (2 hours)
7. Dips (Accompaniments): Mint chutney, Imli chutney, coconut chutney, Salsa sauce, Hummus, Hung curd dips, Guacamole etc. (4 hours)
8. Marinates: Curd marinates, Green marinates, Pickled marinate etc. (2 hours)
9. Tikkas and Kababs: Paneer tikka, Soya chaaps, Seekh kabab, Hara kabab (2 hours)


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- | | |
|---|-----------|
| 10. Healthy snacks 1: Sprouts, Cheela, Roasted snacks, Bhel, Fruit chat | (2 hours) |
| 11. Healthy Snacks 2: Fermented snacks (Idli (variations), Dhokla) | (2 hours) |
| 12. Extruded snacks: Bhujia, Chakli, Fafda, Gathiya | (2 hours) |
| 13. Packaging materials and techniques of packaging snacks | (2 hours) |

ESSENTIAL READINGS:

- Raina, U., Kashyap, S., Narula, V., Thomas, S., Suvira, Vir, S., & Chopra, S. (2005). Basic Food Preparation – A Complete Manual. Delhi: Orient Longman.
- Khanna, K., Gupta, S., Seth, R., Mahana, R., & Rekhi, T. (2004). The Art and Science of Cooking. Delhi: Phoenix Publishing House Private Limited.

SUGGESTED READINGS:

- Kumar, B. (2021). Theory of Culinary Arts Delhi: Rudra Publications
- Arora, K. (2011). Theory of Cooking. New Delhi Frank Bros & Co.
- Lusas E.W., Rooney, L.W. (2002). Snack Food Processing: Delhi, CRC Press LLC.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Paper and Skill Progression

The paper provides understanding a huge untapped sector of food wastage. This waste across globe is an environment concern. Students will be able to deeper understanding to the huge market of food wastage from industries. The course is designed to provide exclusive hands on training to students so that they can contribute the same to industries in search of food waste management.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sustainable Eco-Tourism and Entrepreneurship	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To train students in concepts and principles of sustainable ecotourism leading to a new generation of entrepreneurs
- To inculcate field-based practical skills in translating ecological systems into wealth generation while conserving natural resources
- To transform local biological wealth into a hub of global attraction and generate a scientific basis of Indian traditional knowledge

Learning outcomes

The Learning Outcomes of this course are as follows:

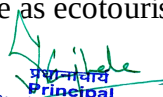
- After studying this course, students will be able to develop next-generation ecological entrepreneurs
- After studying this course, students will be able to evolve eco-literate society by integrating market-based instruments with eco-cultural knowledge of traditional societies
- After studying this course, students will be able to practice ecological knowledge for wealth generation, environmental conservation, and popularization of Indian traditional knowledge

SYLLABUS

Practical/Hands-on Exercises

(02 Credits: 60 hours)

- Assess the current state of ecotourism in little-known/explored areas and examine ecotourism potential
- Field surveys to identify the existing locations having ecological, wildlife, scenic, and ethnic potential for ecotourism and analyze existing prevalent eco-practices having the potential to integrate with ecotourism programme
- Identify ten plant species having ecological, economic, and cultural significance as ecotourist


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attraction

- Develop stories on the selected wild habitats to attract ecotourists from within and outside the country
- Identify suitable track and prepare a checklist of birds and animals with their stories for a diverse group of ecotourists
- Examine the current state of natural resources and develop suitable messages and appropriate media for educating different target groups
- Survey and identify the target group for ecotourism based on their age, education, economic and other criteria and evaluate their psychological barriers to ecotourism
- Conduct inventory of facility and analyze a preliminary competitive advantage over ecological attractions in the nearby area
- Analyze tourist spending patterns and track preferences for ecotourism attractions in nearby areas and add value to ecological, wildlife, and cultural attractions
- Survey attitude and perception of residents regarding ecotourism plan and analyze costs and benefits of the sustainable ecotourism development programme using a demand-driven marketing approach
- Develop messages, stories, and pictures to attract tourists and promote ecotourism in the target area
- Analyze basic elements of ecotourism, the special needs of ecotourists, develop trips and travel packages offering an array of experiences and predict the market trends
- Develop ecotourist activities for individuals, families, and groups and craft social media campaigns for the proposed ecotourism business
- Develop a plan for strategic alliances and partnerships with other projects/groups /organizations for public- private partnership in the proposed ecotourism programme

Teaching and learning interface for practical skills:

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including

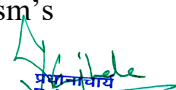
- (a) laboratory practicals;
- (b) field-work exercises;
- (c) customized exercises based on available data;
- (d) survey analyses;
- (e) developing case studies;
- (f) demonstration and critical analyses;
- (h) experiential learning individually and collectively.

Prospective sector(s):

- Forest Departments
- Tourism industry
- World Bank
- UNDP
- WWF
- Environmental NGOs

Suggested Reading:

- Ballantyne, R. and Packer, J., 2013. International Handbook on Ecotourism. Edward Elgar Publishing Limited, UK
- Blumstein, D.T., Geffroy, B., Samia, D.S. and Bessa, E., 2017. Ecotourism's promise and
- Peril. A Biological Evaluation. Springer Int. Publ. (Chapters 10–11)
- Fennell, D.A., 2014. Ecotourism. An Introduction. Routledge, London, UK
- Fletcher, R., 2014. Romancing the wild. In Romancing the Wild. Duke University Press.


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- Tanguay, G.A., and Rajaonson, J., (2015). Evaluating Sustainable Tourism Using Indicators:
- Problems and Solutions. In: Brophy, S.C., (Ed), Ecotourism: Practices, Benefits and Environmental Impacts. Nova Science Publishers, pp. 119 – 134.
- Wearing, S. and Schweinsberg, S., 2019. Ecotourism: Transitioning to the 22nd century. Routledge

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

E-Tourism

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
E-Tourism	2	0	0	2	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the application of e-business in tourism sector with understanding of contemporary issues of the use of electronic technology in the tourism business.
- To learn about e-business strategies and how to apply it to help them comprehend a variety of basic e-business ideas and theories.
- To teach fundamental concept of what e-business is and how to conduct e-business successfully in the tourism sector.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to gain insight into concept of e-tourism, travel intermediaries and travel websites.
- After studying this course, students will be able to learn and explain the emerging ICT tools and its impact in the industry.
- After studying this course, students will be able to understand and implement the use of social media platforms/artificial intelligence in e-tourism.

SYLLABUS OF SEC-36

Unit-I

(20 hours)

Introduction to E-tourism, stages of ICT revolution, ICTS and new business tools, Strategic and Operational use of IT in Tourism, The Internet and tourism – a powerful combination. Networks for intermediaries: Travel trade intermediaries-Features of a travel trade web site, implementing a travel trade website, online travel intermediaries.

Unit– II

(20 hours)

E-business for Destination Management Organizations: Principles and concepts – Positioning DMOs in value net, destination e-business system model, e-Business Partnerships for DMOs, Case Studies of Red Apple DMC, OYO Rooms, OLX, Zoom Car, Ofo Cycles etc.

Unit– III

(20 hours)

Social Media Marketing in Tourism - Facebook, Twitter, YouTube, WhatsApp - Travel Blogs –Usage of Artificial Intelligence- Virtual Reality - Challenges for conventional business models and Competitive strategies.

Essential/Recommended Readings

- Reynolds, Jonathan. (2012). E-Business: A management Perspective. Oxford University Press.
- Kulkarni. P, Jahirabadkar. S & Chande. P. (2012). E-Business. Oxford University Press.
- World Tourism Organization. (2001). E-business for tourism: Practical guidelines for tourism, Destinations and businesses. World Tourism Organization.
- D. Buhalis: e-Tourism, Information Technology for Strategic Management
- Buhalis & Costa: Tourism Business Frontiers
- Poon: Tourism, Technology and Competitive Strategies Harish Bhatt & Badan: Impact of ICT in Tourism

Suggested Reading:

- Stiakakis. E. & Georgiadis C. K. (2009). Drivers of a tourism e-business strategy: the impact of information and communication technologies. Oper Res Int J. DOI 10.1007/s12351-009-0046-6.
- European Commission (2004). Electronic Business in Tourism: Key issues, case studies, conclusions. European Commission. Enterprise publications. Sector Report: No. 07-II, August 2004.
- Šimunić. M, Pilepić L., Šimunić M. (2013). Tourism and e-business: the semantic paradigm as a precondition for success. Informatol. 46, 2013., 1, 1-7.
- Buhalis. D., & Hyun Jun S. (2011). E-Tourism. Contemporary Tourism Reviews: Series. Goodfellow Publishers Limited, Woodeaton, Oxford, OX3 9TJ.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Design Thinking

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Design Thinking	2	0	0	2	Class XII	NIL

Learning Objectives

To provide basic understanding of problem search, design process, design thinking and ability to convert an innovative product idea to a prototype.

Learning Outcomes

After studying the course, the student will be able to:

- Understand innovation process
- Do product designing
- Empathy research.
- Do designing brief and proof of concept.
- Do prototyping, product testing and validation

SYLLABUS:

Unit I: Design thinking and innovation in product or process designing. Identifying user needs. Human Centered Design. **(8 hours)**

Unit II: Innovation Opportunities. Problem space exploration. Ideation. Empathy Research **(13 hours)**

Unit III: Novel product or process Opportunities. Solution space exploration. Design brief. Concept generation. User validation **(13 hours)**

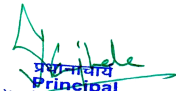
Unit IV: Converting ideas to product. Developing Prototypes. Iterative improvement. Proof of concept - Product testing and validation **(18 hours)**

Unit V: Disruptive design innovations – case studies **(8 hours)**

Teaching Plan

Week 1: Design thinking and innovation in product or process designing

Week 2: Identifying user needs. Human Centered Design


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Week 3: Innovation Opportunities.
Week 4: Problem space exploration. Ideation.
Week 5: Empathy Research
Week 6: Novel product or process Opportunities. **Week 7:** Solution space exploration. Design brief. **Week 8:** Concept generation. User validation
Week 9: Converting ideas to product.
Week 10: Developing Prototypes.
Week 11: Iterative improvement.
Week 12: Proof of concept - Product testing and validation
Week 13, 14 & 15: Disruptive design innovations – case studies

Essential Readings:

1. *Creative Confidence: Unleashing the creative potential within us all* by Tom Kelley & David Kelley, Crown Business (New York, 2013)
2. *The Design of everyday things* by Don Norman, Basic Books (2013)
3. *Design Thinking: Understanding how designers think and work* by Nigel Cross, Bloomsbury Visual Arts (2019)

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Innovation and Entrepreneurship

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Innovation and Entrepreneurship	2	0	0	2	Class XII	NIL

Learning Objectives

The primary objectives of the course will be to:

- Encourage the process of creative thinking and innovation
- Build an entrepreneurial perspective to identify and tackle problems and explore new opportunities
- Gain insight into building business models and plans
- Identify tools and strategies that entrepreneurs may use for start-up, innovation and reinvention
- Understand how to go from an idea to product and scale it up for sustainability
- Develop skills to work in teams and build connections, collaborations and social networks .

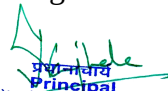
Learning Outcomes

By the end of the course students should be able to:

- Identify and comprehend the concepts of creativity, innovation and invention in various contexts.
- Enrich their theoretical and conceptual foundations in entrepreneurship.
- Gain hands-on experience that shall empower them to identify business and social opportunities and venture in the entrepreneurial landscape.
- Prepare themselves to take informed decisions in establishing start-ups and ongoing innovation in organisations.

