UNIVERSITY OF DELHI

CNC-II/093/1(26)/2023-24/179
Dated: 13.09.2023

N O T I F I C A T I O N

Sub: Amendment to Ordinance V

[E.C Resolution No. 14/ (14-1-4) dated 09.06.2023]

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 Interdisciplinary and Applied Sciences based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY
BSc. (Hons.) Biochemistry
Semester IV

DISCIPLINE SPECIFIC CORE COURSE - (DSC-10)
METABOLISM OF AMINO ACIDS AND NUCLEOTIDES

CREDIT 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 Amino Acids and Nucleotides (BCH-DSC-401)	4	2L	00	2P	Class XII with Science and Biology	NIL

Learning Objectives

The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these

molecules with respect to health diseases in addition to providing an overview of inhibitors of metabolism for treating the diseases of metabolic disorders.

Learning outcomes

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

1. Explain the importance of nitrogen cycle.
2. Explain the degradation and biosynthetic pathways of amino acids and nucleotides in humans.
3. Discuss the importance of amino acids as precursors to a variety of important biomolecules.
4. Examine the role of inhibitors of nucleotide metabolism as chemotherapeutic drugs
5. Discuss the integration of the amino acid, nucleotide, carbohydrate and lipid metabolism

SYLLABUS OF DSC-10

BCH-DSC-10 : METABOLISM OF AMINO ACID AND NUCLEOTIDES
Semester – IV

THEORY (Credits 2)

Total Hours: 30

Unit I: Overview of Nitrogen and Amino Acid Metabolism (6 Hours)

Nitrogen cycle, incorporation of ammonia into biomolecules, Role of essential and non-essential amino acids in growth and development, Metabolic fates of amino groups. Transamination, role of pyridoxal phosphate, Glucose-alanine cycle, Krebs bicycle, urea cycle, its regulation and inherited defects of urea cycle, Gamma Glutamyl cycle.

Unit II: Catabolism, Biosynthesis and precursor functions of amino acids (10 Hours)

Catabolic pathways of individual amino acids, Glucogenic and ketogenic amino acids. Metabolism of one carbon unit, Overview of amino acid synthesis: Biosynthesis of non-essential amino acids and its regulation, Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methyl malonic acidemia (MMA), homocystinuria, and Hartnup's disease, ***Precursor Functions of Amino Acids*****:** Biosynthesis of creatine and creatinine, polyamines (putrescine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA)

Unit III: Biosynthesis and Degradation of Nucleotides (10 Hours)

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways, Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides, Inhibitors of nucleotide metabolism. Lesch Nyhan Syndrome, Gout and SCID (Adenosine deaminase deficiency), Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides

Unit IV: Integration of Metabolism **(4 Hours)**

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

2.3 Practical (Credits 2)

Total Hours: 60

1. Assay of serum transaminase – SGOT and SGPT
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.
5. Glutamate Dehydrogenase Assay
6. Aspartate Transcarbomylase kinetics
7. Case studies on SCID, Gout and Lesch Nyhan Syndrome.

2.4 Essential readings:

- Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
- Devlin, T.M. (2011) Textbook of Biochemistry with Clinical Correlations (7th ed.), John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4 / BRV ISBN:978-0-470-60152-5.
- Nelson, D.L. and Cox, M.M. (2017) Lehninger: Principles of Biochemistry (7th ed.) W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10- 1464126119.
- Principles of Biochemistry (2013) 4th ed., Voet, Donald, Voet, Judith & Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.
- Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937.

3. Keywords

Metabolism, essential and non-essential amino acids, Nucleotides, Biosynthesis, Salvage pathway, metabolic disorders, HGPRT, Adenosine deaminase

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)
Hormones: Biochemistry and 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		
Hormones: Biochemistry and Function (BCH-DSC-402)	**4**	**2L**	**0**	**2P**	**Class XII with Science and Biology**	**NIL**

Learning Objectives

The course is designed to enable the students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. The course emphasizes on studying the different types of hormones along with their physiological action. The students will be taught the consequences of any hormonal imbalances (over and underproduction of hormones) with special emphasis on human diseases. It provides an understanding of the different endocrine factors that regulate metabolism, growth, electrolyte and mineral homeostasis, glucose homeostasis, stress physiology and reproductive function. It also prepares a student for postgraduate studies in any course related to molecular medicine.

Learning outcomes

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

1. Explain the molecular mechanism and signaling pathways mediating Hormone Action
2. Describe the physiological role of each hormone in regulating growth, appetite, metabolism and reproduction
3. Examine the regulatory mechanisms regulating Hormone secretion and release.
4. Discuss the basis of endocrine diseases taking case studies.

SYLLABUS OF DSC-11

BCH-DSC-11 : HORMONES : BIOCHEMISTRY AND FUNCTION
Semester – IV

2.2 Course Contents
Theory (2 credits)

Total Hours: 30

Unit 1: Introduction to hormones and Hypothalamic- hypophyseal system: (5 Hours)

Introduction to hormones; Hypothalamic - pituitary axis- anatomy, histology, vasculature, and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior

pituitary hormones; Hormone feed- back regulatory cascade. Posterior pituitary hormones – structure, physiology and biochemical actions of AVP and Oxytocin; Diabetes insipidus.

Unit 2: Hormones regulating growth, energy metabolism and calcium homeostasis
(10 Hours)

Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies.

Thyroid gland- Biosynthesis of thyroid hormone and its regulation: Role of TRH, TSH in T_4 synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Goiter, Graves' disease, cretinism, myxedema.

Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 3: Hormones regulating glucose homeostasis, stress physiology and electrolyte balance: (10 Hours)

Hormones of the Pancreas: structure, synthesis, regulation of release, incretins, physiology and biochemical actions of insulin and glucagon. Role of these hormones in blood glucose homeostasis; Pathophysiology - diabetes type I and type II. GIT hormones: Secretin, gastrin and incretins.

Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol; Role of POMC and CRH in cortisol synthesis; Adrenal medullary hormones: epinephrine and norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronic stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit 4: Reproductive hormones: (5 Hours)

Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based Contraceptives.

2.3 Practical (2 Credits)

Total Hours: 60

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+}.
3. Determining the thyroid profile by estimating T_4 and TSH under normal and pathophysiological conditions. Or Estimation of estrogen during different days of the menstrual cycle.
4. Presentation Assignments on GI Tract hormones and Adipokines
5. HCG based pregnancy test.
6. Estimation of serum electrolytes.
7. Case studies: Diabetes Insipidus, Acromegaly and dwarfism, Diabetes Mellitus, Rickets, Osteoporosis, Cushing syndrome

2.4 Essential readings:

1. Vander's Human Physiology (2008) 11th ed.,Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
2. Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
3. Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939; ISBN-13. 978-1259837937

Suggested readings:

1. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Keywords

Hypothalamic-hypophyseal axis, hormones, calcium and glucose homeostasis, hormonal disorders.

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-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)

Total Hours: 30

Unit I: Structure of DNA and genomic organization **(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,) (6^{th} 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.

POOL OF DSEs

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-4)
BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS

CREDIT 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 Mechanisms and Responses in Plants (BCH-DSE-4)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

The course aims to provide thorough understanding of metabolic processes in plants and the role of different biosynthetic pathways in growth and development of plants. The course will also impart basic concepts and applications of plant secondary metabolites.

Learning outcomes

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

1. Describe the structure and function of plant cell organelles in plant metabolism.
2. Explain the various plant biochemical processes and metabolic pathways including photosynthesis, photorespiration, nitrogen fixation and assimilation and plant secondary metabolism and their biological significance.
3. Discuss the role of plant hormones in plant growth and development.
4. Evaluate the various plant responses to different abiotic and biotic stress conditions.
5. Plan and execute plant tissue culture.

SYLLABUS OF DSE-4

BCH-DSE-4 : BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS
Semester – IV

2.2 Course Contents
Theory (Credits – 2)

Total Hours : 30

Unit I: Photosynthesis and Respiration **(8 Hours)**

Introduction to Plant cells, Cell wall, Vacuole and Tonoplast membrane, Plastids and Peroxisomes. Overview to photosynthesis and Carbon assimilation, Light reaction and photosystems, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Photoinhibition. Glycolytic pathway and its alternative reactions in plants, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain in plants, alternative NAD(P)H oxidative pathways.

Unit II: Nitrogen metabolism (7 Hours)

Nitrogen cycle; Biological nitrogen fixation; Structure and function of Nitrogenase complex. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate aminotransferase (GS-GOGAT) pathway.

Unit III: Plant physiology and Secondary metabolites (10 Hours)

Plant vascular system; Plant hormones and their role in plant growth and development; Regulation of plant morphogenetic processes by light. Plant stress responses to abiotic and biotic stresses: Water deficit, temperature, salinity, insect manifestation. Secondary metabolites: types, structure and functions of Alkaloids, Phenolics and terpenoids.

Unit IV: Plant tissue culture (5 Hours)

Cell and tissue culture techniques, types of cultures: organ and explant culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

2.3 Practical:

Credits: 2 Total Hours : 60

1. Induction of hydrolytic enzymes (proteases /amylases/lipase) in germinating wheat seeds.
2. Effect of plant hormones on plant growth (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds).
3. Extraction and assay of Urease from Jack bean.
4. Estimation of carotene/phenols/tannins in fruits and vegetables.
5. Estimation of ascorbic acid in fruits and vegetables.
6. Effect of light on chlorophyll production.
7. Separation and analysis of chloroplast proteins (Rubisco) using SDS-PAGE.
8. Plant tissue culture

2.4 Essential readings:

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science. ISBN 978-0-8153-4121-5.

3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749. 94
4. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN-13: 978-0878938667, ISBN-10: 0878938664

4. Keywords

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-5)
NUTRITIONAL BIOCHEMISTRY

CREDIT 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		
Nutritional Biochemistry (BCH-DSE-5)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

This course provides students with knowledge and understanding of the characteristics, function, metabolism and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Learning outcomes

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

1. Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
2. Demonstrate the relationship between nutrition and health.
3. Discuss the macro and micronutrients and their nutritional deficiencies.
4. Describe techniques used in the assessment of nutritional status and nutritional disorders.
5. Explain drug nutrient interactions.

SYLLABUS OF DSE-5

BCH-DSE-5 : NUTRITIONAL BIOCHEMISTRY
Semester – IV

2.2 Course Contents

Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Nutrition and Energy Metabolism (4 Hours)

Defining nutrition, role of nutrients. Unit of energy, Food energy, SDA. Energy expenditure and its components, Energy Balance, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Macronutrients (10 Hours)

Food sources of carbohydrates, functions of carbohydrates, RDA, Factors affecting bioavailability, Glycemic index and glycemic load. Dietary fiber and the role of fibre in health. Role of Gut microbiome in maintaining health. Role of prebiotics and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, AI, excess and deficiency of EFA, factors affecting bioavailability. Dietary implications of ratios of n6 and n3, MUFA, PUFA and SFA, Cholesterol in the body.

Functions of proteins in the body. RDA for different age groups. Essential and Nonessential amino acids. Complete and incomplete protein, Amino Acid Interactions: Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Protein quality determinants NPU, Biological Value, PDCAAS, Nitrogen balance. PEM: Marasmus and Kwashiorkor.

Unit III: Fat and water soluble Vitamins (9 Hours)

Vitamin A, D, E, K and dietary sources, RDA, Role of Vitamin A in Visual cycle and overview of other functions. Role of Vitamin K in Gamma carboxylation (blood clotting). Role of Vitamin E as an antioxidant. Role of Vitamin D in maintenance of bone physiology and overview of other functions. Vitamin C- Dietary sources, RDA, role in collagen synthesis. The B Complex vitamins- Dietary sources, RDA. Functions and role in metabolism, Role of Vitamin B12 and Folate in Haematopoiesis and Neurology. Biochemical basis for deficiency symptoms, Hypervitaminosis.

Unit IV: Minerals (7 Hours)

Minerals: Dietary Sources, RDA. Sodium, Potassium, Calcium, Iron, Chloride, Copper and Phosphorus- Function, metabolism, Excretion, Deficiency, Toxicity, Trace Elements Iodine, Fluoride, Mg, Zn, Se, Chromium, Molybdenum: Function, Metabolism, deficiency, Toxicity and Sources.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Anthropometric identifications for nutrition related diseases, BMR calculation
2. Determination of oxidative stress: TBARS in serum, antioxidant enzymes in hemolysate/plant sources.
3. Estimation of A/E vitamin in serum.
4. Estimation of minerals in drugs/food/serum.
5. Determination of nutritive value of foods.
6. Understanding fortification and supplementation
7. Presentation and discussion on Food as medicine.
8. Group discussion on Nutrient-nutrient and drug-nutrient interactions
9. Case studies on nutritional disorders.

2.4 Essential readings:

1. Coombs Jr. G. F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
2. 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.
3. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 9780195171693
4. Tom Brody (1999). *Nutritional Biochemistry* (2nd Ed). Harcourt Braces. ISBN:9814033251, 978981403325.
5. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

Suggested reading:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Keywords

Nutrition, macronutrients, micronutrients, energy balance, nutrient deficiency

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-7)
CELLULAR COMMUNICATIONS

CREDIT 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		
Cellular Communications (BCH-GE-7)	04	02	0	02	Class XII with Science and Biology	Basic course in cell biology

Learning Objectives

- Explain the concept of Cell-cell communication.
- Describe the various types of receptors, signal transduction pathways, second messengers and effector molecules.
- To understand how signalling pathways, regulate cell motility, metabolism, growth, organogenesis, and cell death.
- Discuss the crosstalk between signal transduction pathways crosstalk and are auto-regulated.
- To know about various diseases associated with cellular communication pathway defects.

Learning outcomes

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

1. Describe various types of cell - cell communication.
2. Discuss the various types of receptors and signal transduction pathways in bacteria, plants and animal system.
3. Explain the importance of various signalling pathways in the regulation of metabolism, growth, organogenesis and cell death.
4. Discuss the cellular communication defects that lead to various types of diseases including cancers.

SYLLABUS OF GE-7

BCH-GE-7 : CELLULAR COMMUNICATIONS
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours : 30

Unit: 1 Introduction to cell- cell communication. (2 Hours)

Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Cognate signalling.

Unit: 2 Receptors and Signal transduction pathways (16 Hours)

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G-Protein-coupled Receptors: Heterotrimeric G proteins, Second messengers: cAMP, cGMP, Lipid-derived Second Messengers (IP3, DAG) NO, Calcium Signalling. Effector systems - adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG).

Enzyme linked receptors: Receptor Tyrosine Kinases: EGF, insulin and erythropoietin. Ras - MAP kinase cascade, and JAK - STAT pathway.
Ion-channel linked receptors; Neurotransmitter receptors (Acetylcholine receptor). Nerve transmission.

Intracellular receptors: Cytoplasmic and nuclear receptors. Steroid hormone, thyroid hormone receptors. Gene regulation.

Integrin receptors. Integrin signalling. Cell matrix communication Receptor Regulation. Cross talk.

Unit 3: Photoreceptors and signal transduction in plants (4 Hours)

Phytochromes, cryptochromes and phototropins signalling.

Unit 4: Cell death signalling (4 Hours)

Apoptosis, Autophagy

Unit 5: Bacterial signalling (4 Hours)

Quorum sensing, autoinducers, chemotaxis.

2.3 Practical

Credit: 2 **Total Hours : 60**

1. Yeast response to mating pherohormones .
2. Study of Chemotaxis response in Tetrahymena/ paramecium/ dictostylium
3. Study change in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in zebrafish larvae.
4. Chemotaxis/ motility assay in microbes.
5. Effect of plant hormones on plant growth or photomorphogenesis in response to light. (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds)

Essential readings:

1. Lodish, U. H. (2016) Molecular Cell Biology. W.H. Freeman, 2016.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman. ISBN:9781319230906
3. Lim, W., Mayer, B., & Pawson, T. (2015). Cell signaling: principles and mechanisms. New York: Garland Science, Taylor & Francis Group.
4. Kocher, S. L., and Gujral, S. K. (2020). Plant Physiology Theory and Application. Cambridge University Press DOI: https://doi.org/10.1017/9781108486392.018
5. Demuth, D., & Lamont, R. (Eds.). (2006). Bacterial Cell-to-Cell Communication: Role in Virulence and Pathogenesis (Advances in Molecular and Cellular Microbiology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511541506

Suggested readings:

1. ZFIN protocols
2. Harris UM. A., McGee, S. A., and Batzi J. M. (2018). Uncooking Yeast: Cells Signalling a Rise to Inquiry. Tested Studies for Laboratory Teaching. Proceedings of the Association for Biology Laboratory Education. 38 (9) 1-48
3. Plant physiology and biotechnology laboratory manual. Compiled by: David Law, Lada Malek and JoAnne Henderson. 2006. https://old.amu.ac.in/emp/studym/99997510.pdf

3. Keywords

Chemical signaling, Receptors, signal transduction, GPCRs, RTKs, Photoreceptors, cell death signaling, bacterial signalling

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

GENERIC ELECTIVES COURSE - (GE-8)
BIOCHEMICAL CORRELATION OF DISEASES

CREDIT 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 CORRELATION OF DISEASES (BCH-GE-8)	**04**	**02**	**0**	**02**	**Class XII with Science and Biology**	**XIIth pass in biology**

Learning Objectives

The course aims to provide students with knowledge and understanding of the spectrum of human diseases. It will introduce the concept of a well-balanced diet, healthy lifestyle, the biochemical mechanism of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that could be employed for prevention of infectious and non-infectious diseases.

Learning outcomes

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

1. Discuss the importance of a balanced diet, regular exercises and healthy lifestyle in leading a disease-free life.
2. Explain the functioning of the immune system and endocrine system and the basis of various autoimmune and hormonal disorders.
3. Correlate the genetic mutation and metabolic disorders.
4. Discuss the molecular mechanism of microbial pathogenicity, drug resistance and implications in public health management.

SYLLABUS OF GE-8

BCH-GE-8 : BIOCHEMICAL CORRELATION OF DISEASES
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit I: Inherited Metabolic diseases and Hormonal disorders (9 Hours)

Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Unit II: Nutritional deficiency and lifestyle-based diseases (7 Hours)

Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Unit III: Autoimmune diseases (6 Hours)

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases- Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic lupus erythematosus (SLE), Rheumatoid arthritis.

Unit IV: Infectious diseases (8 Hours)

Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

2.3 Practical:

Credits: 2 **Total Hours : 60**

1. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
2. Measurement of Blood pressure
3. Determination of blood Lipid Profile: Triglyceride, Cholesterol
4. Glucose tolerance test
5. Widal test
6. Permanent slides of malarial parasites/Leishmania
7. Case studies related to autoimmune diseases, life-style disorders and hormonal imbalance

2.4 Essential readings:

1. Berg, J.M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2019). Biochemistry (9th ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
2. Coico, R. (2021). Immunology: A Short Course (8th ed.). John Wiley & Sons, Inc (New Jersey). ISBN: 9781119551577.
3. Devlin, T. M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
4. Willey, J., Sandman, K., Wood, D. (2019). Prescott's Microbiology (11th ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

1. Sherwood, L. (2012). Introduction to Human Physiology (8th ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
2. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6th ed.). New Delhi, Pearson Education, Inc. ISBN: 978-81-317-2610-5.
3. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

3. Keywords

Lifestyle and metabolic disorders, nutritional deficiency, hormonal disorder, autoimmunity and infectious diseases.

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

GENERIC ELECTIVES COURSE – (GE-9)
FUNDAMENTALS OF MOLECULAR 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		
Fundamentals of Molecular Biology (BCH-GE-9)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological science

Learning Objectives

This course is designed to introduce the concepts of how the genetic material is organized within genomes and the difference in the architecture of the genome in various organisms. It deals with the replication of the genetic material in prokaryotes and eukaryotes as well as the expression of genes into RNA as well as proteins; all being crucial life processes required for the perpetuity and successful functioning of living organisms. It also introduces the concept of regulation of gene expression in prokaryotes.

Learning outcomes

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

1. Perform the isolation of bacterial genomic DNA and assess its purity
2. Evaluate the characteristic properties of DNA and RNA using biochemical assays like Dische test and Bial's test.
3. Identify the different nitrogenous bases present in Nucleic acids
4. Compare the DNA replication in prokaryotes and eukaryotes.
5. Discern the processes of conversion of the information stored in the genetic code into mRNA as well as proteins.

SYLLABUS OF GE-9

BCH-GE-9 : FUNDAMENTALS OF MOLECULAR BIOLOGY
SEMESTER - IV

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit 1 Genome organization in organisms (3 Hours)

Definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Supercoiling of DNA, linking number, topoisomerases.

Unit 2 Replication of genomes (9 Hours)

General features of DNA replication, properties of prokaryotic and eukaryotic DNA polymerases. Three stages of DNA replication, end replication problem, telomerase, Inhibitors of DNA replication and applications in medicine.

Unit 3 Transcription (10 Hours)

Transcription in prokaryotes, RNA polymerase, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Concept of operons (Lac operon). Eukaryotic RNA polymerases. Inhibitors of transcription and applications in medicine.

Unit 4 Translation (8 Hours)

Features of the genetic code, structure of ribosomes, charging of tRNAs, amino acyl tRNA synthetases; three stages of protein synthesis - initiation, elongation and termination. Inhibitors of protein synthesis.

2.3 Practicals

CREDITS: 2 **Total Hours: 60**

1. Quantitative determination of DNA and RNA by absorbance at 260 nm.
2. Estimation of DNA by Dische's reagent.
3. Estimation of RNA by Bial's reagent.
4. Separation of nitrogenous bases by paper chromatography.
5. Isolation of chromosomal DNA from *E. coli* and estimation of its purity by 260nm/280nm absorbance.

2.4 Suggested Readings

1. Nelson, D.L. and Cox, M.M. (2013). *Lehninger: Principles of Biochemistry* (6^{th} ed.,) W.H. Freeman & Company (New York), ISBN-13; 978-1-4641-0962-1 / ISBN:10-14641-0962-1.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L., (2012). *Biochemistry* (7th ed.,) W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.
3. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436.

3. Keywords

Genes, Replication, Transcription, Translation, Genetic code, Protein synthesis.

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

SEMESTER V
BSC (HONS.) BIOCHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE – (DSC-13)
MOLECULAR CELL 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		
Molecular Cell Biology (BCH-DSC-501)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course aims to provide advanced knowledge about the function of cellular organelles and the mechanism of protein sorting in the cell. It will also provide details of cellular communications in the cell and understanding of molecular regulation of cell growth and cell death. The course will outline the molecular details of cancer development and treatment.

Learning outcomes

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

1. Explain the process of protein trafficking in the cell and role of various regulatory proteins involved in the process.
2. Discuss the different modes of cellular communication in a multicellular organism
3. Explain the regulatory mechanisms involved in controlling the process of mitosis, meiosis, apoptosis, necrosis and autophagy.
4. Examine the molecular and genetic basis of cancer development and various molecular approaches used for cancer treatment.

SYLLABUS OF DSC-13

BCH-DSC-501 : MOLECULAR CELL BIOLOGY
SEMESTER - V

Theory (2 Credits)

Total Hours: 30

Unit I: Protein Sorting and Secretory Pathway **(7 Hours)**

Overview of the endomembrane system; Co-translational and post-translational targeting of proteins into Endoplasmic Reticulum; Protein Modifications, Folding and Quality Control in ER; Protein targeting to Golgi complex and Lysosomes; Exocytosis; Sorting of Proteins to Mitochondria, Chloroplasts and Peroxisomes.

Unit II: Cellular Signaling (10 Hours)

Chemical signaling- endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Hormone receptors- extracellular and intracellular. G protein coupled receptors, G proteins, second messengers- cAMP, cGMP, IP3, DAG, Ca^{2+}, Effector systems- adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases-EGF, Insulin and Ras-MAP kinase cascade. Non-receptor tyrosine kinase-erythropoietin receptor JAK-STAT pathway. Intracellular receptor family: Steroid hormone receptor and NO receptors.

Unit III: Cell cycle and Apoptosis (8 Hours)

Overview of the cell cycle; Stages of eukaryotic cell cycle; Events of Mitotic Phase and Cytokinesis; Role of cyclins and cyclin-dependent kinases; Molecular mechanisms of cell cycle regulation and Cell Growth; Meiosis and its regulation; Cell death: Apoptosis, Necrosis and Autophagy; Intrinsic and extrinsic apoptotic pathways; Regulation of apoptotic pathways.

Unit IV: Molecular Basis of Cancer Biology (5 Hours)

Types of cancer; Stages of cancer development; Properties of Cancerous Cells; Genetic basis of cancer; Cancer causing agents: radiations, chemical carcinogens and introduction to viral oncogenes; Role of cancer critical genes: oncogenes and tumor suppressor genes; Molecular approaches for cancer treatment.