PEDAGOGY

While suitable concepts and theory will be utilized, the emphasis of the course will be on inquiry driven hands-on activities and experiential learning in a team setting. As this is essentially a group activity based course, the two lectures scheduled for each week shall be held together. The class to be split up ideally in groups of 5 – 7 students each, who will work


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together for the rest of the semester on identifying a specific problem and by semester-end present a feasible innovative prototype capable of being funded as a start-up.

SYLLABUS

Unit I: Understanding Creativity

- Understanding the concept and process of creativity; students exploring within themselves the nature of the creative process; approaches to understanding creativity (Ref. B1)
- Differentiate between invention and innovation (Ref. OR1)
- Understanding entrepreneurial mindset and skills (creativity, decision making, risktaking behaviour, networking) and entrepreneurship in different contexts (eg. Social, Cooperative, Commercial, Public, Not for Profit organisations) (Ref. B1)
- Case studies of some successful innovations/start-ups – Different group can be given a different Case Study and the groups can have a discussion on same (Ref. Suggestive Case Studies A)

(15 practical hours)

Unit II: Ideation

- Identifying a specific problem through observation, contemplation, networking and research (Ref. B2)
- Generating ideas for problem solving using mind mapping, brainstorming, focus groups, idea generation tool kit (SCAMPER) (Ref. B1)
- Learning through failures of others – case studies of some ventures that could not sustain – Different group can be given a different Case Study and the groups can have a discussion on same (Ref. Suggestive Case Studies B)

(15 practical hours)

Unit III: Understanding the business

- Building a business plan using the lean canvas model (Ref. OR2)
- Understanding customers/stakeholders and evaluating the business plan through survey/questionnaire/interview/secondary research (Ref. B1 and B2)
- Designing, prototyping and iteration (Ref. B2)
- Networking and growth strategies (Ref. B3)
- Building and managing organisations (Ref. B3)
- Role of leadership and team based culture (Ref. B3 and OR4)

(20 practical hours)

Unit IV: Venturing Forth

- Financing the innovation: pitching and communicating the idea
- Sources of finance: crowdfunding, venture capital, equity funds, angel investing, borrowing (including government initiatives, bank and public funded schemes) (Ref. OR5 and OR6)
- Various forms of IPR (patent, copyright, trademark, geographical indication, industrial design) (Ref. OR7 and OR8)
- Setting and scaling up (Ref. B3)
- Entrepreneurial resilience and ongoing creativity (Ref. B1)

(10 practical hours)

Suggested Readings: Books

B1. The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Jeff Dyer, Hal Gregersen, C.M. Christensen, Harvard Business Review Press, 2011

B2. Design Thinking: Business Innovation, Maurício Vianna, Ysmar Vianna, Isabel K. Adler, Brenda Lucena, Beatriz Russo, MJV Press, 1st Electronic Edition, 2011
(also available at https://cdn2.hubspot.net/hubfs/1701231/Documents/Design_Thinking_-_The_Book/Design_Thinking_The_Book.pdf)

B3. Contemporary Strategy Analysis: Text and Cases, Robert M Grant, Wiley, 9th Edition, 2016 (Chapter 6 and Chapter 9)

Online Resources

OR1. Discovery, Innovation and Invention
<https://www.laits.utexas.edu/~anorman/long/DII.html>

OR2. How to create your lean canvas
https://leancanvas_production.s3.amazonaws.com/cms/LeanCanvas.pdf

OR3. Organisational behaviour and human relations, Module 12, Creativity in decision making
<https://courses.lumenlearning.com/wm-organizationalbehavior/>

OR4. Organisational behaviour and human relations, Module 13, Leadership
<https://courses.lumenlearning.com/wm-organizationalbehavior/>

OR5. Sources of Funding Innovation and Entrepreneurship
https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020-chapter4.pdf

OR6. Government Schemes for Startups
<https://www.startupindia.gov.in/content/sih/en/government-schemes.html>

OR7. Intellectual Property Rights in India
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/627956/IP-Rights-in-India.pdf

OR8. What is Intellectual Property? WIPO 2020 doi:10.34667/tind.42176
<https://www.wipo.int/publications/en/details.jsp?id=4528>

Suggestive Case Studies A

1. Amul
2. Goonj
3. Aravind Eye care systems
4. Apple
5. Pixar
6. ISRO
7. Khan Academy
8. Nyka
9. Swiggy

10. Sulabh International
11. OYO
12. Mumbai's Dabbawalas
13. Lijjat Papad
14. Jaipur Rugs
15. WOW! Momo
16. Biryani by Kilo

Suggestive Case Studies B

1. Nokia
2. Cafe Coffee Day
3. HMT watches
4. Atlas Cycles
5. Jet Airways
6. Kodak
7. Stayzilla
8. SKS Microfinance IPO
9. Satyam Computers
10. Groupon Inc.

Weekly Plan:

Week I: Understanding the concept and process of creativity; Approaches to understanding creativity; differentiate between invention and innovation.

Week II: Activity week - Students exploring within themselves the nature of the creative process in groups (eg. exploring the surroundings for possible problems and challenges that may have innovative solutions).

Week III: Understanding entrepreneurial mindset and skills (creativity, decision making, risk taking behaviour, networking) in different contexts through discussion of a case study (may select one case study from Suggestive Case Studies A).

Weeks IV - IX: Activity Weeks - The class to be split up ideally in groups of 5 – 7 students each, who will work together for the rest of the semester on identifying a specific problem and by semester-end present a feasible innovative prototype capable of being funded as a start-up.

Week IV: To begin with, each group shall identify a problem through observation, contemplation, brainstorming, networking and research.

Week V: Each group to generate ideas for solving their identified problem using mind mapping, focus groups, idea generation tool kit (SCAMPER).

Week VI: Each group to critically assess the feasibility of the proposed ideas by learning through the failures of others – case studies of some ventures that could not sustain (may use a case study from Suggestive Case Studies B).

Week VII: Each group to build a business plan using the lean canvas model and survey/questionnaire/interview/secondary research.

Week VIII: Each group to design and prototype their proposed business solution/model/product.

Week IX: The groups evaluate their proposed business plan/model using feedback from networking. Submission of formal business plan (written) by each group.

Week X: Formulating growth/scaling up strategies; building and managing organisations; role of leadership and team based culture, entrepreneurial resilience and ongoing creativity.

Week XI: Financing the innovation: pitching and communicating the idea. Sources of finance: crowdfunding, venture capital, equity funds, angel investing, borrowing (including government initiatives, bank and public funded schemes)

Week XII: Various forms of IPR (patent, copyright, trademark, geographical indication, industrial design)

Week XIII, XIV and XV: Activity weeks - Submission of final project report (written) and presentation (oral) by each group, Viva.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

SEC Museum and Museology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Museum and Museology	2	1	0	1	XII Class	NA

Learning Objectives

The objective of this paper is to introduce and provide basic understanding about Museum and Museology as a discipline. Through this paper the students will be exposed to various aspects of museum history- (museum movement in India, particularly), its functioning, types and purpose. It will highlight the role of the museum as an important centre for preservation and dissemination of knowledge. This paper is of particular value to those who are seeking careers as curators, art collectors, researchers and conservators.

Learning outcomes

Upon completion of this course the student shall be able to:

- Understand museum as a resource center.
- Understand the historical process of institutionalization of archaeology and culture through museums.
- Develop an insight into the various roles of museum as an organizer, preserver and manager of artifacts.
- And how museum is an effective center for dissemination of knowledge and information, and space for dialogue and interaction.
- Also develop some understanding about new museums.
- A student having studied this course will be skilled in culture and tourism based industries: possible employment includes tour guides, archaeology assistants, archivist, jobs in art galleries, museums, auction houses, researchers in NGOs and other institutions, culture and art based writing and journalism and on social media

SYLLABUS

Unit I - Theory (15 hours)

- (i) Definition and meaning of Museum and Museology.
- (ii) History of museums in India- Colonial to post independence.
Research based project (any two): History of- National Museum/ Indian Museum/ Salar Jung Museum/ Chhatrapati Shivaji Maharaj Vastu Sangrahalaya
- (iii) A brief introduction to New Museology

Unit II - Practical (30 hours)

- (i) Various functions of a museum- Collection, documentation (manual, digital and photographic), preventive conservation and exhibition should be taught in conjunction with practical/ project.
- (ii) Types of museums: Project

Practical/Project: **Visit any one museum** to understand the nature and scope of its collection and exhibition techniques - National Museum/ Redfort Archaeological Museum/National Craft Museum and Hastkala Academy/ National Gallery of Modern Art/ National Science Centre /Gandhi Smriti Museum/Delhi Sulabh International Museum of Toilet/ Sanskriti Kendra (individual/ group assignments may be designed and assigned on one of these museums)

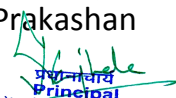
30 hours for practical with minimum 3-5 Days for Museum visit and field work.

Essential/recommended readings

Unit I:

This unit introduces students to the concept of Museum and Museology. With the help of International Council of Museum (ICOM) definitions - meaning, purpose and changing roles of museum can be understood. Unit will look into the history of colonial museums and their transformation into National Museums in the post-independence era. With the help of case studies of various national museums and their making, their historical trajectory can be studied and understood in the background of the museum movement in India. Provide a brief introduction to the concept of new museology and how new museums became an agent of change in the Museum world.

- Burdhan, Anand (2017), Colonial Museum: An Inner History, Research India Press, Delhi
- Choudhary, R. D. (1988). Museums of India and their Maladies. Calcutta: AgamPrakashan.
- Desvaltees, Andre, & Francas Mairesse Arrond Cown (2010), Key concept in Museology ICOM-2010, Paris.
- Dwivedi, V P, Museums and Museology: New Horizons. Agam Kala Prakashan


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- Guha-Thakurta, Tapti. (2004). Objects, Histories: Institution of Art in Colonial India, New York: Columbia University Press.
- Mathur, Saloni. (2007). India by Design: Colonial History and Cultural Display. Berkley: University of California
- Mathur, Saloni. (2000). "Living Ethnological Exhibits: The Case of 1886", Cultural Anthropology, Vol. 15 No. 4, pp 492-524
- सहाय, शिव स्वरूप (2019). संग्रहालय की ओर , मोतीलाल बनारसीदास, नई दिल्ली
- Tiwari, Usha Rani and Pandey, Aarti. 2016. नव संग्रहालय विज्ञान. Kala Prakashan
- Vergo, Peter, (1997)New Museology. Germany: Reaktion Books.

Unit II:

In this unit various functions of museum are to be studied. With the help of examples and case studies, types of Museums and their features will be discussed. By studying the nature of the collection and the exhibition methods student shall be able to identify the museum types.

- Aggarwal, O. P. (2006). Essentials of Conservation and Museology, Delhi: Sundeep Prakashan.
- Agrawal, O.P. (Translation: Tiwari, R.P.) (2012) पुस्तकालय सामग्री और कला वस्तुओं का परीक्षण, Delhi.
- Dean, David and Gary, Edson (1994) Handbook for Museums, Routledge.
- Dwivedi, V P, Museums and Museology: New Horizons. Agam Kala Prakashan
- Jain, Sanjay (1999), म्यूजियम और म्यूजियोलॉजी एक परिचय, Kanika Prakashan, New Delhi
- Munsuri, Shahida. Museums, Museology and New Museology. India: Readworthy Press Corporation, 2018.
- Nair, S. N. (2011). Bio-Deterioration of Museum Materials, Calcutta: Agam Prakashan
- शुक्ला, गिरीश चंद्र।, संग्रहालय विज्ञान, मोतीलाल बनारसीदास

Suggestive readings

Museum:

- Ambrose Timothy, Paine Crispin (1993, 2006), Museum Basics, Routledge
- Burdhan, Anand (2017), Museological Pedagogy: Colonial Politics versus People's Museography, Research India Press
- Bedekar. V. H, New Museology, Museum Association of India, New Delhi
- Dwivedi, V P, Museums and Museology: New Horizons. Agam Kala Prakashan
- Macdonald, S. (Ed.). (2010). The politics of display: Museums, science, culture. Routledge.London

- Mathur, Saloni and Kavita Singh(reprint2020), no-touching, no spitting, no praying: The Museums in South Asia,Routledge.
- Roychowdhury, Madhuparna (2015). Displaying India's Heritage: Archaeology and the Museum Movement in Colonial India, Orient Black Swan.
- Munsuri, Shahida. Museums, Museology and New Museology. India: Readworthy Press Corporation, 2018
- Macdonald, Sharon (2006), A companion to Museum Studies, Blackwell, UK and Australia.
- Punja, Shobhita, (2014) Treasures: Salar Jung Museum, Hyderabad. Niyogi Books, Delhi.
- Punja Shobhita (2014) Treasure: Chhatrapati Shivaji Maharaj Vastu Sanghralaya, Mumbai, Niyogi Books, Delhi.