2.3 Practical (2 Credits)

Total Hours: 60

1. Isolation of organelles by subcellular fractionation and validation of separated organelles by marker enzymes.
2. Study the changes in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in model organisms.
3. Preparation of hepatocyte primary culture and cell enumeration.
4. Study of cell viability/death assay by use of trypan blue and MTT assay.
5. Polyploidy in onion root tip by colchicine treatment.
6. Study of apoptosis through analysis of DNA fragmentation patterns.
7. Identification and study of cancerous cells using permanent slides and photomicrograph.

2.4 Essential readings:

1. Cooper, G.M. (2018). The Cell: A Molecular Approach. (8th ed.). Sinauer Associates Inc: Oxford University Press. ISBN: 9781605357072
2. Karp, G., (2010). Cell and Molecular Biology: Concepts and Experiments (8th ed.). John Wiley & Sons. Inc. ISBN: 978-1-118-65322-7.
3. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell. (6th ed.). Garland Science. ISBN: 978-0815345244

4. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh. A., Martin, K.C., Yaffe, M., Amon, A. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman & Company (New York). ISBN-13: 978-1319208523/ ISBN-10: 1319208525

Suggested readings:

1. Kleinsmith, L. J., Hardin, H., Wayne G., Becker, M. (2009). The World of the cell (7th ed.). ISBN-13: 978-0805393934 / ISBN-10: 0805393935.

3. Keywords

Protein Sorting, Protein Modification, exocytosis, Cellular communication, autophagy, mitosis, meiosis, Apoptosis, Necrosis, Cancer, Oncogenes, Chemotherapeutics.

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)
CONCEPTS IN GENETICS 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		
Concepts in Genetics and Evolution (BCH-DSC-502)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The aim of the course is to provide an understanding of both classical and modern concepts in the areas of mapping techniques, transmission, molecular, quantitative, population and evolutionary Genetics. Practicals are well correlated with the theory topics and designed to support skill-oriented learning outcomes. The course also works as preparation for further studies in a Master's programme in molecular biology or related topics.

Learning outcomes

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

1. Explain the principles of Mendelian genetics, extensions and applications.
2. Examine the various factors that confer genotypic and phenotypic variability.
3. Correlate human and viral genetics to create linkage and genetic maps.
4. Perform experiments using genetic model system *Drosophila melanogaster*.
5. Analyse biological data using statistical tools
6. Discuss the principles of transmission and inheritance in real life situations.

SYLLABUS OF DSC-14

BCH-DSC-502 : CONCEPTS IN GENETICS AND EVOLUTION
SEMESTER - V

2.2 Course Contents

Theory (2 Credits)

Total Hours: 30

Unit I: Mendelian and Non-Mendelian genetics (8 Hours)

Revision of Mendelian Genetics; Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Complementation test using examples from

Drosophila eye colour mutants to differentiate allelic variants from gene interaction. Pleiotropic gene interaction - epistatic and non- epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit II: Linkage, crossing over and mapping techniques (9 Hours)

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications, 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 III: Molecular genetics (8 Hours)

Sex determination: Genetic basis of sex determination in Humans, *Drosophila melanogaster* and *C. elegans. 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 IV: Quantitative and Evolutionary Genetics (5 Hours)

Inheritance of complex traits, analysis of quantitative traits, quantitative trait loci (QTL), narrow and broad sense heritability, and their identification. Hybrid vigor and transgressive inheritance.

Molecular evolution - analysis of nucleotide and amino acid sequences, homologous sequences, molecular phylogenies, phenotypic evolution and speciation, Understanding the concept of fitness with respect to evolutionary genetics.

2.3 Practical (2 Credits)

Total Hours :60

1. Understanding Mendelian genetics (dry lab).
2. Monohybrid crosses in *Drosophila* for studying autosomal/sex-linked inheritance.
3. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
4. Smear technique to demonstrate sex chromatin in buccal epithelial cells/neutrophils.
5. Understanding Hardy-Weinberg principle. PTC testing in a population and calculation of allelic and genotype frequencies.
6. Understanding chromosomal structure.
   - The study of normal and abnormal human karyotype (dry lab).
   - understanding polyploidy by studying karyotypes in plants
7. Study of human pedigrees (dry lab).

2.4 Essential readings:

1. Principles of Genetics (2015) 7th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 9781119142287
2. Genetics - A Conceptual Approach (2020), 7th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 978-01346047

Suggested readings:

1. An Introduction to Genetic Analysis (2017), 11th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1464109486

2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. Edition 12. Benjamin Cummings.

3. Keywords

Complementation, Allelic and gene interaction, Gene mapping, Non-nuclear inheritance and Epigenetics, Sex determination, Quantitative and Evolutionary Genetics

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-15)
GENE EXPRESSION AND REGULATION

CREDIT 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 Expression and Regulation (BCH-DSC-503)	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 knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem-solving skills.

Learning outcomes

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

1. Analyse the processes of transcription and translation in prokaryotes and eukaryotes
2. Discuss the features of the genetic code and various experimental approaches used to crack the code
3. Perform estimation of RNA by orcinol method
4. Discuss the molecular basis of RNA processing and RNA splicing
5. Perform isolation of RNA from bacteria and plant cells
6. Evaluate the various ways in which transcription and translation are regulated

SYLLABUS OF DSC-15

BCH-DSC-503 : GENE EXPRESSION AND REGULATION
SEMESTER - V

2.2 Course Contents
Theory (2 credits)

Total Hours: 30

Unit I: Transcription in Prokaryotes and Eukaryotes (10 Hours)

Transcription cycle in bacteria, Sigma factor, bacterial promoters and RNA Polymerases, various stages of RNA synthesis- initiation, elongation and termination, rho-dependent and rho-independent termination. Introduction of basal eukaryotic transcription machinery: three classes of eukaryotic RNA polymerases – I, II and III, and their respective promoters. Details of transcription by RNA polymerase II, features of RNA polymerase II core promoters. Inhibitors of eukaryotic and prokaryotic transcription and their applications.

Unit II: RNA Processing **(4 Hours)**

Various types of mRNA processing- polyadenylation and capping, brief overview of rRNA and tRNA processing. Chemistry of RNA splicing, the spliceosome machinery, group I and group II introns, alternative splicing.

Unit III: Translation **(7 Hours)**

Salient features of the genetic code, triplet nature, degenerate, wobble hypothesis, codon usage bias. Experimental approaches used to decipher the genetic code. Messenger RNA, transfer RNA, charging of tRNA. Structure of the ribosome. Three stages of translation-initiation, elongation and termination in prokaryotes and eukaryotes.

Unit IV: Regulation of gene expression **(9 Hours)**

Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of *lac* and *trp* operon, riboswitches. Eukaryotic gene regulation by chromatin remodelling, regulation of galactose metabolism in yeast, action of enhancers and insulators, working of activators and repressors, synthesis and mechanism of action - siRNA and miRNA.

2.3 Practical (2 Credits)

Total Hours: 60

1. Quantitative estimation of RNA by Orcinol Method
2. Extraction of total RNA from bacteria /yeast
3. To study growth curve and diauxic growth curve in *E. coli*
4. To study inducible promoter activity by reporter assay
5. To study the effect of inhibitors on protein synthesis
6. DNA Footprinting (Dry Lab)

2.4 Essential readings:

1. Nelson, D.L. and Cox, M.M (2017) *Lehninger: Principles of Biochemistry* (7th ed.) W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436

Suggested readings:

1. Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., (2018) *Lewin's Gene X* (10th edition). Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

3. Keywords

RNA, Transcription, Translation, Genetic code, Gene expression, Operon

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-2)
BIOCHEMICAL APPLICATIONS IN FORENSIC SCIENCES

CREDIT 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 (BCH-DSE-2)	04	02	0	02	Class XII with Science and Biology	NIL

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:

1. Explain the fundamental concepts and principles of forensic science and their significance.
2. Demonstrate forensic investigation, preservation of evidences, as well as chemical, physical and biological analysis of biological samples
3. Establish the age, sex and identity of an individual of an individual by document evaluation, fingerprints, footprints and DNA analysis.
4. Analyze samples for drug testing, ink and stain testing and document and handwriting verification.
5. Perform Narco Analysis, polygraphy, lie detection and facial reconstruction.

SYLLABUS OF DSE-2

BCH-DSE-2 : BIOCHEMICAL APPLICATIONS IN FORENSIC SCIENCES
Semester – V

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Introduction to forensic science and application of biological sciences to forensic investigation (10 Hours)

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 (6 Hours)

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 (6 Hours)

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 (8 Hours)

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 Hours : 60**

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. Keywords

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-3)
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		
Microbiology (BCH-DSE-3)	04	02	0	02	Class XII with Science and Biology	XIIth pass with biology

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:

1. Identify different types of microbes
2. Perform routine microbiological practices including sterilisation, media preparation, maintenance of microbial culture, microbial growth etc.
3. Plan basic research using microbes
4. Discuss the varied applications of microbes.

SYLLABUS OF DSE-3

BCH-DSE-3 : MICROBIOLOGY
Semester – V

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: History and Diversity of Microbial world **(8 Hours)**

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 (6 Hours)

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 (6 Hours)

Conjugation, Transformation and Transduction. Gene mapping in Bacteria

Unit IV: Application of Microbes (10 Hours)

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 Hours : 60

1. To prepare and sterilise 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.). Benajamin/ Cummings. ISBN 1o 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. Keywords

Microbiological Techniques, Media, Sterilization, Growth curve

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-6)
IN-SILICO TOOLS IN PROTEOMICS AND GENOMICS

CREDIT 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		
In-silico Tools in Proteomics and Genomics (BCH-DSE-6)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to Biological sciences

Learning Objectives

The objective of this course is to impart basic understanding of computational biology with a broader knowledge of genomics and proteomics. In silico tools used in the study of genomes and proteins will be emphasized. The course presents an overview of theoretical knowledge, and practical methods for characterization of functional elements in DNA and Protein data. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, genome analysis, prediction of protein structures and protein-protein interactions.

Learning outcomes

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

1. Discuss the basics of bioinformatics and computational biology
2. Describe the use of several softwares/tools in omics biology.
3. Discuss, access and use biological databases in the public domain.
4. Explain protein structure using visualization softwares.
5. Perform sequence alignments
6. Discuss the fundamental aspects of *in-silico* protein structure prediction.
7. Explain the applications of bioinformatics from genomes to personalized medicine.
8. Describe the concept of drug designing using a bioinformatic approach.

SYLLABUS OF DSE-6

BCH-DSE-6 : In-silico Tools in Proteomics and Genomics
Semester – V

2.2 Course Contents

Theory
Credits: 2 **(30 Hours)**

Unit I: Introduction to omics biology **No. of hours: 4**

History of omics biology, introduction to central dogma, Scope of bioinformatics, Tools and databases (sequence alignment, BLAST, NCBI and PDB databases)

Unit II: Genomics **No. of hours: 9**

Introduction to Genomics, Structure and Organization of Prokaryotic and Eukaryotic Gene. Genome Sequencing, Human Genome Project, Genome Browsers, Gene annotation, Gene Identification and Sequence analysis

Unit III: Protein structure prediction and proteomics **No. of hours: 9**

Introduction to proteomics, 2D gel Electrophoresis, Mass spectroscopy, computational prediction of protein 2D and 3D structure - Homology Modeling, Fold Recognition and *ab-intio* methods, protein - protein interactions (yeast two hybrid system, pull down assay), Protein Disordered Regions

Unit IV: Applications of genomics and proteomics **No. of hours: 8**

Functional Genomics, Comparative genomics, Proteomics in Drug discovery, Protein-Drug interaction studies, Computer Aided Drug Discovery (CADD). Role of genomics and proteomics in Diagnostics and Therapeutics. Role of AI in genomics and proteomics.

2.3 Practical:

Credits: 2 **(60 Hours)**

1. Sequence retrieval (protein and gene) from NCBI.
2. Sequence Analysis - BLAST suite of tools for pairwise alignment.
3. Gene Prediction Tools (Genscan/Glimmer)
4. Structure download (protein and DNA) from PDB & Molecular view by visualization Software (Pymol/Rasmol)
5. Protein Secondary Structure Prediction Tools (GORR)
6. Protein Tertiary Structure Prediction (Homology Modelling/SWISS Model)
7. Protein -Protein Interaction Databases (STRING)
8. Protein-Ligand Docking and Interaction studies (CADD)

2.4 Essential readings:

1. David M. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press; ISBN 978-087969712-9.
2. Pevsner, J. (2003). Bioinformatics and Functional Genomics (1st ed.), John Wiley & Sons, Inc. (New Jersey); ISBN: 0-47121004-8.
3. Baxevanis A.D. and Ouellette Francis B.F. (2005), Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.), John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Ghosh, Z. and Mallick, B., (2008) Bioinformatics – Principles and Applications, (1st ed.) Oxford University Press (India), ISBN: 9780195692303.
5. Introduction to Proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., Humana Press Inc., New Jersey, USA. 2002.

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-5)
NUTRITION AND FOOD 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		
Nutrition and Food Science (BCH-GE-5)	04	02	0	02	Class XII with Science	NIL

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

BCH-GE-5 : NUTRITION AND FOOD SCIENCE
SEMESTER – V

2.2 Course Contents
Theory
Credits: 2 **Total Hours: 30**

Unit 1 –Basics of Food Science and Nutrition **(10 Hours)**

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 (10 Hours)

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 (10 Hours)

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 (5 Hours)

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 Hours:60

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. Keywords:

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

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

GENERIC ELECTIVE COURSE - (GE-6)
PHYSIOLOGY AND SPORTS AND EXERCISE

CREDIT 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 (BCH-GE-6)	**04**	**02**	**0**	**02**	**Class XII with Science**	**Basic course on human physiology**

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.

BCH-GE-6 : PHYSIOLOGY OF SPORTS AND EXERCISE
SEMESTER - V

2.2 Course Contents

Theory

Credits: 2 **Total Hours : 30**

Unit I: Introduction to Exercise Physiology (Total Hours: 4)

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 Hours : 10)

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 Hours: 8)

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 Hours : 8)

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 Hours: 60**

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. Keywords

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

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

GENERIC ELECTIVES COURSE - (GE-10)
INTERMEDIARY 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		
INTERMEDIARY METABOLISM (BCH-GE-10)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

The course aims to familiarise the learner with the pathways of fuel and energy metabolism with an emphasis on their interrelationship and integrated regulation.

Learning outcomes

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

1. Discuss the underpinnings of fuel metabolism
2. Describe the mechanism of ATP synthesis.
3. Discuss the biosynthesis and degradation pathways.
4. Evaluate the interrelationships of carbohydrate and lipid metabolism
5. Discuss the biosynthesis and degradation of amino acids and nucleotides
6. Correlate the integration of metabolism

SYLLABUS OF GE-10

BCH-GE-10 : INTERMEDIARY METABOLISM
SEMESTER - V

2.2 Course Contents
Theory (Credit 2)

Total Hours : 30

Unit I: Carbohydrate metabolism **(14 Hours)**

Glycolysis as a universal pathway, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis, Pentose phosphate pathway, Pyruvate dehydrogenase complex, oxidation of acetyl CoA. TCA cycle, amphibolic role, ATP calculation, Glycerol-3-phosphate and malate-aspartate shuttle.

Unit II: Fatty acid catabolism **(6 Hours)**

TAG as energy source, β oxidation of saturated fatty acids in mitochondria, Fatty acid activation and overview of regulation, formation of ketone bodies and metabolism

Unit III: Amino acid and nucleotide metabolism (6 Hours)

Transamination, Deamination, urea cycle and its regulation, Glucose-alanine cycle, Krebs bicycle, Nucleotide Biosynthesis - salvage pathways, Degradation.

Unit IV Integration of metabolism (4 Hours)

Metabolic shifts in absorptive, post absorptive, fasting and starvation states.

2.3 Practical:

Credits: 2 **Total Hours : 60**

1. Estimation of blood glucose by GOD-POD method
2. Demonstration of alcohol fermentation by yeast.
3. Estimation of serum cholesterol.
4. Estimation of serum TAGs.
5. Estimation of urea in serum
6. Estimation of uric acid in serum

2.4 Essential readings:

1. Nelson, D.L. and Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
2. Berg, J.M., Tymoczko, J.L., Stryer L., (2012) Biochemistry 7th ed., W.H. Freeman and Company (New York); ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.
3. Campbell, M.K., Farrel, S.O. (2012) Biochemistry 7th ed, S.O. Brooks/Cole, Cengage Learning (Boston); ISBN: 13:978-1-111-42564-7 ISBN:10:1-4292-2936-5.
4. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0.

Suggested Readings:

1. Principles of Biochemistry (2013) 4th ed., Voet, Donald, Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.

3. Keywords

Catabolism, anabolism, Glycolysis, TCA, Glycogen metabolism, Gluconeogenesis, nucleotide metabolism, beta oxidation, salvage pathway and integration

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

SEMESTER VI
BSc. (Hons.) Biochemistry

DISCIPLINE SPECIFIC CORE COURSE – (DSC-16)
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/ Practice		
Human Physiology (BCH-DSC-601)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The objective of the course is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It will prepare students for higher education in any field related to medical physiology.

Learning outcomes

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

1. Explain the homeostatic control and functioning of the human body systems
2. Discuss the regulatory mechanism regulating different organ system.
3. Describe the functioning of the different organ systems.
4. Explain the basis of various physiological diseases.
5. Perform and analyse various physiological tests that examine the function of various systems of the human body.

SYLLABUS OF DSC-16

BCH-DSC-16 : HUMAN PHYSIOLOGY
SEMESTER - VI

2.2 Course Contents
Theory (2 Credits)

Total Hours: 30

Unit I: Circulatory system **(7 Hours)**

Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms). Blood Composition and Blood coagulation. Anatomy of Heart. Heartbeat Coordination: Cardiac action potential and Pacemaker potential. Cardiac cycle. Cardiac output and its regulation. The role of blood vessels in circulation: Arteries, Veins and Blood capillaries.

Unit II: Life Processes (15 Hours)

Respiratory physiology: Ventilation and lung mechanics. Inspiration, Expiration, Lung compliance and its determinants. Transport of oxygen and carbon dioxide in blood. Regulation of respiration.

Renal physiology: Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Urine concentration: The counter current multiplier system. Blood buffer systems.

Gastrointestinal physiology: Propulsion, motility, digestion and assimilation of food. Secretory functions of the gastrointestinal tract. Enteric nervous system. Regulation of GI tract functions. Hepatic physiology and Enterohepatic circulation.

Unit III: Introduction to muscular and neural physiology (4 Hours)

Molecular mechanisms of skeletal and smooth muscle contraction: role of troponin, tropomyosin, and calcium in contraction, excitation-contraction coupling. Overview of Central and Peripheral Nervous System and neural conduction.

Unit IV: Reproductive Physiology (4 Hours)

Sex determination and differentiation. Oogenesis, Spermatogenesis, capacitation and transport of sperm, blood-testis barrier. Fertilization, Implantation and Placentation.

2.3 Practical (2 Credits)

Total Hours: 60

1. Hematology:
    a. Determination of Packed Cell Volume, Bleeding Time and Clotting Time.
    b. Preparation of blood smear and estimation of differential leucocyte count.
    c. Enumeration of Blood cells: RBC and WBC
    d. Estimation of hemoglobin and calculation of blood indices
2. Serum Proteins Electrophoresis
3. Understanding the anatomy/structure of following: Heart, GI Tract, Kidney and Nephron, Neuron, Lung and alveoli, skeletal, smooth and cardiac muscle
4. Pulmonary function tests: Understanding Lung capacities and Lung volumes using Spirometry
5. Determination of the Blood Pressure.
6. Case studies: Renal clearance, Gastrointestinal disorder, Anemia, Jaundice (any two)
7. Virtual Lab on ECG

2.4 Essential Readings:

- Widmaier, E.P., Raff, H. and Strang, K.T. (2019) Vander's Human Physiology 15th ed., McGraw Hill International Publications (New York), ISBN: 978-1259903885
- Fox, S.I. (2018) Human Physiology 15th ed., McGraw Hill International Publications, (New York) ISBN 978-1259864629

Suggested Readings:

- Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052
- Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
- Gerard G Totora. (2017). Principles of Physiology and Anatomy 15th Edition, Wiley. ISBN: 978-1-119-40006-6

3. Key word:

Physiology, Homeostasis, life processes, heart, neurophysiology, reproduction

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)
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/ Practice		
Basics of Immunology (BCH-DSC-602)	4	2L	0	2P	Class XII with Science and Biology	NIL

Learning Objectives

The course is designed to understand the basic concepts in Immunology. It is important to understand the structure of the cells and organs associated with the immune system to appreciate their function in fighting infections. So, the students will study their structure and the various receptors associated with them. They will be exposed to the concept of antigen antibody and the types of immune responses generated in the body. The recognition of the antigen by B and T cells and the role of Major histocompatibility complex in generation of immune response will be elaborated.

Learning outcomes

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

1. Explain the concept of innate and adaptive immunity.
2. Describe the structure and function of cells and organs of the immune system
3. Discuss the Attributes of an immunogen, structure and the functions associated with different isotypes of antibodies
4. Explain the humoral immune response and antibody diversity.
5. Explain the Antigen presentation mechanisms and generation of cell mediated immunity

SYLLABUS OF DSC-17

BCH-DSC-17 : BASICS OF IMMUNOLOGY
SEMESTER - VI

2.2 Theory (2 Credits)

Total Hours: 30

Unit 1 : Introduction to the Immune System: (8 Hours)

Historical Perspective, Innate and Adaptive immunity and their role in generation of immune response, Primary and Secondary Immune Response, Cells and Organs of the Immune System, Hematopoiesis, Antigens, Properties of Immunogen, Haptens, Adjuvants, B Cell and T Cell Epitopes, Structure and Effector Functions of Different Types of Antibodies, Biological Activities of Subclasses of Antibodies, Antigenic Determinants on Immunoglobulins, Immunoglobulin Superfamily, B cell receptor,

Unit 2 : **Innate Immunity:** **(6 Hours)**

Anatomical Barriers, Soluble and Membrane Bound Molecular Sensors (PRRs), Inflammation, Phagocytic cells and Innate Immunity, Toll like receptors, Activation Pathways of Complement System, Regulation and Biological Consequences of Complement Activation.

Unit 3 : **Humoral Immune Response** **(8 Hours)**

B Cell Development, Maturation & Differentiation, Clonal Selection theory, Genetic basis of Antibody Diversity, Class switching.

Unit 4 : **Cell mediated Immune Response** **(8 Hours)**

Major Histocompatibility, General Organization and Inheritance of the MHC, Antigen Presenting Cells, Processing and Presentation of Antigen by the endocytic and cytosolic pathways, Development, Maturation & Differentiation of T cells, Role of Cytotoxic T lymphocytes, T cell and B cell interactions

2.3 Practical (2 Credits)

Total Hours: 60

1. Immunodiffusion –Double immunodiffusion and Single radial immunodiffusion
2. Differential Leucocyte Count
3. Visualization of lymphoid Organs and lymphatic system (Videos)
4. Isolation of lymphocytes from blood/spleen
5. Complement mediated lysis.
6. Active and Passive agglutination reactions
7. Dot blot and ELISA

2.4 Essential readings:

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H. Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3/ISBN: 10:0-7617-8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R. and Sunshine, G., John Wiley & sons, Inc. (New Jersey), ISBN: 978-0-470-08158-7.

Suggested Readings:

1. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowar, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4
2. Cellular and Molecular Immunology (2021), 10th edition, Abbas, A.K., Lichtman, A.H., Shiv Pillai, Elsevier, ISBN: 9780323757485

3. Keywords:

Immunity, innate, adaptive, antibody, MHC, Humoral and Cell mediated immune response, Processing of antigens

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-18)
FUNDAMENTALS OF RECOMBINANT DNA 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		
Fundamentals of Recombinant DNA Technology (BCH-DSC-603)	4	2L	0	2P	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

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

1. Perform restriction digestion of DNA samples.
2. Prepare genomic and cDNA libraries,
3. Perform basic cloning techniques to design a recombinant protein in a bacterial system.
4. Design primers for PCR, perform DNA amplification by PCR, and understand the principles of DNA sequencing.

SYLLABUS OF DSC-18

BCH-DSC-18 : FUNDAMENTALS OF RECOMBINANT DNA TECHNOLOGY
SEMESTER - VI

2.2 Course Contents

Theory (2 Credits)

Total 30 hours

Unit 1: Principles of gene cloning **(14 hours)**

Restriction and modification systems, restriction endonucleases and other enzymes used in gene cloning. Cloning vectors used in *E. coli*: plasmids pBR322, pUC, pGEM3Z. Ti-plasmid, and viral vectors (λ bacteriophage, CMV and SV40), high-capacity vectors BAC and YAC. Ligation of DNA molecules. Linkers, adapters and homopolymer tailing.