Examination scheme and mode:

Total Marks: 100 marks

Internal Assessment: 25 marks

End Semester University Exam: 75 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEC Reading the Archive

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Reading the Archive	2	1	0	1	Class XII	NA

Learning Objectives

This course seeks to develop skills and methods of historical research through the critical evaluation of primary sources. The first unit of the course will emphasize that the historical archive cannot be treated as mere “information” and that issues of authorship, representation and access are crucial to any understanding of primary sources. At the core of the course are three carefully designed basic research projects that will introduce students to a wide variety of primary sources that range from colonial ethnographic and legal texts to visual photographic archives. The student will focus on one kind of archive in each project along with an important text that will illuminate the reading of this kind of archive by a historian.

Learning outcomes

- To expose students to a wide variety of archives used in historical work.
- To introduce students to scholarship that has critically and creatively used different kinds of primary sources.
- To develop skills to access, contextualize, and analyze primary sources and carry out research.
- A student having studied this course will be skilled in culture and tourism based industries: possible employment includes tour guides, archaeology assistants, archivist, jobs in art galleries, museums, auction houses, researchers in NGOs and other institutions, culture and art based writing and journalism and on social media

SYLLABUS

Unit 1: Theory (15 hours)

Introduction to Primary Sources: Power and Memory in the Archive

Unit 2: Projects

Practical (30 hours.)

- 1) The documentary archive: colonialism and nationalism
- 2) Photography and the visual archive.
- 3) Gender, law and the archive

Essential/recommended readings

Unit 1: Introduction to Primary Sources: Power and Memory in the Archive Theory

This unit will introduce the student to the notion of the archive as a cultural institution produced in contexts of power that allows both for the production, and elision of different kinds of historical narratives. It will also underline the issue of access, and digitization which is crucial to researchers today.

Students will be taken for a guided visit to either the National Archives of India or the Delhi State Archives.

Readings:

- Aparna Balachandran and Rochelle Pinto, Archive and Access, Bangalore, Centre for Internet and Society, 2011, 14-29, 50-81. <https://cis-india.org/raw/histories-of-the-internet/blogs/archives-and-access>
- Joan Schwartz, & Terry Cook, "Archives, Records, and Power: The Making of Modern Memory," Archival Science, Vol. 2, 1-19.

Unit 2: This unit is divided into 3 sections containing research projects that use different types of archives. *The Documentary Archive: Colonialism and Nationalism:*

In this section, the student can choose to do EITHER a project on a colonial text, or on a document produced in the course of the nationalist struggle in India. In the first case, students will understand the making of colonial knowledge; in the second, they will access the voices of peasants filtered through the accounts of the nationalist elite. Students can choose any section/chapter/ pages of the primary source in consultation with the teacher.

- a. *Primary source:* H.H. Risley and E.A Gait, Report on the Census of India, 1901; *Secondary reading:* Bernard Cohn, "The Census, Social Structure and Objectification in India" in *Anthropologist Amongst the Historians*, Delhi: OUP, 1987, 224-254.
 - b. *Primary Source:* Shahid Amin, Tridip Suhrud and Megha Tod eds, *Thumb Printed: Champaran Indigo Peasants Speak to Gandhi*, Navajivan Trust and National Archives of India, 2022.
Secondary Reading: Shahid Amin, *Thumb Printed: Champaran Indigo Peasants Speak to Gandhi* edited by Shahid Amin, Tridip Suhrud and Megha Tod, Navjivan Press and National Archives of India, Introduction, xiii-xxxvi.
- 2) In this section, the students can choose to either do a project on colonial-era photographs or on online personal photographic archives. In the first

case, the student will be engaged with the idea of the camera as a technology of rule; in the second the focus will be on cultural memory and digitization. Students can choose any section/pages/chapter/s of the primary source in consultation with the teacher.

a. *Primary Source*: William Johnson, *The Oriental Races and Tribes, Residents and Visitors of Bombay: A Series of Photographs with Letter Press Descriptions*, London: W. J. Johnson, 1863, https://archive.org/details/gri_33125008252070; *Secondary Reading*: Christopher Pinney, *Camera Indica: The Social Life of Indian Photographs*, London: Reaktion, 1997, Chapter 1: 'Stern Fidelity' and Penetrating Certainty.' 17-71.

b. *Primary Source*: The Indian Memory Project <https://www.indianmemoryproject.com/>
Secondary Reading: Katja Muller, "Between Lived and Archived Memory: How Digital Archives Can Tell History." *Digithum*, 19, 2017, 1-18. https://redib.org/Record/oai_articulo1211444-between-lived-archived-memory-how-digital-archives-can-tell-history

3) In this section, students will reflect on historical archives are gendered in character through an analysis of a legal text on the Age of Consent controversy. The project will allow students see legal debates and law-making as masculine projects even as the legal archive allows us some access to the agency and voices of women. Students can choose any section/pages/chapter/s of the primary source in consultation with the teacher.

a. *Primary Source*: Age of Consent Act Report, Government of India, Calcutta, 1929.

b. *Secondary Reading*: Tanika Sarkar, "Rhetoric against Age of Consent: Resisting Colonial Reason and the Death of a Child-Wife," *Economic and Political Weekly*. 1993, Vol.28,

1869-1878.

Suggestive readings

- Anjali Arondekar "Without a Trace: Sexuality and the Colonial Archive." *Journal of the History of Sexuality*, vol. 14, no. 1/2, 2005, 10–27.
- Antoinette Burton, ed., *Archive Stories: Facts, Fictions, and the Writing of History* (Durham: Duke University Press, 2005)
- Arlette Farge, *The Allure of the Archives*, New Haven: Yale University Press, 2013, 79-113.
- Crispin Bates, "Race, caste and tribe in central India: the early origins of Indian anthropometry" In Peter Robb (Ed.), *The Concept of Race in South Asia*, Delhi: OUP, 219-59.

- Edwards, Elizabeth. "Photography and the Material Performance of the Past." *History and Theory*, vol. 48, no. 4, 2009, 130–50.
- Kama MacLean, "The Portrait's Journey: The Image, Social Communication and Martyr-Making in Colonial India." *The Journal of Asian Studies* 70, no. 4, 2011 1051–82.
- Ranajit Guha, "The Prose of Counter Insurgency", *Subaltern Studies: Writings of South Asian History and Society*, Vol 2, Delhi: Oxford University Press, 1-42.
- Shahid Amin, "Gandhi as Mahatma: Gorakhpur District, Eastern UP, 1921-2' in R. Guha (ed.), *Subaltern Studies: Writings on South Asian History and Society*, vol. 3, Delhi, Oxford University Press, 1984, 1-61.
- Tanika Sarkar "A Book of Her Own. A Life of Her Own: Autobiography of a Nineteenth-Century Woman." *History Workshop*, no. 36, 1993, 35–65.

Examination scheme and mode:

Total Marks: 100 marks

Internal Assessment: 25 marks

End Semester University Exam: 75 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

WORKING WITH PEOPLE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
WORKING WITH PEOPLE	2	1	0	1	Class XII	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To inculcate values in strengthening knowledge and skills in field work practice learning
- To develop aptitude and attitude to work in the field
- To enhance skills of self-awareness, self-development, goal setting and time management

Learning outcomes

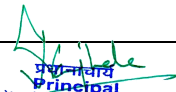
At the end of the semester the students will be able to

- Develop a practical understanding of using different skills while working with individuals and groups
- Develop skills and competencies to work effectively in field settings
- Acquire understanding about self, goal setting, networking, and communication

SYLLABUS

Course Content

Unit I: Developing Personal and Professional Self	(No. of hours)
Unit Description: This unit will provide a conceptual understanding of Self-awareness and sensitivity. The students will learn about goal setting, time management and ethics in social work practice.	3
Subtopics:	Weeks: I-III
● Understanding personal self and professional self.	


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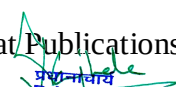
- Professional Ethics: Responsibility, accountability, loyalty, commitment, cultural sensitivity and competence. - Goal setting and time management	
Unit II: Planning for Field Work Practice Unit Description: This unit will introduce the students to strategic learning plans required for field work, thematic modules for different target groups and importance of rapport building and communication while working in community.	(No. of hours) 4 Weeks: IV-VII
Subtopics: - Preparation of Field work learning plans and strategies. - Rapport building, initiating dialogues and sustaining communication. - Thematic learning modules for targeted populations: Children, adolescent, youth and elderly.	
Unit III: Documentation in Field Work Unit Description: This unit will focus on documentation and maintaining records while working with individuals, groups and communities. The students will also learn to develop community profile.	(No. of hours) 4 Weeks: VIII-XI
Subtopics: - Case records - Group work records - Community profile	
Unit IV: Application of Skills and Techniques Unit Description: This unit will introduce various skills and techniques required in understanding self and mobilising support.	(No. of hours) 4 Weeks: XII-XV
Subtopics: - Understanding Self: Johari Window - Strength and Weakness- SWOT Analysis - Mobilising Community Support: Networking, Advocacy and Public Relation	

Practical component (if any) – Unit III & IV application based

(30 hours)

Essential readings

- Datar, S. et al. (2010). Skill Training for Social Workers: A Manual. New Delhi: Sage Publications
- Kumar, S. (2002). Methods for Community Participation: A Complete Guide for Practitioners. London: ITDG Publishing.
- Nair, R., Juvya, S., & Nadkarni, V. (2020). Field Instructions in Social Work Education, The Indian Experience. Routledge India.
- Subhedar, I. S. (2001). Field Work Training in Social Work. New Delhi: Rawat Publications.


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- Trevithik, P. (2000). Social Work Skills: A Practice Handbook. Buckingham, Philadelphia: Open University Press.
- Verma, R.B.S. & Singh, A.P. (2013). Standard Manual for Field Work Practicum in Social Work. Lucknow: New Royal Book Company.

Suggested readings

- NAPSWI. (2016). NAPSWI's Code of Ethics for Professional Social Workers in India. New Delhi: National Association of Professional Social Workers in India

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

LIFE SKILL EDUCATION

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LIFE SKILL EDUCATION	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart life skills education in field work practice
- To strengthen life skills for career building, critical thinking, attitudinal base for innovate leadership
- To learn the application of life skills in diverse field work settings

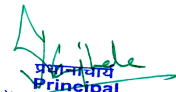
Learning outcomes

At the end of the semester the students will be able to

- Focus on development of values in strengthening knowledge and life skills, bringing high quality standards in field work practice-learning
- Understand the strength-based life skill development, team work, innovate leadership, design thinking and career building skills
- Develop universal human values while utilizing life skills in field work

SYLLABUS

Unit I: Life Skills Introduction Unit Description: To introduce students to the basic concepts of life skill management.	(No. of hours) 3 Weeks: I-III
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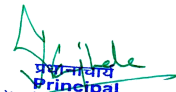
Subtopics: • Basic Life Skills: Concept, Components and Significance • Life Skills Development: National Perspective • Universal Human Values – Love, Compassion, Truth, Non-violence, Peace, Gratitude, Patience and Tolerance	
Unit II: Basic Life Skills Unit Description: To learn the set of essential life skills that can lead to high employability and good work culture.	(No. of hours) 4 Weeks: IV-VII
Subtopics: • Team Work Skills: Social Etiquettes, Democratic Decision, and Collaboration • Innovative Leadership: Initiative taking, Time Management, Capacity building, Life Coaching • Career Building Skills: Exploring Career Opportunities, Mentoring, Resume Preparation, facing Interview & Group Discussion, Presentation Skills, Creating social media profile	
Unit III: Significant Life skills and Techniques Unit Description: To understand potential changes that can be brought about by employing essential life skills	(No. of hours) 4 Weeks: VIII-XI
Subtopics: • Developing Strategies for enhancing Life Skills • Life Skills (Cognitive based): Critical Thinking, Knowledge construction, Evaluating reasoning, Solution Focused Thinking, • Life Skills (Behavioural Based): Ethics, Integrity, Problem Solving, Decision making	
Unit IV: Application of life skills in Field Work Unit Description: To learn the application of essential life skills in diverse settings through case studies about interventions	(No. of hours) 4 Weeks: XII-XV
Subtopics: Developing specific life skills intervention plan for • Stress Management and Coping strategies • Simulation exercises: Brainstorming, Role plays for Team building • Case Management	

Practical component (if any) – Unit III & IV application based

(30 hours)

Essential readings

- Bandyopadhyay and Subrahmanian (2008), Gender Equity in Education: A Review of Trends and Factors


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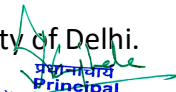
- Brinkman, F. J. (2016). Environment, Religion and Culture in the Context of the 2030 Agenda for Sustainable Development, (April).
- Brown, T. (2012). Change by Design. Harper Business
- Care, E., Kim, H., Anderson, K., & Gustafsson-Wright, E. (2017). Skills for a Changing World: National
- Census of India. (2011), Registrar General of India
- Clarke, D., Bundy, D., Lee, S., Maier, C., Mckee, N., Becker, A., Paris, F. (n.d.). Skills for Health Skills-based health education including life skills: An important component of a Child-Friendly/Health-
- Dewan S, Sarkar U (2017) From education to employability: Preparing South Asian Youth for the world of work, UNICEF ROSA
- International Youth Foundation. (2014). Strengthening life skills for youth : A practical guide to quality programming.
- Kwauk C & Braga. (2017) Life skills education is more than teaching skills, Brookings institution Washington DC
- LIFESKILLS EDUCATION. (n.d.). Retrieved from, http://www.cbse.nic.in/cce/life_skills_cce.pdf
- Perspectives and the Global Movement. Retrieved from <https://www.brookings.edu/wp-content/uploads/2017/03/global-20170324-skills-for-a-changing-world.pdf>

Suggested readings

- Martin, R. (2007). How Successful Leaders Think. Harvard Business Review, 85(6): 60.
- Govt. of India. (2014 & 2016) Educational Statistics at a glance, MHRD,
- Murphy-Graham (2012), Opening Minds, Improving Lives: Education and Women's Empowerment in Honduras
- Sen Madhucchanda (2010), An Introduction to Critical Thinking, Pearson, Delhi
- South, T., Life, A., & Forum, E. (2005). Life Skills-Based Education in South Asia.
- Street, C. (2012). Global Life Skills Education Evaluation, (February).
- WHO (1997). Life Skills Education for Children and Adolescents in Schools. Geneva: WHO.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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PARTICIPATORY LEARNING AND ACTION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PARTICIPATORY LEARNING AND ACTION	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the basic principles and process of using Participatory Learning in field work settings
- To learn various techniques of Participatory Learning for working in rural and urban communities
- To learn the skills involved in application of participatory learning techniques

Learning outcomes

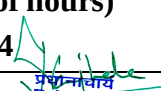
At the end of the semester the students will be able to

- Identify the situations where participatory learning techniques can be applied
- Demonstrate the process of various techniques and skills of participatory learning in field setting
- Analyse PLA data and reflect the same in report writing

SYLLABUS

Course Content

Unit I: Introduction to Participatory Learning and Action	(No. of hours)
Unit Description: This unit introduces the students to the concept of	4


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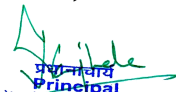
Participatory Learning and Action (PLA). The students will also learn the advantages of PLA and its use over other similar techniques.	Weeks: I-IV
Subtopics: • Participatory learning Action (PLA): Meaning, origin and principles • Participatory learning: Basic rules and phases • Preparations for PLA	
Unit II: PLA : Tools and Techniques Unit description: This unit aims to familiarize students with various tools and techniques of PLA which can be applied in community setting.	(No. of hours) 4 Weeks: V-VIII
Subtopics: • PLA techniques I: Community mapping (social & resource mapping), • PLA Techniques II: livelihood analysis, Venn(chapati) diagram, Time line analysis, Vector scoring, (preference ranking, issue prioritization, wealth ranking), Calendars (Seasonal calendar, Daily routine diagram), Transect walk • Roles and responsibilities of PLA teams	
Unit III: Practical Application of Participatory Learning techniques Unit Description: The students will be engaged in hands on learning for practical application of PLA techniques through workshops and group exercises.	(No. of hours) 3 Weeks: IX-XI
Subtopics: • Project work: Community Mapping, • Project work: Need assessment (Calender/Seasonal Analysis/Transect Walk/Vector scoring) • Project work: Resource identification & Utilization	
Unit IV: Analysis of data through PLA Techniques Unit description: The students will learn to analyse the information collected through PLA tools.	(No. of hours) 4 Weeks: XII-XV
Subtopics: • Use of PLA for research and community action • Processing, analysis and interpretation of data generated through participatory learning tools • Report writing: Tips and techniques	

Practical component (if any) – Unit III & IV application based

(30 hours)

Essential readings

- Chambers, R (1983) Rural Development: Putting the last first. Longman inc., USA, 1983.


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- Chambers, R (2008). *Revolutions in Development Inquiry*. Institute of Development Studies, 2008, Earthscan, London.
- Mikkelsen, B (1995). *Methods for Development Work and Research: A guide for practitioners*. London, Sage.
- N. Narayansamy (2009): *Participatory Rural Appraisal-Principles, Methods and Application*, first edition. Gandhigram Rural University, Tamil Nadu, India
- Ramesh, R (2020): *Participatory Rural Appraisal :PRA Application in Rural Development Planning*. National Institute of Rural Development and Panchayati Raj Ministry of Rural Development, Government of India.
- Slocum, R; Wichhart, D; Rocheleau, D and Thomas-Slayter, B (eds.) (1995). *Power, Process and Participation – Tools for change*. London, IT Publications

Suggested readings

- Jules N. Pretty, Irene Guijt, Ian Scoones, & John Thompson (1995): *A Trainer's Guide for Participatory learning and Action*. International Institute for Environment and Development, London.
- Gosling, L and Edwards, M (2003). *Toolkits: A practical guide to assessment, monitoring, review and evaluation*. Second edition. Save the Children, UK
- The Leprosy Mission Trust India TLMTI (2015): *Participatory Learning Approach Training Manual*, New Delhi.
- Mukherjee, N. (1993): *Participatory rural appraisal: Methodology and applications (Studies in rural participation)*. Concept publications, India.
- Mascarenhas, J (1991): *Participatory Rural Appraisal and Participatory Learning methods: recent experiences from Myrada and South India*, RRA Notes, Issue 13, pp.26–32, IIED, London.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

PROGRAMME MEDIA

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PROGRAMME MEDIA	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the concept of programme media and its importance in field work practice
- To learn about various types of programme media and their effective use in field work
- To learn to demonstrate creative ideas and tools in field settings

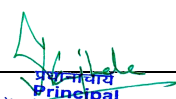
Learning outcomes

At the end of the semester the students will be able to

- Learn the concept of programme media in social work
- Develop various programme media tools to be used in field settings
- Demonstrate the skills essential for using programme media in the field work

SYLLABUS

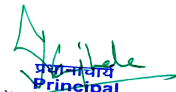
Unit I: Understanding Programme Media Unit Description: This unit will give an opportunity to the students to understand the concept of programme media in social work.	(No. of hours) 4 Weeks: I-IV
Subtopics: • Programme media: Concept, characteristics, purpose and significance • Communication in programme media	


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• Role of programme media: propaganda and public opinion	
Unit II: Mediums and Methods of Programme Media Unit Description: Student will learn different types of programme media to be used for diagnostic, problem-solving and therapeutic purposes.	(No. of hours) 4 Weeks: V-VIII
Subtopics: • Types of programme media: Talk, public meeting & hearing, group discussion, press conference, movement, advertisement, campaign, storytelling and entertainment/games • Information and digital literacy: Concept, importance and components • People's participation in programme: Film screening, discussion and review	
Unit III: Handmade Creations and Creative Writings in Social Work Unit Description: This unit will give an opportunity to the students to learn various handmade creations and creative writings of programme media to interact with client groups.	(No. of hours) 3 Weeks: IX-XI
Subtopics: • Handmade creations: Collage, poster making, wall paintings • Creative writings: short story writing, slogans writing and preparing brochures, hand-outs & pamphlets, FAQs • IEC materials: Flip chart, flash cards, flyers, leaflets, banners, hoardings and standee	
Unit IV: Programme Media for Masses Unit Description: The students will be engaged in various learning activities related to application of programme media in field settings.	(No. of hours) 4 Weeks: XII-XV
Subtopics: • Tools preparation: Puppet shows & folk songs, • Performing arts: street plays, drama & theatre &, mime, skit and role plays • Significance of digital media: TV, community radio broadcast and various social media platforms	

Practical component (if any) – Unit III & IV application based

(30 hours)


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Essential readings

- Balwant, G. (1991). Folk Theatre in India. Bombay: Rupa & Co.
- Chen, H. T. (2005). Practical Programme Evaluation: Assessing and Improving Planning, Implementation and Effectiveness. California: Sage Publication.
- Cortright, R. & Hinds, G. (1959). Creative Discussion. New York: The Macmillian Company.
- Dev, M. P. (2009). Creative Writing: A Beginner's Manual. New Delhi: Pearson Longman.
- Mathur, D. (2003). AASHAA, Short Stories by Indian Women, Odyssey II. London: Indian Bookshelf and New Delhi: Star Publishing.
- Menon, M. & Gandhi, V.P. (1997.) Media and Communications - Vol. I. (New Information Order). New Delhi: Kanishka Publishers/Distributors.

Suggested readings

- National School of Drama. (2006). Nukkad Natak Rachna aur Prastuti. Delhi: NSD.
- Mohan, K. & Banerji, M. (1990). Developing Communication Skills. Pilani: Birla Institute of Technology and Science.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre- requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Finance for Everyone	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To offer an integrated approach to the understanding of concepts and applications of financial planning.
- To help the students in their financial planning.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the importance of financial literacy and the institutions providing financial services.
- After studying this course, students will be able to prepare a financial plan, budget and manage personal finances.
- After studying this course, students will be able to open, avail and manage services offered by banks.
- After studying this course, students will be able to open, avail and manage services offered by post offices.
- After studying this course, students will be able to plan for life insurance and property insurance.
- After studying this course, students will be able to choose instruments for investment in shares.