Unit 2: Selection for recombinants and clone identification (5 hours)

Uptake of DNA by cells and selection of recombinants. Making cDNA and Genomic DNA libraries. Clone identification by colony hybridization.

Unit 3: Expression of cloned genes (6 hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes: Hybrid promoters trc, tac. Challenges in producing recombinant protein in *E. coli.* Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 4: Polymerase chain reaction, DNA sequencing and Site Directed Mutagenesis

(5 hours)

Fundamentals of polymerase chain reaction, Types of PCR; reverse transcriptase PCR, Primer designing. DNA sequencing by Sanger's method including automated DNA sequencing, pyrosequencing. Site–directed mutagenesis (overlap extension method).

2.3 Practical (2 Credits)

Total: 60 hours

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Preparation of competent cells and transformation with plasmid DNA.
4. Amplification of a DNA fragment by PCR.
5. Alpha-Complementation of β−galactosidase for Blue and White selection.
6. Hyper expression of a recombinant protein (SDS PAGE).
7. Poly histidine-tagged recombinant protein and purification using Ni– affinity resin

2.4 Essential readings:

- Brown, T.A. (2016) Gene Cloning and DNA Analysis (7th ed.), Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- Primrose, S.B., and Twyman, (2006) Principles of Gene Manipulation and Genomics (7th ed.), R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
- Glick B.R., Pasternak, J.J. and Patten, C.L., (2010) *Molecular Biotechnology:* Principles and Applications of Recombinant DNA (4th ed.), ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
- Michael R Green and J. Sambrook (2014) Molecular Cloning: A laboratory manual, (4th ed.), Cold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2.

Suggested readings:

- Brown, T.A. (2007) Genomes (3rd ed.), Garland Science publishing, ISBN: ISBN 0 8153 4138 5.

3. Keywords

Genetic Engineering, cloning, Recombinant Protein expression and purification, Biotechnology.

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-4)
BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS

CREDIT 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 Mechanisms and Responses in Plants (BCH-DSE-4)	04	02	00	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

The course aims to provide thorough understanding of metabolic processes in plants and the role of different biosynthetic pathways in growth and development of plants. The course will also impart basic concepts and applications of plant secondary metabolites.

Learning outcomes

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

1. Describe the structure and function of plant cell organelles in plant metabolism.
2. Explain the various plant biochemical processes and metabolic pathways including photosynthesis, photorespiration, nitrogen fixation and assimilation and plant secondary metabolism and their biological significance.
3. Discuss the role of plant hormones in plant growth and development.
4. Evaluate the various plant responses to different abiotic and biotic stress conditions.
5. Plan and execute plant tissue culture.

SYLLABUS OF DSE-4

BCH-DSE-4 : BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Photosynthesis and Respiration **(8 Hours)**

Introduction to Plant cells, Cell wall, Vacuole and Tonoplast membrane, Plastids and Peroxisomes. Overview to photosynthesis and Carbon assimilation, Light reaction and photosystems, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Photoinhibition. Glycolytic pathway and its alternative reactions in plants, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain in plants, alternative NAD(P)H oxidative pathways.

Unit II: Nitrogen metabolism (7 Hours)

Nitrogen cycle; Biological nitrogen fixation; Structure and function of Nitrogenase complex. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate aminotransferase (GS-GOGAT) pathway.

Unit III: Plant physiology and Secondary metabolites (10 Hours)

Plant vascular system; Plant hormones and their role in plant growth and development; Regulation of plant morphogenetic processes by light. Plant stress responses to abiotic and biotic stresses: Water deficit, temperature, salinity, insect manifestation. Secondary metabolites: types, structure and functions of Alkaloids, Phenolics and terpenoids.

Unit IV: Plant tissue culture (5 Hours)

Cell and tissue culture techniques, types of cultures: organ and explant culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

2.3 Practical:

Credits: 2 Total Hours : 60

1. Induction of hydrolytic enzymes (proteases /amylases/lipase) in germinating wheat seeds.
2. Effect of plant hormones on plant growth (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds).
3. Extraction and assay of Urease from Jack bean.
4. Estimation of carotene/phenols/tannins in fruits and vegetables.
5. Estimation of ascorbic acid in fruits and vegetables.
6. Effect of light on chlorophyll production.
7. Separation and analysis of chloroplast proteins (Rubisco) using SDS-PAGE.
8. Plant tissue culture

2.4 Essential readings:

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science. ISBN 978-0-8153-4121-5.

3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749. 94
4. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN-13: 978-0878938667, ISBN-10: 0878938664

3. Keywords

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-5)
NUTRITIONAL BIOCHEMISTRY

CREDIT 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		
Nutritional Biochemistry (BCH-DSE-5)	04	02	0	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

This course provides students with knowledge and understanding of the characteristics, function, metabolism and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Learning outcomes

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

1. Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
2. Demonstrate the relationship between nutrition and health.
3. Discuss the macro and micronutrients and their nutritional deficiencies.
4. Describe techniques used in the assessment of nutritional status and nutritional disorders.
5. Explain drug nutrient interactions.

SYLLABUS OF DSE-5

BCH-DSE-5 : NUTRITIONAL BIOCHEMISTRY
Semester – VI

2.2 Course Contents
Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Nutrition and Energy Metabolism (4 Hours)

Defining nutrition, role of nutrients. Unit of energy, Food energy, SDA. Energy expenditure and its components, Energy Balance, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Macronutrients **(10 Hours)**

Food sources of carbohydrates, functions of carbohydrates, RDA, Factors affecting bioavailability, Glycemic index and glycemic load. Dietary fiber and the role of fibre in health. Role of Gut microbiome in maintaining health. Role of prebiotics and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, AI, excess and deficiency of EFA, factors affecting bioavailability. Dietary implications of ratios of n6 and n3, MUFA, PUFA and SFA, Cholesterol in the body.

Functions of proteins in the body. RDA for different age groups. Essential and Nonessential amino acids. Complete and incomplete protein, Amino Acid Interactions: Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Protein quality determinants NPU, Biological Value, PDCAAS, Nitrogen balance. PEM: Marasmus and Kwashiorkor.

Unit III: Fat and water soluble Vitamins **(9 Hours)**

Vitamin A, D, E, K and dietary sources, RDA, Role of Vitamin A in Visual cycle and overview of other functions. Role of Vitamin K in Gamma carboxylation (blood clotting). Role of Vitamin E as an antioxidant. Role of Vitamin D in maintenance of bone physiology and overview of other functions. Vitamin C- Dietary sources, RDA, role in collagen synthesis. The B Complex vitamins- Dietary sources, RDA. Functions and role in metabolism, Role of Vitamin B12 and Folate in Haematopoiesis and Neurology. Biochemical basis for deficiency symptoms, Hypervitaminosis.

Unit IV: Minerals **(7 Hours)**

Minerals: Dietary Sources, RDA. Sodium, Potassium, Calcium, Iron, Chloride, Copper and Phosphorus- Function, metabolism, Excretion, Deficiency, Toxicity, Trace Elements Iodine, Fluoride, Mg, Zn, Se, Chromium, Molybdenum: Function, Metabolism, deficiency, Toxicity and Sources.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Anthropometric identifications for nutrition related diseases, BMR calculation
2. Determination of oxidative stress: TBARS in serum, antioxidant enzymes in hemolysate/plant sources.
3. Estimation of A/E vitamin in serum.
4. Estimation of minerals in drugs/food/serum.
5. Determination of nutritive value of foods.
6. Understanding fortification and supplementation
7. Presentation and discussion on Food as medicine.
8. Group discussion on Nutrient-nutrient and drug-nutrient interactions
9. Case studies on nutritional disorders.

2.4 Essential Readings:

1. Coombs Jr. G. F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
2. 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.
3. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 9780195171693
4. Tom Brody (1999). *Nutritional Biochemistry* (2nd Ed). Harcourt Braces. ISBN:9814033251, 978981403325.
5. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

Suggested reading:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Keywords

Nutrition, macronutrients, micronutrients, energy balance, nutrient deficiency

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-7)
MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN DISEASES

CREDIT 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 Basis of Non-communicable Human Diseases (BCH-DSE-7)	04	02	00	02	Class XII with Science and Biology	Course in human physiology

Learning Objectives

Non-communicable diseases are a diverse group of chronic diseases that are not transferred between individuals. NCDs have long-term health consequences and often create a need for long-term treatment and care. This course is aimed at providing the learner with an understanding of the multiple aetiological factors that lead to NCDs. It will also discuss the molecular and biochemical basis of the symptoms of major NCDs like Cardiovascular disease, Cancer, lifestyle disorders, chronic renal and lung disease. Apart from the major NCDs some other NCDs will also be taught. The practicals will address the diagnostics of some of these NCDs. The course will not only help students get an insight into some aspects of molecular medicine but will also give them some background if they wish to pursue a post-graduation in molecular medicine or any other relevant field.

Learning outcomes

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

1. Discuss the relationship between lifestyle and noncommunicable diseases.
2. Analyze the various molecular and biochemical interactions that contribute to the cause of NCDs.
3. Explain the networking between different endogenous and exogenous factors that contribute to NCDs burden.
4. Describe specific biomarkers that can be used to diagnose a disease or Disorder.
5. Perform tests of various diagnostic parameters that are used to identify NCDs.
6. Discuss the disease burden in today's urban society and also understand the wide spectrum of symptom diversity that occurs in such diseases through case studies.

SYLLABUS OF DSC-7

BCH-DSC-7 : MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN DISEASES
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit 1: Multifactorial complex disorders (10 Hours)

Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases: Polycystic ovarian syndrome, COPD, ARDS, Emphysema, Chronic and acute renal failure, Glomerulonephritis; Cancer: Molecular basis for neoplastic growth, metastasis, and cancer pathology; Cancer immunity; Molecular approaches to cancer treatment: Cervical cancer and preventive vaccine, Biomarkers for early detection of cancer- breast, prostrate, hepatic.

Unit 2: Metabolic and Lifestyle disorders (10 Hours)

Obesity and eating disorders like Anorexia nervosa and Bulimia. Diabetes mellitus, Metabolic syndrome and the relationship with hypertension, hypothyroidism and stress. Cardiovascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.

Unit 3: Diseases due to misfolded proteins (5 Hours)

Introduction to protein folding and proteasome removal of misfolded proteins; Etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, Sickle cell Anemia, Thalassemia.

Unit 4: Monogenic diseases (5 Hours)

Inborn errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, and clotting disorders (Hemophilia and Deep vein Thrombosis).

2.3 Practicals

Credits: 2 **Total Hours: 60**

1. Assessment of Obesity and metabolic syndrome
2. Estimation of glycosylated haemoglobin
3. Permanent slides for different types of cancer
4. Diagnosis of Thalassemia / Sickle cell Anemia
5. D dimer test / CRP tests
6. Serum LDH isozymes as a diagnostic tool

7. TropT as a cardiac marker
8. Biomarkers used in cancer diagnosis (virtual)
9. Case Studies on NCDs
10. Role of vaccination in adults to prevent NCDs with age: Group discussion.

2.4 Essential readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541
3. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M. Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
4. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6

Suggested readings:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Key words:

Non-communicable disease, Lifestyle disorders, cancer, Monogenic disease, Multifactoral disease, Misfolded proteins.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-8)
RESEARCH METHODOLOGY

CREDIT 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 (BCH-DSE-8)	04	02	00	02	Class XII with Science and Biology	NIL

Learning Objectives

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

Learning outcomes

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

1. Describe the importance of research in knowledge generation.
2. Explain the research process
3. Evaluate the importance of the major quantitative and qualitative research methods
4. Construct an effective research proposal
5. Examine the importance of research ethics
6. Record and analyse data using computer software
7. Prepare a Scientific presentation and article.

SYLLABUS OF DSE-8

BCH-DSE-8 : RESEARCH METHODOLOGY
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Research (4 Hours)

Objectives and characteristics of research; significance of research, types of research methods-qualitative and quantitative; basic and applied; descriptive and analytical; various phases of research-problem identification, generation of hypothesis, experimental design, results and discussion. Writing a research proposal-schematic presentation.