SYLLABUS

Unit 1: Introduction, Financial Planning and Budgeting

(4 hours)

Meaning, importance and scope of financial literacy; Prerequisites of financial literacy – level of education, numerical and communication ability; Various financial institutions – banks, insurance companies, post offices, mobile app based services. Need of availing of financial services from banks, insurance companies and postal services. Concept of economic wants and means for satisfying these needs; Balancing between economic wants and resources; Meaning, importance and need for financial planning; Personal budget, family budget, business budget

and national budget; Procedure for financial planning and preparing a budget; Budget surplus and budget deficit, Avenues for savings from surplus, Sources for meeting the deficit.

Unit 2: Banking Services

(3 hours)

Types of banks; Banking products and services – Various services offered by banks; Types of bank deposit accounts – savings bank account, term deposit, current account, recurring deposit; pan card, address proof, KYC norm; Various types of loans – education loan, consumer durable loan, vehicle loan, housing loan, short term, medium term, long term, microfinance, bank overdraft, cash credit, mortgage, reverse mortgage, hypothecation, pledge, Agricultural and related interest rates offered by various nationalized banks; Cashless banking, e-banking, check counterfeit currency; CIBIL, ATM, net banking, RTGS, NEFT, IMPS, electronic clearance services (ECS), debit and credit card, app based payment system, bank draft and pay order; banking complaints and ombudsman.

Unit 3: Financial Services from India Post Office

(2 hours)

Post office savings schemes: savings bank, recurring deposit, term deposit, monthly income scheme, kisan vikas patra, NSC, PPF, senior citizen savings scheme, sukanya samridhi yojana; india post payments bank. money transfer: money order, e-money order. instant money order, collaboration with the western union financial services; mo videsh, international money transfer service, money gram international money transfer, indian postal order.

Unit 4: Insurance Services

(3 hours)

Life insurance policies: life insurance, term life insurance, endowment policies, pension policies, ULIP, health insurance plans, comparison of policies offered by various life insurance companies, comparison of policies offered by various health insurance companies. Property insurance policies. Post office life insurance schemes: postal life insurance and rural postal life insurance.

Unit 5: Stock Markets – Some Basic Concepts

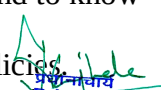
(3 hours)

Terms used in stock markets: SENSEX, NIFTY, primary markets, secondary markets, initial public offering(IPO), follow-on public offering (FPO), offer for sale (OFS), block deal, equity shares, preference shares, debentures, bonus shares, stock split, dividend, buyback, DEMAT account, trading account, delivery instruction slip (DI Slips), blue chips, defensive stocks, face value, market value, market capitalisation, pre-opening session, trading session, opening price, closing price, business days, bull, bear, bull market, bear market, risk, stop loss, derivatives, call option, put option, hedge, holding period; Tax on short term capital gains and long-term capital gains, Mutual Fund and its various schemes.

Practical Exercises: (30 hours)

The learners are required to:

- visit banks, post offices, and insurance companies to collect information and required documents related to the services offered by these institutions and to know the procedure for availing of these services.
- carry out the comparative analysis of different types of life insurance policies.
- carry out the comparative analysis of different types of health insurance policies.
- prepare a personal and family budget for one/six/ twelve months on individual figures.


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Suggested Readings:

- Avadhani, V. A. “Investment Management” Himalaya Publishing House Pvt. Ltd., Mumbai.
- Batra, J.K., Accounting and Finance for Non-finance Managers, Sage Textbook
- Chandra, P. “Investment Game: How to Win” Tata McGraw Hill Education, New Delhi.
- Kothari, R. “Financial Services in India-Concept and Application” Sage Publications India Pvt. Ltd., New Delhi.
- Milling, B. E. “The Basics of Finance: Financial Tools for Non-Financial Managers” Universe Company, Indiana,
- Mittra, S., Rai, S. K., Sahu, A. P., & Starn, H. J. “Financial Planning” Sage Publications India Pvt. Ltd., New Delhi.
- Zokaityte, A. “Financial Literacy Education” Palgrave Macmillan, London.

Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Personal Financial Planning

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Personal Financial Planning	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with different aspects of personal financial planning like savings, investment, taxation, insurance, and retirement planning
- To develop the necessary knowledge and skills for effective financial planning.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to understand the meaning and appreciate the relevance of financial planning.
- After studying this course, students will be able to understand the concept of investment planning and its methods.
- After studying this course, students will be able to examine the scope and ways of personal tax planning.
- After studying this course, students will be able to analyse insurance planning and its relevance.
- After studying this course, students will be able to develop insight into retirement planning and its relevance.

SYLLABUS

Unit 1: Introduction to Financial Planning: (3 hours)

Financial goals, steps in financial planning, budgeting incomes and payments, time value of money. Introduction to savings, benefits of savings, management of spending & financial discipline, Setting alerts and maintaining sufficient funds for fixed commitments.

Unit 2: Investment Planning: (4 hours)

Process and objectives of investment, concept and measurement of return & risk for various asset classes, measurement of portfolio risk and return, diversification & portfolio formation. Gold bond; Real estate; Investment in greenfield and brownfield Projects; Investment in fixed income instruments, financial derivatives & commodity market in India. Mutual fund schemes; International investment avenues. Currency derivatives and digital currency.

Unit 3: Personal Tax Planning: (3 hours)

Tax structure in India for personal taxation, Scope of personal tax planning, exemptions and deductions available to individuals under different heads of income and gross total income. Comparison of benefits - Special provision u/s 115 BAC vis-à-vis General provisions of the Income-tax Act, 1961, tax avoidance versus tax evasion.

Unit 4: Insurance Planning: (2 hours)

Need for insurance. Life insurance, health insurance, property insurance, credit life insurance and professional liability insurance.

Unit 5: Retirement Benefits Planning: (3 hours)

Retirement planning goals, process of retirement planning, Pension plans available in India, Reverse mortgage, Estate planning.

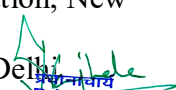
Practical Exercises: (30 hours)

The learners are required to:

- perform electronic fund transfers through net banking and UPI.
- identify certain recent Ponzi schemes in the market.
- prepare tax planning for a hypothetical individual.

Suggested Readings:

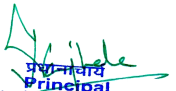
- Halan, M. "Let's Talk Money: You've Worked Hard for It, Now Make It Work for You" Harper Collins Publishers, New York.
- Indian Institute of Banking & Finance. "Introduction to Financial Planning" Taxmann Publication, New Delhi.
- Keown A.J. "Personal Finance" Pearson, New York.
- Madura, J. "Personal Finance", Pearson
- Pandit, A. "The Only Financial Planning Book that You Will Ever Need" Network 18 Publications Ltd., Mumbai.
- Sinha, M. "Financial Planning: A Ready Reckoner" McGraw Hill Education, New York.
- Tripathi, V. "Fundamentals of Investment" Taxmann Publication, New Delhi.


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Note: Learners are advised to use the latest edition of readings.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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YOGA IN PRACTICE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Yoga in Practice	2	0	0	2	Class XII Pass	NIL

Total Credits: 02

Learning Objectives:

Students will be able to discern real significance of yogic operations from original sources and will be prone to practicing in their day to day life.

Learning Outcomes:

- (i) Student will form an understanding of the concept of yoga.
- (ii) Students will learn various aspects of the science of yoga.
- (iii) Theoretical and practical knowledge of Aasanas and pranayams to lead a balanced life.

SYLLABUS OF YOGA IN PRACTICE

Practical

Unit: I

30 hours

- (i) Definition and types of yoga:

Karma yoga, Gyana yoga, Bhakti yoga, Laya yoga, Raja yoga, Hatha yoga, Mantra yoga,

Kundalini yoga. (योग एवं 4ांश – अध्याय -१)

- (ii) Ashtanga Yoga:

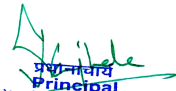
Yam- Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha.

Niyam- Saucha, Santosha, Tapa, Swadhyaya, Ishwarpranidhana

Asana, Pranayama- (the types of Pranayama: Puraka, rechak & Kumbhaka), Pratyahara, Dharana, Dhyana & Samadhi etc.

- (iii) Shat Chakra,s:

Mooladhara, Swadhishtana, Manipura, Anahata, Vishudha, Aagya, Sahasrara- (Sahasradhara chakra). (योग एवं 4ांश – अध्याय – २-३)


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Unit: II**30 hours**

Asana,s and their advantage:-

(i) Asana in standing position:

Surya Namaskara, Tadasana, Padahasthasana, Garudasana, Natarajasana, Cakrasana.

(ii) Asana in sitting position:

Padmasana, Vajrasana, Siddhasana, Bhadrasana, Gomukhasana,

Shashankasana, Mandukasana, Kukkutasana.

(iii) Asana in stomach side position:

Dhanurasana, Bhujangasana, Mayurasana, Marjarasana, Makrasana.

(iv) Asana in backbone side position:

Uttanapadasana, Naukasana, Sarvangasana, Sheershasana, Savasana etc.

(v) Practice of pranayama- Purak, Rechak and Kumbhaka. (योग एवं 4ाव - अ० - ३ - ४, ६)

Essential Readings:

1. योग दर्शन - महर्षि पतंजलि, टीकाकार-हरकृष्ण भास गोयला, गीता प्रेस, गोरखपुर, उत्तर प्रदेश,

४० वां पुनर्मुद्रण ।

2. योग एवं 4ाव - डॉ० विजय कुमार, चौखटा वि० भारती, वाराणसी, उत्तर प्रदेश, प्र० सं० - २०२१ ।

3. प्राणायाम रहस्य - (वैय्यािनिक तर्कों के साथ) - 4ामी रामदेव, वि० प्रकाशन, वि० योग मठ, पतंजलि योगपीठ,

कनखल, हरद्वार ।

4. योग साधना एवं योग चिकित्सा रहस्य - 4ामी रामदेव, वि० प्रकाशन, वि० योग मठ, पतंजलि योगपीठ,

कनखल, हरद्वार ।

5. शतयुव पुत्र - 4ामी रामदेव, पतंजलि योगपीठ, आ० प्रकाशन, कुं डेवाली, वि० - २०६२ । (वैदिक पुत्रकालय, मु० ई)

Suggestive Readings:

1. योग चिरपी - 4ामी अ० तानु सराती, गु० कुल वृंवावन वातक शोध सं०, आसफ अली रोड, नई वि० - २००६ ।

2. डायाम का मह - 4ामी ओमान सराती, हरयाणा साहिब सं०, गु० कुल झर, हरयाणा - २००६ ।

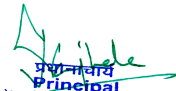
3. आयुवदीय प० चिकित्सा - आचार्य वि० धर शु० 4, भारतीय के० चिकित्सा प०, नई वि० ।

4. रोग और योग - 4ामी कमल सराती, योग प० शन, मुंगेर, बिहार, सं० - २०१३ ।

5. स० योग वि० - राजीव जैन त्रिलोक, मंजुल प० शिंग हाउस, भोपाल, म० प्रदेश, सं० - २००५ ।

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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Cyber Sphere and Security: Global Concerns

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cyber Sphere and Security: Global Concerns	2	1	0	1	Class XII	NIL

Learning Objectives

The Learning Objective of this course is as follows:

- To spread awareness and enlightening visions of the indiscriminate and diversified students to ensure their immediate and basic cyber safety and prevent loss due to sheer ignorance.

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to apprehend key terms of cyber domain and identify cyber threats.
- After studying this course, students will be able to understand cyber law concepts, intellectual property and Digital Rights Management.
- After studying this course, students will be able to diagnose and examine basic security loopholes, anomalous behavior in internet.
- After studying this course, students will be able to understand principles of web security.
- After studying this course, students will be able to secure and protect personal data with safe Internet usage.
- After studying this course, students will be able to assimilate approaches for incident analysis and response, risk management and best cyber security practices.