Unit II: Basic principles of research design (8 Hours)

Review of literature using appropriate sources – reviews, patents, research papers, books and e-resources; Significance of controls in research, Types of research designs – exploratory, descriptive, experimental, survey and case study.

Unit III: Statistical tools and Report writing (12 Hours)

Data collection, analysis and graphical presentation; Sample – types and characteristics; Basic Statistical Tools - Measures of central tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Correlation, Regression, Multiple Regression, hypothesis testing, P-value, data analysis and interpretation; Report writing, format of publications and presentations-oral and poster.

Unit IV: Scientific conduct and ethics in Research (6 Hours)

Biosafety and Ethics - compliance and concerns; Plagiarism-Software tools and Creative Commons; Introduction to Intellectual Property Rights; Citation and acknowledgement, Impact factor, h-index, Indian and international funding agencies.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Citation formats and citation generator
2. Plagiarism tools
3. Design of a research survey on a specific problem
4. Writing a concept note / research proposal
5. Writing of a mini-review paper
6. Systematic review, meta data analysis and presentation
7. Poster/oral presentations

2.4 Essential readings:

1. Cresswell, J. (2009) *Research Design: Qualitative and quantitative Approaches* Thousand Oaks CA, (3rd ed.), Sage Publications
2. Kothari, C.R. (2004) *Research Methodology: Methods and Techniques* (2nd ed.), New Age International Publishers.
3. Kumar, R. (2011) *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.), SAGE publisher
4. Walliman, N. (2017*) Research Methods: The Basics,* **(**2nd ed.), London; New York: Routledge
5. *WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.*

3. Keywords

Research methodology; Patents; Plagiarism; Ethics; Biosafety; Report writing

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

POOL OF GENERIC ELECTIVES

GENERIC ELECTIVE COURSE - (GE-7)
CELLULAR COMMUNICATIONS

CREDIT 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		
Cellular Communications (BCH-GE-7)	04	02	00	02	Class XII with Science and Biology	Basic course in Cell Biology

Learning Objectives

- Explain the concept of Cell-cell communication.
- Describe the various types of receptors, signal transduction pathways, second messengers and effector molecules.
- To understand how signalling pathways, regulate cell motility, metabolism, growth, organogenesis, and cell death.
- Discuss the crosstalk between signal transduction pathways crosstalk and are auto-regulated.
- To know about various diseases associated with cellular communication pathway defects.

Learning outcomes

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

1. Describe various types of cell - cell communication.
2. Discuss the various types of receptors and signal transduction pathways in bacteria, plants and animal system.
3. Explain the importance of various signalling pathways in the regulation of metabolism, growth, organogenesis and cell death.
4. Discuss the cellular communication defects that lead to various types of diseases including cancers.

SYLLABUS OF GE-7

BCH-GE-7 : CELLULAR COMMUNICATIONS
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours : 30

Unit: 1 Introduction to cell- cell communication. (2 Hours)

Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Cognate signalling.

Unit: 2 Receptors and Signal transduction pathways (16 Hours)

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G-Protein-coupled Receptors: Heterotrimeric G proteins, Second messengers: cAMP, cGMP, Lipid-derived Second Messengers (IP3, DAG) NO, Calcium Signalling. Effector systems - adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG).

Enzyme linked receptors: Receptor Tyrosine Kinases: EGF, insulin and erythropoietin. Ras - MAP kinase cascade, and JAK - STAT pathway.
Ion-channel linked receptors; Neurotransmitter receptors (Acetylcholine receptor). Nerve transmission.

Intracellular receptors: Cytoplasmic and nuclear receptors. Steroid hormone, thyroid hormone receptors. Gene regulation.

Integrin receptors. Integrin signalling. Cell matrix communication Receptor Regulation. Cross talk.

Unit 3: Photoreceptors and signal transduction in plants (4 Hours)

Phytochromes, cryptochromes and phototropins signalling.

Unit 4: Cell death signalling (4 Hours)

Apoptosis, Autophagy

Unit 5: Bacterial signalling (4 Hours)

Quorum sensing, autoinducers, chemotaxis.

2.3 Practical

Credit: 2 **Total Hours : 60**

6. Yeast response to mating pherohormones .
7. Study of Chemotaxis response in Tetrahymena/ paramecium/ dictostylium
8. Study change in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in zebrafish larvae.
9. Chemotaxis/ motility assay in microbes.
10. Effect of plant hormones on plant growth or photomorphogenesis in response to light. (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds)

Essential readings:

1. Lodish, U. H. (2016) Molecular Cell Biology. W.H. Freeman, 2016.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman. ISBN:9781319230906
3. Lim, W., Mayer, B., & Pawson, T. (2015). Cell signaling: principles and mechanisms. New York: Garland Science, Taylor & Francis Group.
4. Kocher, S. L., and Gujral, S. K. (2020). Plant Physiology Theory and Application. Cambridge University Press DOI: https://doi.org/10.1017/9781108486392.018
5. Demuth, D., & Lamont, R. (Eds.). (2006). Bacterial Cell-to-Cell Communication: Role in Virulence and Pathogenesis (Advances in Molecular and Cellular Microbiology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511541506

Suggested readings:

1. ZFIN protocols
2. Harris UM. A., McGee, S. A., and Batzi J. M. (2018). Uncooking Yeast: Cells Signalling a Rise to Inquiry. Tested Studies for Laboratory Teaching. Proceedings of the Association for Biology Laboratory Education. 38 (9) 1-48
4. Plant physiology and biotechnology laboratory manual. Compiled by: David Law, Lada Malek and JoAnne Henderson. 2006. https://old.amu.ac.in/emp/studym/99997510.pdf

3. Keywords

Chemical signaling, Receptors, signal transduction, GPCRs, RTKs, Photoreceptors, cell death signaling, bacterial signalling

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

GENERIC ELECTIVES COURSE - (GE-8)
BIOCHEMICAL CORRELATION OF DISEASES

CREDIT 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 CORRELATION OF DISEASES (BCH-GE-8)	04	02	00	02	Class XII with Science and Biology	XIIth pass with biology

Learning Objectives

The course aims to provide students with knowledge and understanding of the spectrum of human diseases. It will introduce the concept of a well-balanced diet, healthy lifestyle, the biochemical mechanism of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that could be employed for prevention of infectious and non-infectious diseases.

Learning outcomes

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

1. Discuss the importance of a balanced diet, regular exercises and healthy lifestyle in leading a disease-free life.
2. Explain the functioning of the immune system and endocrine system and the basis of various autoimmune and hormonal disorders.
3. Correlate the genetic mutation and metabolic disorders.
4. Discuss the molecular mechanism of microbial pathogenicity, drug resistance and implications in public health management.

SYLLABUS OF GE-8

BCH-GE-8 : BIOCHEMICAL CORRELATION OF DISEASES
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit I: Inherited Metabolic diseases and Hormonal disorders (9 Hours)

Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Unit II: Nutritional deficiency and lifestyle-based diseases (7 Hours)

Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Unit III: Autoimmune diseases (6 Hours)

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases- Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic lupus erythematosus (SLE), Rheumatoid arthritis.

Unit IV: Infectious diseases (8 Hours)

Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

2.3 Practical:

Credits: 2 **Total Hours : 60**

8. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
9. Measurement of Blood pressure
10. Determination of blood Lipid Profile: Triglyceride, Cholesterol
11. Glucose tolerance test
12. Widal test
13. Permanent slides of malarial parasites/Leishmania
14. Case studies related to autoimmune diseases, life-style disorders and hormonal imbalance

2.4 Essential readings:

5. Berg, J.M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2019). Biochemistry (9th ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
6. Coico, R. (2021). Immunology: A Short Course (8th ed.). John Wiley & Sons, Inc (New Jersey). ISBN: 9781119551577.
7. Devlin, T. M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
8. Willey, J., Sandman, K., Wood, D. (2019). Prescott's Microbiology (11th ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

4. Sherwood, L. (2012). Introduction to Human Physiology (8th ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
5. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6th ed.). New Delhi, Pearson Education, Inc. ISBN: 978-81-317-2610-5.
6. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

3. Keywords

Lifestyle and metabolic disorders, nutritional deficiency, hormonal disorder, autoimmunity and infectious diseases.

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

GENERIC ELECTIVES COURSE - (GE-11)
TOOLS OF GENETIC ENGINEERING

CREDIT 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		
Tools for Genetic Engineering (BCH-GE-11)	04	02	00	02	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach:

- Basics of theoretical and practical aspects of recombinant DNA technology.
- Various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

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

1. Grow bacterial culture and obtain single isolated colonies
2. Estimate the concentration of DNA by UV spectroscopy
3. Extract plasmid DNA from recombinant *E. coli*
4. Perform restriction digestion and evaluate the end products by agarose gel electrophoresis
5. Perform Polymerase chain reaction and amplify a DNA fragment
6. Explain the various methods for expression of recombinant genes in *E.coli*
7. Perform gene cloning

SYLLABUS OF GE-11

BCH-GE-11 : TOOLS FOR GENETIC ENGINEERING
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

UNIT I: Introduction to recombinant DNA technology **(5 Hours)**

Overview of gene cloning. Restriction and Modification systems, Restriction endonucleases, DNA modifying enzymes (DNA polymerase I, Taq polymerase, DNAse I, DNA Ligase).

UNIT II: Cloning vectors for prokaryotes and eukaryotes **(6 Hours)**

Salient features of vectors (pBR322, pUC8, Lambda bacteriophage, Ti plasmid) used in cloning.

UNIT III: **Introduction of DNA into cells and selection of recombinants (9 Hours)**

Ligation of DNA molecules: linker, adapters, homopolymer tailing. Introduction of DNA into bacterial cells, selection of transformed cells, insertional inactivation. Identification of recombinant phages. cDNA and Genomic DNA libraries. Clone identification by colony and plaque hybridization.

UNIT IV: Basics of Polymerase Chain Reaction and DNA sequencing (5 Hours)

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by chain-termination method, pyrosequencing.

UNIT V: Expression of cloned genes (5 Hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes. Hybrid promoters trc, tac, λpL and T7 promoter-based expression–vectors. Challenges in producing recombinant protein in *E. coli.* Fusion tags (poly-histidine, GST) and their role in purification of recombinant proteins.

2.3 Practicals

Credits : 2 **Total Hours: 60**

1. Growing a culture of *E.coli* and obtaining isolated colonies by streak-plate method.
2. DNA estimation by UV spectrophotometry.
3. Isolation of plasmid DNA from *E. coli.*
4. Restriction digestion of plasmid DNA and agarose gel electrophoresis.
5. Amplification of a DNA fragment by PCR (demonstration)

2.4 Essential Readings

1. Gene Cloning and DNA Analysis (2016) 7th ed., Brown, T.A., Wiley Blackwell Publishing (Oxford, UK), ISBN: 978-1-119-07256-0.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

3. Key Words

Genetic Engineering, Recombinant Proteins, PCR, DNA Sequencing

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

DEPARTMENT OF MICROBIOLOGY
SEMESTER-IV
B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 10: ADVANCES IN CELL 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		
MICROB-DSC401: ADVANCES IN CELL BIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	Basic Concepts of Cell Biology

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to introduce the students to the essentials of eukaryotic cell biology.
- The students will gain knowledge about the physical and chemical architecture of cells as well as structural and functional details of different cell organelles.
- They will become familiar with cell cycle events, and mechanisms of cell communication and cell death.
- They will be educated about the hallmarks, etiology and diagnosis of cancers.
- They will be introduced to the cutting edge science of stem cell technology, their production and various applications.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the different components of cell signalling pathways used for cell communication.
- Student will be able to recall cell division, mechanisms of cell cycle regulation, and types of cell death.
- Student will be able to evaluate the importance of stem cells and their associated technologies and applications.

- Student will be able to describe the different types of cancers, their causes, characteristics, diagnosis, and treatment modalities.
- Student will be able to analyze DNA by Feulgen staining followed by microscopic observation. Student will be able to analyze the different stages of cell division: mitotic stages by temporary mount and meiosis stages by the permanent mount.
- Student will be able to evaluate chromosome polyploidy by colchicine treatment of plant material followed by staining.

SYLLABUS OF DSC-10

UNIT – I (20 hours)

Cell Signalling: Modes of cell-cell signalling: endocrine, paracrine, autocrine. Signalling molecules: nitric oxide, carbon monoxide, steroid hormones, neurotransmitters, peptide hormones and growth factors. Cell surface receptors and receptor-ligand interactions: G protein-coupled receptors, receptor protein tyrosine kinases, cytokine receptors. Signal transduction: cyclic AMP, cyclic GMP and MAP kinase pathways.