SYLLABUS (Theory + Practical)

Unit I: Introducing Cyber ‘Sphere’ and ‘Security’ (3 hours)

- Cyber Terminologies: Cyber Sphere, Cyber Security, Cyber Crime, Cyber Attack, Cyber Espionage, Cyber Warfare, Cybernetics
- Cyber Security and Paradigms
- Cyber Security: Objectives and Roles

Unit II: Cyber Crime: Insight, Mitigation and Control (3 + 6 hours)

- Cyber Crime and Cyber Activism: An Overview
- Typologies of Cyber Crimes: Generic Cyber Crimes, Advanced Persistent Threats (APTs), Cyber Threat in Mobile Technology, Cloud Computing and BYOD
- Cyber Crime Identification, Risk Assessment, Management and Control

Unit III: Cyber Policies and Cyber Law (3 + 6 hours)

- Cyber Policies and Cyber Law: Dimensions, Determinants, Dilemmas
- Existing Cyber Policies and Must Follow Up Actions
- Grey Areas in Cyber Laws

Unit IV: Security Tools and Usage (3 + 6 hours)

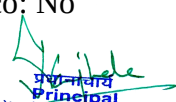
- Knowledge and Identification of Security Tools
- Cyber Security Aspects
- Cyber Security Toolkits

Unit V: Cyber Security: Case Studies (3 + 6 hours)

- Government Institutions
- Banks and Financial Institutions, Commercial Websites, Point of Sale issues and Online Payment
- Real Time Cases

Essential Readings:

- Bertrand Venard (2019). ‘Cyber Security: The New Art of War’, Lecture delivered at Developing Countries Research Centre [dcrcc], University of Delhi, 1 April 2019.
- Bertrand Venard (2019). ‘The Determinants of Cybersecurity Behaviours: Qualitative Research Among French Students’ in C. Onwubiko, X. Bellekens, A.Erola, M. Jaatun and C. Nogueira (eds.), Proceedings of the Cyber Science 2019: Cyber Situational Awareness for Predictive Insight and Deep Learning. UK: University of Oxford.
- Bertrand Venard (2019). Cybersecurity Among students. UK: Wolfson College, University of Oxford.
- Bertrand Venard (2019). Cyber Aggressions in the XXIst Century: Equation of a Crisis. UK: University of Oxford.
- Cristopher Hadnagy (2018). Social Engineering: The Science of Human Hacking, 2nd Edition. New York: Wiley
- John Erickson (2008). The Art of Exploitation (2nd Edition). San Francisco: No Starch Press.


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- Kevin Mitnick and Robert Vamosi (2017). The Art of Invincibility. Boston: Little, Brown and Company.
- Kevin Mitnick (2012). The Ghost in the Wires: My Adventures as the World's Most Wanted Hacker. New York: Back Bay Books.
- Yogesh Atal and Sunil K Choudhary (2013). Combating Corruption: The Indian Case. Hyderabad and New Delhi: Orient Blackswan.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.

Harmonium

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Harmonium	2	0	0	2	Class XII	NIL

Learning Objectives

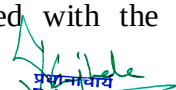
The Learning Objectives of this course are as follows:

- To initiate the students to a very popular instrument of Indian music through a general discussion on the role of Harmonium in accompanying various singing forms
- To throw light on the various types of musical instruments that are played in Hindustani music
- To discuss the features of various types of wind instruments
- To teach the student the fundamentals of playing the Harmonium, such as the correct placement of the fingers on the instrument, the right posture for sitting etc.
- To demonstrate tonal exercises, such as palta-s and alankar-s, vital for playing.
- To initiate his training in the realm of playing the instrument with the basic ragas, like Alhaiya, Bilawal and Yaman

Learning outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to learn the origin, development and classification of musical instruments.
- After studying this course, students will be able to learn the importance of wind instruments.
- After studying this course, students will be able to learn gat and dhun in prescribed ragas.
- After studying this course, students will be able to demonstrate the various talas and their layakaries.
- After studying this course, students will become well-versed with the techniques of playing Harmonium


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- After studying this course, students will be able to achieve dexterity of the hand, through regular practice of the playing exercises at home.
- After studying this course, students will be able to read and learn new compositions in the prescribed ragas.
- After studying this course, students will be able to grasp the various grammatical aspects of the prescribed ragas, like how they arise, what are the respective rules that govern these ragas, how do the notes move in the ragas, what are the performing times of the ragas etc.
- After studying this course, students will be able to learn the art of playing a raga, especially with regard to having the Tabla as an accompanying instrument.

SYLLABUS Practical (60 Hours)

Unit I

Origin and Development of Musical Instruments

Unit II

Classification of instruments

Unit III

Study of Wind Instruments

Unit IV

Writing notation of compositions in prescribed ragas

Unit V

Writing notation of Talas with Thah, Dugun, Tigun and Chaugun in Kaharva

Unit VI

Theoretical knowledge of the prescribed ragas

(Practical - 1): Stage Performance & Viva-Voce:

Prescribed Ragas:

- Alhaiya Bilawal
- Yaman
- Khamaj

Unit I

Ability to play five alankars in the prescribed ragas.

Unit II

One Sargam Geet to be played each in the prescribed ragas

Unit III

One Lakshan Geet each to be played in the prescribed ragas

Unit IV

Two Drut Khyals with elaborations in any of the prescribed ragas

Unit V

Ability to play a Dhun in raga Khamaj

Unit VI

In-depth knowledge of the prescribed ragas

Unit VII

Knowledge and demonstration of the following tala with dugun, tigan and chaugun - Kaharva

Unit VIII

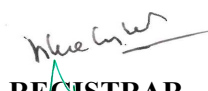
Basic knowledge of Harmonium and its various parts

Recommended Books:

- Sangeet Bodh – Sharadchandra Shridhar. Paranjape:-Madhye Pradesh Hindi Granth Acadamy , Bhopal, IstEdition: 1972
- Samvadini – Jayant Bhalodkar :- Kanishka Publication, New Delhi, Ist Edition: 2006
- Dhvani Aur Sangeet - Lalit Kishore Singh:- Bhartiye Gyanpeeth, Lodi Road, New Delhi, Ist Edition: 1954
- Kramik Pustak Malika – Part- II :- V.N. Bhatkhande, Sangeet Karyalaya, Hathras, Editor: Laxminarayan Garg, January: 2008
- Sangeet ShastraVigyan - Dr.Pannalal Madan:- Rajasthan Hindi Granth Acadamy, Jaipur, 2nd Edition: 1991, Abhishek Publication
- Tal Parichay Part III ,Girishchandra Srivastava, Rubi Prakashan , Allahabad, 2nd Edition: June: 2002

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi.


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GENERIC ELECTIVES (GE-EVS-7): CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Inculcate interdependent and interrelated theories of corporate branding, environmental sustainability, and social equity
- Understand the working and driving forces of CSR and its significance as a stepping stone to Sustainable Business Models
- Gain insights into CSR as a tool to ensure social justice and adopt environmental wisdom from industries
- Empower with emerging frameworks and practices in CSR for environmental sustainability and improve quality of life

Learning outcomes

After the course, students will be able to:

- Explain the concept of CSR from an environmental sustainability perspective and its significance in next-generation marketing strategies
- Apply concepts of CSR to develop strategies for responsible marketing, business success, and environmental protection.
- Develop systems thinking and evolve as a responsible consumer
- Decipher linkages between concepts of circular economy, sharing economy, and carbon/ecological footprints, and identify opportunities and challenges to specific businesses and target consumers.
- Gain insights into five dimensions of sustainability performance: economic, environmental, governance, social and ethical
- Practice sustainability management, implement cleaner technologies, and argue in favour of environmental protection.

SYLLABUS OF GE-EVS-7

Theory (02 Credits: 30 lectures)

UNIT – I Sustainable Development (8 Hours)

Definitions, goals and frameworks; Sustainability: Definition and concept, Bottom of the pyramid and fairtrade; Evolution of concepts, Socio-ethical and environmental aspects, Benefits in strategic planning; Associated world's leaders and corporations, Financial, social and reputational benefits, Circular and share economy (8 lectures)

UNIT – II Corporate social responsibility (CSR) (6 Hours)

CSR: Definition and concept, Philosophy and practices of CSR; Measuring CSR; Impact of CSR on rural livelihoods, natural resources management, biodiversity conservation; Carbon footprint; Cleaner technologies; Emerging CSR policies in India

UNIT – III CSR and Sustainability (9 Hours)

Why and when to apply CSR activities, Competitiveness vs Ethical, Green markets and budget, Bottlenecks of being sustainable, Public-private partnerships for socio-ecological entrepreneurship, Vocal for local embedding sustainability; Business strategies for sustainable individuals, firms, and industries, Power-Inequality-Environment-CSR nexus, Managing, Monitoring, and Reporting CSR, Beyond framing CSR as strategic, political or utopian (9 lectures)

UNIT – IV Case studies (7 Hours)

CSR applications for improving livelihoods, enhancing soil health and crop productivity in stress environment, adaptation to climate change, and diversification of crop patterns improving rural wastewater management (7 lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Analyze variations in CSR efforts in saving the environment by countries differing in biodiversity and ecosystem diversity
2. Critically analyze OECD Guidelines for Multinational Enterprises on corporate responsibility
3. Select a company/business organization and, based on its activities and products, identify the environmental issues that need to be addressed for societal need
4. Evaluate diverse environmental issues based on their impact on society and organizational brand value and develop its vision document and a CSR plan for environmental conservation
5. Determine priorities and evolve a code of conduct document for the selected company to maximize its CSR for environmental issues
6. Based on the activities of the target business organization, develop an action plan and policies to suit the international guidelines and standards of CSR for environmental conservation

7. Identify the constraints to implement the guidelines and standards set based on dialogue with different stakeholders and surveying the local circumstances
8. Analyze the variations in guidelines and standards to meet the CSR in countries differing in biodiversity and cultural values
9. Identify the environmental indicators to formulate a monitoring and reporting system for CSR success
10. Evolve the appropriate communication style for different internal and external stakeholders
11. Field surveys and lab-based assays for monitoring the targeted ecosystem, biodiversity, environmental compartment, and socio-ecological systems for the impact of CSR

Essential/recommended readings

- Bachnik, K., Kaźmierczak, M., Rojek-Nowosielska, M., Stefańska, M. and Szumniak-Samolej, J. (eds.), 2022. *Corporate Social Responsibility and Sustainability: From Values to Impact*. Routledge.
- Camilleri, M.A., 2017. *Corporate Sustainability, Social Responsibility and Environmental Management*. Cham, Switzerland: Springer International Publishing.
- Geoffrey H., 2010. *When Principles Pay: Corporate Social Responsibility and the Bottom Line*, Columbia University Press.
- McKenna, K., 2015. *Corporate Social Responsibility and Natural Resource Conflict*. Routledge.

Suggested readings

- Roberts, L., Georgiou, N. and Hassan, A.M., 2022. Investigating biodiversity and circular economy disclosure practices: Insights from global firms. *Corporate Social Responsibility and Environmental Management*. DOI: 10.1002/csr.2402
- Ringham, K., 2017. *CSR and Sustainability: From the Margins to the Mainstream: A Textbook*, Routledge
- Rendtorff, J.D., 2019. *Philosophy of Management and Sustainability: Rethinking Business Ethics and Social Responsibility in Sustainable development*. Emerald Group Publishing.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

General Elective 2: HUMAN-WILDLIFE CONFLICT AND MANAGEMENT

Theory (30 Lectures)

Course objectives:

- Analyze causal factors determining conflicts between humans and wildlife
- Gaining insights into complexity of habitat sharing between wildlife and human societies
- Acquire deeper understanding of causal factors of habitat shrinkage and its impact on wildlife dynamics and threats and benefits to human societies
- Reveal the nexus between humans-culture-economy-wildlife
- Develop scientific and social perspective of wildlife conservation.

Unit 1: Introduction to wildlife management

(5 lectures)

Need of environmental management; wildlife conservation: moral obligation? philosophy of wildlife management; why is it necessary to worry about human wildlife conflicts? What is the role of government, wildlife biologists and social scientists, concept of deep and shallow ecology.

Unit 2: Evolution of the concept of wildlife management

(5 lectures)

Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation laws in India

(5 lectures)

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

Unit 4: Socio-economic and legal basis of conflicts

(5 lectures)

Concepts of development and encroachment, who is the intruders: human or animal? Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forestdwellers (Recognition of forest right) Act, 2006.

Unit 5: Wildlife conflicts

(3 lectures)

Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

Unit 6: Human wildlife coexistence

(7 lectures)

Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, case study of Chipko movement, sacred groves forests, India's Bishnoi community and their conservation practices; ecological- economic welfare and development: conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

Practicals/Hands-on Exercises: Based on the theory.

1. Prepare a case study that has potential to develop as a human-wildlife conflicts in the area of your choice.
2. Write a case study describing different aspect of human-wildlife conflict and depict all associated factors in a schematic diagram
3. Using a case study, demonstrate the importance of historical facts in providing solutions in the present day
4. Evaluate merits and demerits of multistage sampling technique while collecting information on human-wildlife conflicts
5. Develop a questionnaire to identify the causal factors of human-wildlife conflicts emerging in a target regions
6. Analyze the roles of psychological factors in development of human-wildlife conflicts
7. Evaluate the relationship between resource scarcity and abundance in determining human-wildlife conflicts
8. Correlate the success and failure in resolving human-wildlife conflicts with existence of institutional framework
9. Use methods of triangulating information, field observations, photography and Problem Animal Control Report as complementary methods to focused interviews to understand the problem and suggest the solution
10. Understanding the significance of mediation among different policies on societal benefits and wildlife conservation to resolve human-wildlife conflicts

Learning outcomes:

After successful completion of this course, students will be able to:

- Develop clear perspective on human-wildlife conflict by defining and examining its historical & present-day status
- Discriminate the underlying factors associated with successful & unsuccessful efforts on providing solutions to human-wildlife conflicts

- Demonstrate the relevance of cultural factors in understanding the issues and providing acceptable and practical solutions
- Critically evaluate different case studies for identifying factors that may have major impact in resolving human-wildlife conflicts

Suggested Readings

1. Angelici, F.M. and Rossi, L., 2020. Problematic Wildlife II. Springer International Publishing.
2. Conover, M. 2001. *Resolving Human Wildlife Conflicts*, CRC Press.
3. Conover, M.R. and Conover, D.O., 2022. Human-Wildlife Interactions: From Conflict to Coexistence. CRC Press.
4. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* **13**: 458-466.
5. Hill, C.M., Webber, A.D. and Priston, N.E. eds., 2017. Understanding conflicts about wildlife: A Biosocial Approach (Vol. 9). Berghahn Books.
6. Manfred, M.J., 2008. Who Cares About Wildlife? Social Science Concepts for Exploring Human-wildlife Relationships and Conservation Issues.
7. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation* **45**: 97-102.
8. Nyhus, P.J., 2016. Human–wildlife conflict and coexistence. *Annual Review of Environment and Resources*, 41, pp.143-171.
9. Warrier, R., Noon, B.R. and Bailey, L.L., 2021. A framework for estimating human-wildlife conflict probabilities conditional on species occupancy. *Frontiers in Conservation Science*, p.37.
10. Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistence*. Cambridge.

ABILITY ENHANCEMENT COURSE
Offered by
DEPARTMENT OF ENVIRONMENTAL SCIENCE

AEC 1: Environmental Science: Theory into Practice – I

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department Offering the Course
		Lecture	Tutorial	Practical/ Practice			
AEC 1: Environmental Science: Theory into Practice – I	02	01	–	01	All UG Courses	All UG Courses	Department of Environmental Studies/Sciences

Learning Objectives

The Ability Enhancement Course on Environmental Science: Theory into Practice (I & II) at Undergraduate level (AEC- I) aims to train students to cater to the need for ecological citizenship through development of a strong foundation on the critical linkages between ecology-society-economy.

The Learning Objectives of this course are as follows:

- **Disciplinary knowledge**
Enable students to develop a comprehensive understanding of various facets of life forms, ecological processes, and the impacts on them by humans during the Anthropocene era.
- **Critical thinking**
Build capabilities to identify relevant environmental issues, analyse the various underlying causes, evaluate the practices and policies, and develop framework to make informed decisions.
- **Moral and ethical awareness/reasoning**
Develop empathy for all life forms, appreciation for the various ecological linkages within the web of life, awareness and responsibility towards environmental protection and nature preservation.

[State the purpose for creating and teaching the course. Describe what the course aims to do from the teacher's perspective.]

Learning outcomes

The Learning Outcomes of this course are as follows.

After the course the students will be empowered and able to:

- Analyse natural processes and resources that sustain life and govern economy.
- Predict the consequences of human actions on the web of life, global economy, and quality of human life.
- Think critically and develop appropriate strategies (scientific, social, economic, administrative, and legal) for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.
- Demonstrate values and show compassionate attitudes towards complex environmental-economic-social challenges, and participate at national and international levels in solving current environmental problems and preventing the future ones.
- Adopt sustainability as a practice in life, society, and industry.

Teaching Learning process

The teaching–learning methodologies are designed to provide the undergraduate students a comprehensive understanding of the subject in a simplistic manner as well as evoke critical reasoning and analytical thinking among them. Some of the theoretical concepts related to practicals/outreach activities, etc. should be covered during practical sessions. The various approaches to teaching–learning process include classroom lectures, video presentations, and ICT enabled teaching tools. Forenhancing practical understanding, field visits are encouraged to relevant places in Delhi like Biodiversity parks, Protected areas, Wetlands, Sewage treatment plants, etc.

SYLLABUS OF AEC-1: Environmental Science: Theory into Practice – I

UNIT – I

(1 -2 Weeks)

Introduction to Environmental Studies (1 lectures and 1 practical/ outreach activities)

- Multidisciplinary nature of environmental studies; components of environment: atmosphere, hydrosphere, lithosphere, and biosphere
- Scope and importance; Concept of sustainability and sustainable development; Brief history of environmentalism

UNIT – II

(3-7 Weeks)

Ecosystems (5 lectures and 7 practical/ outreach activities)

- Definition and concept of Ecosystem
- Structure of ecosystem (biotic and abiotic components); Functions of Ecosystem: Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes. Concepts of productivity, ecological pyramids and homeostasis

- Types of Ecosystems: Tundra, Forest, Grassland, Desert, Aquatic (ponds, streams, lakes, rivers, oceans, estuaries); importance and threats with relevant examples from India
- Ecosystem services (Provisioning, Regulating, Cultural, and Supporting); Ecosystem preservation and conservation strategies; Basics of Ecosystem restoration

UNIT – III

(8-11 Weeks)

Natural Resources (5 lectures and 6 practical/ outreach activities)

- Land resources: Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods; Land cover, land use change, land degradation, soil erosion, and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities
- Water resources: Natural and man-made sources; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international & inter- state conflicts over water
- Energy resources: Renewable and non-renewable energy sources; Use of alternate energy sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and bio gas; Agro-residues as a biomass energy source
- Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g., National Solar Mission, Cauvery River water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc)

UNIT – IV

(12-15 Weeks)

Environmental Pollution and Control (4 lectures and 6 practical/ outreach activities)

- Environmental pollution (Air, water, soil, thermal, and noise): causes, effects, and controls; Primary and secondary air pollutants; Air and water quality standards
- Nuclear hazards and human health risks
- Solid waste management: Control measures for various types of urban, industrial waste, Hazardous waste, E-waste, etc; Waste segregation and disposal
- Pollution control measures: Introduction to legal, biological, and physico-chemical methods; Role in sustainability
- Pollution case studies: Ganga Action plan (GAP), Delhi air pollution and public health issues, Plastic waste management rules, Bhopal gas tragedy, etc

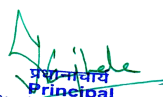
(The total number of weeks should add up to 15 only)

Practical component (if any) –

(15 Weeks)

Unit I

Introduction to Environmental Studies (1 practical/ outreach activity)


 श्री वेंकटेश्वर महाविद्यालय
 Sri Venkateswara College
 दिल्ली विश्वविद्यालय / University of Delhi
 धौला कुआँ, नई दिल्ली / Dhola Kuan, New Delhi-21

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Analysis of achievement of Sustainable Development Goals of any country.
- Gain insights of sustainability framework for an industrial activity using activity worksheets
- Use of environmental activity worksheets to understand interdependence and interactions between different environmental components.

Unit 2

Ecosystems (7 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Schematic collection of data for depicting ecological pyramids in the College campus
- Differentiation of natural and managed ecosystems using Google Earth/Google Map
- Field visit to terrestrial and aquatic ecosystems (a) forests, (b) grasslands, (c) wetlands, (d) biodiversity parks, etc.
- Develop a working model of any ecosystem
- Use of worksheets to identify structure and function of different ecosystems.

Unit 3

Natural Resources (6 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities (College may choose as per requirement)

- Visit to a paper recycling unit/rainwater harvesting plant/solar plant/biogas plant in the College campus
- Develop and understand working model of renewable/non-renewable sources of energy
- Mapping of natural resources of a given study area using Google Earth
- Time-series analysis of natural resource consumption of a given country using publicly available data
- Comparison of energy demand and consumption of a particular state over the years using graphical tools
- Assessing the consumption pattern of a natural resource in the dominant industry at local scale and status of natural resource in areas supplying it

Unit 4

Environmental Pollution (6 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Determine water quality of a given location using rapid pollution monitoring kits
- Assess air quality index (AQI) of any location using real-time air quality parameters
- Determine magnitude of solid waste generated in a home/college on a monthly basis
- Develop and maintain compost/vermicompost using biodegradable waste in the College
- Identify suitability of given water samples for various purposes using given kits
- Prepare water audit report of the college/house/locality/colony.
- Map solid and liquid discharge of the college/colony and develop a management plan

(show it using schematic diagram, and photographs.

- Repurpose waste for economic and environmental benefits in your college/near by area/colony (submit a small video).
- Analyze river-society-economy nexus based on primary or secondary data (use quantitative data, and show it using photographs on a poster).

Essential/recommended readings

Unit 1

Introduction to Environmental Studies

1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). *Environment*, 8th Edition. Wiley Publishing, USA. **Chapter 1** (Pages: 1-17); **Chapter 2** (Pages: 22-23); **Chapter 3** (Pages: 40, 41); **Chapter 4** (Pages: 64, 66).
2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 1** (Page: 3-28).

Unit 2

Ecosystems

1. Odum, E.P., Odum, H.T., and Andrews, J. (1971). *Fundamentals of Ecology*. Saunders, Philadelphia, USA. **Chapter 1** (Pages: 1-16); **Chapter 2** (Pages: 18-76); **Chapter 10** (Pages: 414-458).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 3** (Pages: 38-52); **Chapter 4** (Pages: 53-62); **Chapter 5** (Pages: 100-103); **Chapter 6** (Pages: 106-128).
3. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 13** (Pages: 307-323); **Chapter 18** (Pages: 420-442); **Chapter 28** (Pages: 747-769).