UNIT – II (10 hours)

Cell Cycle and Cell Death: Phases and regulation of eukaryotic cell cycle. Mitosis and meiosis. Types of cell death: necrosis, apoptosis and autophagy, mitophagy. Characteristics and pathways of apoptosis: intrinsic and extrinsic.

UNIT – III (5 hours)

Cell Renewal: Stem cells: characteristics and types: somatic stem cells, embryonic stem cells, induced pluripotent stem cells. Therapeutic applications of stem cells.

UNIT – IV (10 hours)

Cancer biology: Hallmarks of cancer. Causes of cancer: carcinogens, cancer-causing microorganisms. Proto-oncogenes and oncogenes. Tumor suppressor genes. Characteristic features of cancer cells. Types of cancers. Cancer stem cells. Approaches to cancer diagnosis. Currently available cancer treatment modalities (including bone marrow transplantation, immune cell and oncolytic viral therapies).

Practical component

UNIT 1: (20 hours)

Cell division and cytochemical analysis of DNA: Performance of cytochemical staining of DNA by Feulgen stain. Microscopic examination and analysis of the different stages of mitosis through temporary mounts of stained onion root tip. Microscopic examination and analysis of the different stages of meiosis through temporary mounts / permanent slides.

Unit 2: (10 hours)

Chromosome polyploidy and properties of cancer cells: Study of polyploidy in onion root tip by colchicine treatment followed by acetocarmine stain. Identification and

study of properties of different types of cancerous cells through light and electron micrographs.

Essential/recommended readings

Theory:

1. Molecular Cell Biology by H. Lodish, A. Berk, C. Kaiser, M. Krieger, A. Bretscher, H.Ploegh, A. Amon and K.C. Martin. 9th edition. W.H. Freeman, UK. 2021.
2. Essential Cell Biology by B. Alberts, K. Hopkin, A.D. Johnson, D. Morgan, and M. Raff. 5th edition. W.W. Norton & Co, USA. 2019.
3. Karp's Cell and Molecular Biology by G. Karp, J. Iwasa and W. Marshall. 9th edition. Wiley, USA. 2019.
4. The Cell: A Molecular Approach by G.M. Cooper. 8th edition. Sinauer Associates, UK. 2018.
5. The science of stem cells by J.M.W. Slack. 1st edition. John Wiley & Sons. 2018.
6. Cell Biology by T.D. Pollard, W.C. Earnshaw, J. Lippincott-Schwartz and G.T. Johnson. 3rd edition. Elsevier, USA. 2016.
7. Becker's World of the Cell by J. Hardin and G. Bertoni. 9th Edition. Pearson, USA. 2015.
8. Principles of stem cell biology and cancer: future applications and therapeutics by T. Regad, T. Sayers and R. Rees. 1st edition. John Wiley & Sons. 2015.
9. Essentials of stem cell biology edited by R. Lanza and A. Atala. 3rd edition. Academic Press. 2013.
10. Cell and Molecular Biology by E.D.P. De Robertis. 8th edition. Lippincott, Williams andWilkins, USA. 2006.

Practicals:

1. A Cell Biology Manual by J. Francis. Kendall/Hunt Publishing Co, USA. 2022.
2. Practical Laboratory Manual- Cell Biology by A. Gupta, B.K. Sati. Lambert Academic Publishing, USA. 2019.
3. Cell Biology Practical Manual by R. Gupta, S. Makhija and R. Toteja. Prestige Publishers, India. 2018.
4. Laboratory Manual of Cell Biology by R. Majumdar, R. Sisodia. Prestige Publishers, India. 2018.
5. Essential Cell Biology Vol 1: Cell Structure- A Practical Approach by J. Davey and M.Lord. Oxford University Press, UK. 2003.
6. Essential Cell Biology Vol 2: Cell Function- A Practical Approach by J. Davey and M. Lord. Oxford University Press, UK. 2003.

Suggestive readings

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:
MICROBIAL PHYSIOLOGY AND METABOLISM- 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		
MICROB-DSC402: **MICROBIAL PHYSIOLOGY AND METABOLISM-II**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**Microbial Physiology and Metabolism-I**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable students to understand the underlying mechanisms governing various physiological and metabolic features of prokaryotes.
- These include transport mechanisms for the uptake of nutrients, bacterial growth, and the diversity of prokaryotes due to (i) adaptations to the different habitats in which they grow and (ii) metabolic pathways for energy production and carbon and nitrogen assimilation.
- The course will build the strong foundation needed by the students for further studies in the advanced fields of microbiology including metabolic engineering.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to elaborate on various pathways of fermentation in microbes.
- Student will be able to discuss the classification of chemolithotrophs and phototrophs along with mechanisms of energy production and cellular carbon synthesis.
- Student will be able to describe the nitrogen cycle and its assimilation and dissimilation by processes like nitrogen fixation, ammonia assimilation, nitrification, denitrification etc.

- Student will be able to evaluate the diversity of metabolic pathways in microbes by designing and formulation of microbial culture media and studying the effect of changing chemical environment on fungal growth using various carbon sources.
- Student will be able to evaluate the diversity of metabolic pathways in microbes by studying the effect of changing chemical environment on bacterial growth using various nitrogen sources.

SYLLABUS OF DSC-11

UNIT – I (8 hours)

Microbial fermentations: Principles of fermentation. Alcohol fermentation and Pasteur effect. Lactate fermentation (homofermentative and heterofermentative pathways). Concept of linear and branched fermentation pathways.

UNIT – II (12 hours)

Metabolism in chemolithotrophic autotrophs: Physiological groups of chemolithotrophs (aerobic and anaerobic). Detailed mechanism of energy production and generation of reducing power in H2 oxidizers and methanogens.

UNIT – III (13 hours)

Metabolism in phototrophic autotrophs: Families of phototrophic bacteria, bacterial photosynthetic pigments, generation of energy and reducing power in purple and green bacteria (anoxygenic photosynthesis) and cyanobacteria (oxygenic photosynthesis), photophosphorylation (cyclic and non- cyclic). Production of cellular carbon (C1 metabolism) in autotrophs by Calvin cycle & reductive TCA pathway and by acetyl-CoA in methanogens.

UNIT – IV (12 hours)

Nitrogen Metabolism: Biological nitrogen fixation: Diversity, mechanism of nitrogen fixation, nitrogenase activity and its physiological regulation, alternate nitrogenases, ammonia assimilation, assimilatory nitrate reduction. dissimilatory nitrate reduction (denitrification, nitrate/ nitrite and nitrate/ ammonia respiration).

Practical component

UNIT 1: (15 hours)

Carbon metabolism: Comparison of the growth of A. niger in minimal medium containing different carbon sources (glucose, fructose and lactose) on different days of growth using dry weight method.

Unit 2: (15 hours)

Nitrogen metabolism: Study of the effect of nitrogen sources (ammonium, nitrate and peptone) on the growth of E. coli. Investigation any one bacterium for its nitrifying / denitrifying properties

Essential/recommended readings

Theory:

1. Fundamentals of Bacterial Physiology and Metabolism by Rani Gupta and Namita Gupta. Springer Nature Singapore Pvt. Ltd., Singapore. 2021.
2. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.
3. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
5. Microbial Biochemistry by G.N. Cohen. 2nd edition. Springer, Germany. 2014.
6. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond and C. Fuqua. 4th edition. Oxford University Press, UK. 2011.
7. Microbial Physiology by S.R. Reddy and S.M. Reddy. Scientific Publishers India. 2007.
8. Microbial Physiology by A.G. Moat, J.W. Foster and M.P. Spector. 4th edition. John Wiley& Sons, USA. 2002.

Practicals:

1. Essentials of Practical Microbiology by A. Sastry and S. Bhat. 2nd edition. Jaypee Brothers Medical Publishers, India. 2021.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Laboratory Experiments in Microbiology by T. Johnson and C. Case. 12th Edition. Pearson Education, USA. 2019.
4. Microbiology Practical Manual edited by A. Jain, J. Agarwal, V. Venkatesh. Elsevier, India. 2018.
5. Applied Microbial Physiology: A Practical Approach by P. M. Rhodes and P. F. Stanbury. IRC Press. 1997.

Suggestive readings

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:
VIROLOGY

CREDIT 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		
MICROB-DSC403: **VIROLOGY**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to make students aware of the extent to which the tiniest of microorganism (viruses) leave their impact on human and animal health as well as in agriculture.
- Students will get acquainted with the structures and replication strategies of bacterial, plant and human viruses.
- Students will gain in-depth knowledge of how viruses infect their host, spread across a population, and cause diseases.
- They will learn of preventive measures used for protection against viral infections, and control
- They will acquire knowledge of emerging and re- emerging viruses in context to public health threats taking coronavirus as the case study.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the nature, properties and structure of viruses, and be knowledgeable about sub-viral particles, giant viruses and viral taxonomy.
- Student will be able to discuss bacterial viruses, their salient features, and replication strategy of important bacteriophages.
- Elaborate on plant viruses, modes of transmission and their economic importance.
- Student will be able to evaluate the salient features and replication strategies of important human viruses, and will have understood the concept of oncogenesis, DNA and RNA cancer-causing viruses.
- Student will be able to describe how to prevent viral infections using vaccines and antiviral compounds.

- Student will be able to assess the problems of emerging and re-emerging viruses, having an understanding of the rise of coronavirus as the major public health crisis along with the implemented management protocols.

SYLLABUS OF DSC-12

UNIT – I (9 hours)

Introduction to Virology: History of virology. Nature and general properties of viruses, concept of viroids, virusoids, satellite viruses, prions, giant viruses (mama, mimi and pandora virus), virophages (Sputnik). Structure of viruses: Capsid symmetry, enveloped and non- enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

UNIT – II (8 hours)

Bacteriophages: Diversity, one step multiplication curve. T4 phage: Unusual bases, terminal redundancy, lytic cycle, assembly, maturation and release of progeny virions. Lambda phage: genome structure, concept of early and late proteins, lytic cycle and lysogeny. øX174 phage: Overlapping genes, and rolling circle replication.

UNIT – III (3 hours)

Plant Viruses: Diversity, modes of transmission (non-persistent, semi persistent and persistent), salient features of replication of Geminivirus. Economic importance of plant viruses : adverse and beneficial effects. Virus-like particles (VLPs) and their applications in medicine.

UNIT – IV (18 hours)

Human Viruses: Diversity, routes of transmission: vertical and horizontal (vector-borne, air-borne, oral-faecal borne) infection cycle. Replication of Human Immuno Deficiency Virus (HIV) and Polio Virus. Overlapping genes. Partial double stranded genomes: Hepatitis B. Segmented genomes: Influenza virus. Non-segmented genomes: Picornavirus. Assembly with example of Polio virus. Oncogenic viruses: types of oncogenic DNA and RNA viruses. Emerging and Re-emerging viruses: H1N1, Dengue, Ebola, Zika virus and associated pandemics and epidemics. Case study of the SARS-CoV2 Corona virus as the recent public health threat: emergence, epidemiology, management protocols, emergence of variants, global impact

UNIT – V (7 hours)

Prevention and Control of Viral Diseases: Antiviral compounds and their mode of action: AZT, ritonavir, lamivudine. Interferons and their mode of action. General principles of viral vaccines: live attenuated vaccines, inactivated viral vaccine, subunit vaccine, recombinant viral vaccine.

Practical component

UNIT 1: (22 hours)

Structure and isolation of viruses: Principle and use of electron microscopy to study virus structure. Use of electron micrographs for studying the structural characteristics of the following viruses: Bacterial viruses: ϕX174, T4, λ. Plant viruses: caulimo, gemini, tobacco ringspot, cucumber mosaic and alfalfa mosaic viruses. Human viruses: rhabdo, influenza, paramyxo, hepatitis B and retroviruses.

Isolation of bacterial and plant viruses: Isolation and enumeration of bacteriophages (PFU) from water/sewage samples using double agar layer technique. Qualitative analysis of lytic and lysogenic phage by observation of plaque phenotypes (clear versus turbid). Isolation of plant viruses from infected leaves followed by locally inoculating healthy plant leaves to confirm isolation and infectivity. Use of the local lesion assay to observe characteristic lesions formed on the plant leaves and measure of infectivity of the virus by enumeration of the number of local lesions on the inoculated leaves.