Unit 3

Natural Resources

1. Gadgil, M. and Guha, R. (1993). *This Fissured Land: An Ecological History of India*. University of California Press, Berkeley, USA. (pp. 1-245).
2. McCully, P. (1996). *Rivers no more: the environmental effects of dams*, In: *Silenced Rivers: The Ecology and Politics of Large Dams*, Zed Books, New York, USA. **Page. 29-64**.
3. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapters 10, 11, 12, 13** (Pages: 180-263); **Chapter 14** (Pages: 272-275); **Chapter 15** (Pages: 286-289).
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 25** (Pages: 623-663).

Unit 4

Environmental Pollution

1. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). *Environmental and Pollution Science*, 3rd Edition. Academic Press, USA. **Chapter 16** (Pages: 243-255); **Chapter 18** (Pages: 280-305); **Chapter 21** (Pages: 352-358); **Chapter 22** (Pages: 365-374); **Chapter 23** (Pages: 378-388); **Chapter 25** (Pages: 416-426).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 19** (Pages: 359-381); **Chapter 21** (Pages: 401-421); **Chapter 23** (Pages: 440-453).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapters 19, 20, 12** (Pages: 445-535).

Suggested readings

1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA.
2. Carson, R. (2002). *Silent Spring*. Houghton Mifflin Harcourt, USA.
3. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). *Environmental and Pollution Science*, 3rd Edition. Academic Press, USA.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time

Assessment methods

1. Written examinations (Semester exams) [(**Year 1**: 01 credit (1 hour); **Year 2**: 01 credit (1 hour))]
2. Project work and reports related to field visits, outreach activities, case study, project formulation, assignments, presentations and practical learning (Internal practical assessment) [(**Year 1**: 01 credit (2 hour); **Year 2**: 01 credit (2 hour))]

Year 1 (Sem-I/Sem-II): 01 Credit Theory+ 01 Credit practical exercises, etc.
= **Total 02 Credits (03 hours)**

Year 2 (Sem-I/Sem-II): 01 Credit Theory+ 01 Credit practical exercises, etc.
= **Total 02 Credits (03 hours)**

ABILITY ENHANCEMENT COURSE
Offered by
DEPARTMENT OF HINDI

AEC 1:हिन्दी भाषा: सम्प्रेषण और संचार (हिन्दी क)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
हिन्दी भाषा: सम्प्रेषण और संचार	02	2	--	---	हिंदी - क (उन विद्यार्थियों के लिए जिन्होंने 12 वीं कक्षा तक हिंदी पढ़ी है।)	हिंदी - क (उन विद्यार्थियों के लिए जिन्होंने 12 वीं कक्षा तक हिंदी पढ़ी है।)

पाठ्यक्रम का उद्देश्य (Learning Objectives)

- सम्प्रेषण के स्वरूप और सिद्धांतों से विद्यार्थियों को परिचित कराना
- सम्प्रेषण के विभिन्न माध्यमों की जानकारी देना
- प्रभावी सम्प्रेषण का गुण विकसित करना
- विद्यार्थी की भाषाई दक्षता और भाषा कौशल को बढ़ावा देना
- संचार माध्यमों के लिए लेखन कौशल का विकास

पाठ्यक्रम अधिगम प्रतिफल (Learning outcomes)

- सम्प्रेषण की अवधारणा और प्रक्रिया से परिचित हो सकेंगे
- सम्प्रेषण की तकनीक और कार्यशैली की बहुआयामी समझ का विकास
- प्रभावी सम्प्रेषण करना सीखेंगे

AEC 1: Environmental Science: Theory into Practice –II

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department Offering the Course
		Lecture	Tutorial	Practical/ Practice			
AEC 1: Environmental Science: Theory into Practice – II	02	01	–	01	All UG Courses	All UG Courses	Department of Environmental Studies/Sciences

Learning Objectives

The Ability Enhancement Course on Environmental Science: Theory into Practice (I & II) at Undergraduate level (AEC- I) aims to train students to cater to the need for ecological citizenship through development of a strong foundation on the critical linkages between ecology-society-economy.

The Learning Objectives of this course are as follows:

- **Disciplinary knowledge**
Enable students to develop a comprehensive understanding of various facets of life forms, ecological processes, and the impacts on them by humans during the Anthropocene era.
- **Critical thinking**
Build capabilities to identify relevant environmental issues, analyse the various underlying causes, evaluate the practices and policies, and develop framework to make informed decisions.
- **Moral and ethical awareness/reasoning**
Develop empathy for all life forms, appreciation for the various ecological linkages within the web of life, awareness and responsibility towards environmental protection and nature preservation.

Learning outcomes

The Learning Outcomes of this course are as follows.

After the course the students will be empowered and able to:

- Analyse natural processes and resources that sustain life and govern economy.
- Predict the consequences of human actions on the web of life, global economy, and quality of human life.
- Think critically and develop appropriate strategies (scientific, social, economic, administrative, and legal) for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.
- Demonstrate values and show compassionate attitudes towards complex environmental-economic-social challenges, and participate at national and international levels in solving current environmental problems and preventing the future ones.
- Adopt sustainability as a practice in life, society, and industry.

Teaching Learning process

The teaching-learning methodologies are designed to provide the undergraduate students a comprehensive understanding of the subject in a simplistic manner as well as evoke critical reasoning and analytical thinking among them. Some of the theoretical concepts related to practicals/outreach activities, etc. should be covered during practical sessions. The various approaches to teaching-learning process include classroom lectures, video presentations, and ICT enabled teaching tools. For enhancing practical understanding, field visits are encouraged to relevant places in Delhi like Biodiversity Parks, Protected areas, Wetlands, Sewage treatment plants, etc.

SYLLABUS OF AEC-1: Environmental Science: Theory into Practice – II (Year 2)

Unit V

Global Environmental Issues and Policies (5 lectures 8 practical/ outreach activities)

- Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture
- International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc.
- Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions
- Environment legislation in India: Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

Unit VI

Biodiversity and Conservation (6 lectures and 7 practical/ outreach activities)

- Definition of Biodiversity; Levels of biological diversity: genetic, species and ecosystem diversity
- India as a mega-biodiversity nation; Biogeographic zones of India; Biodiversity hotspots; Endemic and endangered species of India; IUCN Red list criteria and categories
- Value of biodiversity: Ecological, economic, social, ethical, aesthetic, and informational values of biodiversity with examples; sacred groves and their importance with examples
- Threats to biodiversity: Habitat loss, degradation, and fragmentation; Poaching of wildlife; Man-wildlife conflicts; Biological invasion with emphasis on Indian biodiversity; Current mass extinction crisis
- Biodiversity conservation strategies: in-situ and ex-situ methods of conservation; National Parks, Wildlife Sanctuaries, and Biosphere reserves; Keystone, Flagship, Umbrella, and Indicator species; Species reintroduction and translocation
- *Case studies*: Contemporary Indian wildlife and biodiversity issues, movements, and projects (e.g., Project Tiger, Project Elephant, Vulture breeding program, Project Great Indian Bustard, Crocodile conservation project, Silent Valley movement, Save Western Ghats movement, etc)

Unit VII

Human Communities and the Environment (4 lectures and 5 practical/ outreach activities)

- Human population growth: Impacts on environment, human health, and welfare; Carbon foot-print
- Resettlement and rehabilitation of developmental project affected persons and communities; relevant case studies
- Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc
- Environmental justice: National Green Tribunal and its importance
- Environmental philosophy: Environmental ethics; Role of various religions and cultural practices in environmental conservation
- Environmental communication and public awareness: case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC), National Green Corps (NGC) "Eco-club" programme, etc)

(The total number of weeks should add up to 15 only)

Practical component–

(15 Weeks)

Unit V

Global Environmental Issues and Policies (8 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Depict temperature/precipitation trend of a given study area using online data
- Formulate questionnaire/online surveys for assessment of the impact of climate change on people
- Assess Nationally Determined Contributions (NDCs) of developed and developing countries
- Development and simulation of Model UNFCCC for inoculating negotiation skills at climate change summits
- Development and simulation of Moot Court for Mock Trials in Negotiation Green Tribunal
- Identify carbon footprint of your college/home/locality (refer wwf@envis.nic.in).
- Analyze the status of at least 3 sustainable development goals in your neighbourhood and write a proposal to help achieve them at global standard (identify environmental problems and its social and economic impact, define objectives, explain methodology, budgetary requirements, and suggest the expected outcomes). A PowerPoint presentation to be made based on the project proposal.

Unit VI

Biodiversity and Conservation (7 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Acquaintance with open-source databases of biodiversity
- Determine species location in a given study area
- Depict distribution of biodiversity across latitude and altitude
- Show species distribution across space and time
- Quantify species loss across different time periods
- Sampling of plant and animal biodiversity of the College campus
- Identification of the floral diversity of Delhi and other states.
 - Documentation of the plants by clicking pictures, finding out the scientific names/ local names through literature or mobile applications, identification of their conservation status (IUCN red book list), medicinal properties, water consumption status, and socio-economic-environmental importance. A short report to be submitted)
- Exercise to understand the socio-economic-environmental impact of wildlife conservation.

(Students can choose any global animal species and identify the relevance of the species for the ecosystem/ society/ culture/ local economy, historic or present range of the species, emerging threats due to human activities, identification of documented events of natural disasters/ conflicts/ poaching of the species in the present range, conservation status (IUCN red book list), identification of protected areas/ programs of the government/ international organisation, and their opinion to further improve the conservations of the species. A short report to be submitted.

Unit 7

Human Communities and the Environment (5 practical/ outreach activities)

Practical/Exercises/Experiential activities/Outreach activities

(College may choose as per requirement)

- Assessment of carbon foot-print of different countries using online databases and mathematical tools
- Visit to marginalized localities and students for environmental education and environmental awareness
- Formulation of questionnaire/online surveys for assessment of the impact of environmental education
- Visit to any developmental project affected locality for assessing the impacts of economic development on human lives
- Correlation analysis of human population growth and impacts on the environment and human health

Essential/recommended readings

Unit V

Global Environmental Issues and Policies (5 lectures 8 practical/ outreach activities)

1. Divan, S. and Rosencranz, A. (2002). *Environmental Law and Policy in India: Cases, Material & Statutes*, 2nd Edition. Oxford University Press, India. **Chapter 2** (Pages: 23-39); **Chapter 3** (Pages: 41-86).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 19** (Pages: 370-376); **Chapter 20** (Pages: 385-399).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 23** (Pages: 555-598); **Chapter 30** (Pages: 801-807).

Unit VI

Biodiversity and Conservation (6 lectures and 7 practical/ outreach activities)

1. Primack, R.B. (2014). *Essentials of Conservation Biology*, Oxford University Press, USA. Page.1-536.
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 5** (Pages: 97-99); **Chapter 16** (Pages: 299-318).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapters 24** (Pages: 599-690); **Chapter 26** (Pages: 664-714).

Unit VII

Human Communities and the Environment (4 lectures and 5 practical/ outreach activities)

Suggested Readings

1. Divan, S. and Rosencranz, A. (2002). *Environmental Law and Policy in India: Cases, Material & Statutes*, 2nd Edition. Oxford University Press, India. **Chapter 10** (Pages: 416-473).
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA. **Chapter 2** (Pages: 33-36); **Chapter 8** (Pages: 148-162).
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi. **Chapter 1** (Pages: 23-26); **Chapter 31** (Pages: 826-842).

Suggested readings

1. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). *Environmental and Pollution Science*, 3rd Edition. Academic Press, USA.
2. Carson, R. (2002). *Silent Spring*. Houghton Mifflin Harcourt, USA.
3. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA.
4. van Wormer, K. and Besthorn, F. (2017). *Human Behavior and the Social Environment*, Macro Level Groups, Communities, and Organizations, Third Edition, Oxford University Press.

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Assessment methods

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REGISTRAR