Unit 2: (8 hours)

Isolation and propagation of animal viruses: Principle and working method of using chick embryo cultivation technique. Demonstration of the method using videos. Cytopathic effects of viruses: observation of the physical attributes of virus-infected cells of different types with suitable photographs and images.

Essential/recommended readings

Theory:

1. Fields Virology: DNA Viruses (Vol 2) by P.M. Howley, D.M. Knipe, J.L. Cohen, B.A. Damania. 7th edition. Walters Kluwer, Netherlands. 2021.
2. Fields Virology: Emerging Viruses (Vol 1) by P.M. Howley, D.M. Knipe, S. Whelan. 7th edition. Walters Kluwer, Netherlands. 2020.
3. Principles of Virology, Molecular biology, Pathogenesis and Control by S. Flint, L. Enquist, R. Krug, V. Racaniello, A. Skalka. 5th edition. ASM press, USA. 2020.
4. Plant Viruses: Diversity, Interaction and Management by R.K. Gaur, S.M.P. Khurana, and Y. Dorokhov. CRC Press. Taylor & Francis Group. 2018.
5. Principles of Molecular Virology by A.J. Cann. 6th edition. Academic Press, Elsevier Netherlands. 2016.
6. Introduction to Modern Virology by N.J. Dimmock, A.L. Easton and K.N. Leppard. 7th edition.Wiley-Blackwell Publishing. 2016.
7. Understanding Viruses by Teri Shors Jones. 3rd edition. Jones and Bartlett Learning, USA. 2016.
8. Plant Virology by R. Hull. 5th edition. Academic Press, USA. 2014.
9. Virology: Principles and Applications by J. Carter and V. Saunders. 2nd edition. John Wiley andSons, UK. 2013.
10. Plant Viruses by M.V. Nayudu. Tata McGraw Hill, India. 2008.
11. Basic Virology by E.K. Wagner, M.J. Hewlett, D.C. Bloom. 3rd edition. Wiley-Blackwell Publishing. 2007.
12. Virology by J.A. Levy, H.F. Conrat and R.A. Owens. 3rd edition. Prentice Hall, USA. 2000.

Practicals:

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.
2. Bacteriophages by D., Harper, S., Abedon, B., Burrowes, and M. McConville. 1st edition. Springer, Switzerland. 2021.
3. Freshney's Culture of Animal Cells by R. I., Freshney and A. Capes-Davis. John Wiley and Sons. U.K. 2021.
4. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
5. Manual of Clinical Microbiology, 2 Volume set by K. C., Carroll, M. A., Pfaller, M. L., Landry, A. J., McAdam, R., Patel, S. S., Richter and D. W. Warnock. 12th edition. ASM Press. USA. 2019.
6. Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja. 5th edition. New Age International Publishers, India. 2017.
7. Practical Plant Virology by J., Dijkstra and C., Jager. Springer Science and Business Media. Germany. 2012.
8. A Colour Atlas of Virology by J. Versteeg. Mosby International. Taiwan. 1990.

Suggestive readings

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

SEMESTER-V
B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 13: PRINCIPLES OF MOLECULAR BIOLOGY-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		
MICROB-DSC501: **PRINCIPLES OF MOLECULAR BIOLOGY-I**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is for the student to gain comprehensive knowledge of the basic concepts of molecular biology.
- The student will become familiar with DNA-related cellular processes and will become aware of the central dogma of molecular biology, learning about the propagation of information through DNA replication and the unidirectional flow of information from DNA to RNA to proteins through transcription and translation

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe DNA and RNA as genetic material and the structure and properties of the different DNA types as well as the various kinds of RNA.
- Student will be able to explain the process of propagation of information in prokaryotes and eukaryotes by DNA replication and the various enzymes and other proteins that modulate this process.
- Student will be able to describe the basic prokaryotic and eukaryotic transcription processes, including the RNA polymerases and general transcription factors involved, differentiate between the processes in prokaryotes and eukaryotes.
- Student will be able to evaluate the relevance of the double helical structure of DNA in the propagation of genetic material.
- Student will be able to demonstrate the isolation of genomic DNA and plasmid from bacterial cells, and analyze them through agarose gel electrophoresis.

SYLLABUS OF DSC-13

UNIT – I (12 hours)

Structure and properties of nucleic acids: Types of genetic material: DNA and RNA. Structure of DNA: characteristic features of double helix. Properties of different types of DNA: A, B and Z. Denaturation and renaturation of DNA, factors affecting renaturation kinetics, concept of Tm. Principle and method of cot curve analysis of DNA. Factors affecting DNA topology: role of topoisomerases I and II. Concept of linking number. Concept of concatenation and concatamerization. DNA organization in prokaryotes and eukaryotes. Structure and function of RNA: rRNA, tRNA and mRNA.

UNIT – II (17 hours)

Replication of DNA in prokaryotes and eukaryotes: Semi-conservative DNA replication. Unidirectional and bidirectional DNA replication. DNA replication modes with one example each: D-loop (mitochondrial), Θ (theta), rolling circle. Structure of origins of replication in prokaryotes versus eukaryotes, initiators and replicators. Mechanism of origin activation in prokaryotes (E.coli) and eukaryotes (S.cerevisiae). Mechanism of DNA replication: semi-discontinuous replication, leading and lagging strand synthesis. Replication machinery in prokaryotes and eukaryotes: primase, DNA polymerases, DNA ligase. Mechanisms for maintaining fidelity of replication. Differences in prokaryotic and eukaryotic DNA replication. Regulation of replication in prokaryotes and eukaryotes. Replication of chromosome ends: mechanism of action of telomerase, importance of telomerase in ageing.

UNIT – III (16 hours)

Transcription in prokaryotes and eukaryotes: Distinction between replication and transcription. Concept of transcription unit. Concept of operon and polycistronic transcription in prokaryotes. RNA polymerases in prokaryotes and eukaryotes. Structure and properties of promoter in prokaryotes and eukaryotes. Role of enhancers and silencers in gene regulation. General transcription factors in eukaryotes. Process of transcription initiation and elongation in prokaryotes and eukaryotes. Transcription termination: rho-dependent and rho-independent termination mechanisms. Inhibitors of transcription and their mechanism. Comparison of the transcription process in prokaryotes versus in eukaryotes

Practical component

UNIT 1: (12 hours)

Study of different types of DNA and RNA:

Student research study project: Discovery of DNA as genetic material. Discovery of structure of DNA: the double helix.

Study of the structure and properties of different types of DNA using micrographs and/or models: A-DNA, B-DNA and Z-DNA. Study of the structure and properties of various RNAs using micrographs: mRNA, rRNA, tRNA, miRNA, siRNA, guide RNA, xistRNA, snRNA, snoRNA. Discussion on the importance of the double helix

structure in DNA replication by semi- conservative mode: the Meselson & Stahl experiment.

Unit 2: (18 hours)

Isolation and analysis of DNA:

Isolation of genomic DNA from Escherichia coli cultures: cell lysis and DNA precipitation. Analysis of the isolated genomic DNA: principle and working method of agarose gel electrophoresis. Isolation of plasmid DNA using alkaline lysis method. Analysis of the isolated plasmid DNA by agarose gel electrophoresis. Identification of the different forms of plasmid DNA by agarose gel electrophoresis.

DNA estimation: colorimetric estimation of DNA using salmon sperm DNA or calf thymus DNA as standard: diphenylamine method. Spectrophotometric method using absorbance at 260 nm.

Essential/recommended readings

Theory:

1. Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 4th edition. Jones andBartlett Publishers, USA. 2020.
2. Karp's Cell and Molecular Biology by G. Karp, J. Iwasa and W. Marshall. 9th edition. Wiley, USA. 2019
3. Molecular Biology by D. Clark, N. Pazdernik and M. McGehee. 3rd edition. Academic Cell, USA. 2018.
4. Lewin's Genes XII by J. Krebs, E. Goldstein and S. Kilpatrick. 12th edition. Jones and BartlettLearning, USA. 2017.
5. Becker's World of the Cell by J .Hardin and G.P. Bertoni. 9th edition. Pearson, USA. 2015.
6. Principles of Genetics by D.P. Snustad and M.J. Simmons. 7th edition. Wiley and Sons, UK. 2015.
7. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2014.
8. Cell and Molecular Biology by E.D.P. De Robertis and E.M.F. De Robertis. 8th edition. Lippincott Williams and Wilkins, USA. 2006.

Practicals:

1. Molecular Cloning: A Laboratory Manual by M. Green and J. Sambrook Volumes 1-3. 4th edition. Cold Spring Harbor Laboratory Press, USA. 2012.
2. An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.

Suggestive readings

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:
BASIC CONCEPTS 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/ Practice		
MICROB-DSC502: **BASIC CONCEPTS OF IMMUNOLOGY**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**None**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to give the students insight into how the human body tackles diseases and what mechanisms of defense are used in protection processes.
- The students will develop a clear understanding of the various components of the immune system and will become aware of the characteristics of antigens, their types and various antibodies produced by the system to defend us from the invading microorganisms.
- The student also learns about the major histocompatibility complex, the complement system, monoclonal antibodies and cytokines, which are of paramount importance in triggering an efficient immune response.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will be able to describe various types of immune responses and the basic processes involved therein, how the immune system protects us from infection using various lines of defense.
- The student will be able to explain the characteristics and functions of the cells of the immune system as well as the structure and functioning of various organs of the immune system, and immunodiagnostic techniques.
- The student will be able to explain the important properties of antigens as well as how environmental factors affect antigen immunogenicity; the structure, types, and functions of antibodies, monoclonal and chimeric antibodies.

- The student will be able to describe the major histocompatibility complex proteins and their loci in the genome along with the two distinct pathways for processing and presentation of exogenous and endogenous antigens.
- The student will be able to discuss the mechanisms by which the complement system is activated via three distinct pathways so as to support the antibodies and phagocytes to clear microbes and damaged cells with utmost efficacy.

SYLLABUS OF DSC-14

UNIT – I (10 hours)

Basic Introduction to immune system: Components of innate immunity: Anatomical and physiological barriers, chemical mediators, non-specific defence mechanisms, inflammatory response, phagocytosis, Pattern Recognition Receptors (PRR). Features of Adaptive Immunity, Cytokines and cytokine receptor families with emphasis on IL-2R.

UNIT – II (10 hours)

Cells and organs of Immune System: Hematopoiesis, structures, functions and properties of cells of lymphoid lineage (T cell, B cell, NK cell) and myeloid lineage (macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell). Separation of cells using Flow Cytometry. Primary and secondary immune organs (bone marrow, thymus, spleen, lymph nodes, GALT).

UNIT – III (15 hours)

Antigens and antibodies: Properties of Antigens: foreignness, molecular size, heterogeneity. Antigenicity and immunogenicity, environmental factors affecting immunogenicity of an antigen, adjuvants, epitopes of an antigen (T and B cell epitopes), T-dependent and T-independent antigens, haptens.

Elucidation of antibody structure; types, functions and properties of antibodies, antigenic determinants on antibodies (isotypic, allotypic, idiotypic), monoclonal and chimeric antibodies, immunoglobulin superfamily. Immunodiagnostics by SDS-PAGE, western blotting, ELISA and its types, immunofluorescence, immunoelectron microscopy.

UNIT – IV (5 hours)

T Cell Receptor, Major Histocompatibility Complex and Antigen Presentation: Structure and functions of TCR-CD3 complex, MHC I & MHC II molecules, organization of MHC locus (mouse and human), antigen processing pathways (cytosolic and endocytic).

UNIT – V (5 hours)

Complement and Activation Pathways: Components of complement system, Complement activation pathways (classical, alternative and lectin) and their biological consequences.

Practical component

UNIT 1: (18 hours)

Introduction to Immunology:

Student study research project: The contributions of the following scientists to the development of the field of immunology: Edward Jenner, Paul Ehrlich, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Susumu Tonegawa, Jules Bordet, Peter C. Doherty & Rolf M. Zinkernagel, Cesar Milstein & Georges E. Kohler, and George Snell, Jean Dausset & Baruj Benacerraf.

Cells of Immune system:

Familiarizing students with the haemocytometer and its uses. Determining total leucocyte count in the given blood sample: making a smear of human blood and performing total and differential leukocyte count, determining percent count neutrophils, lymphocytes, eosinophils, basophils and monocytes. Study of the association of abnormal blood counts with diseases like leukopenia, leukocytosis, neutropenia.

Unit 2: (12 hours)

Basic Immunodiagnostic techniques:

Concepts of agglutination and identification of human blood groups. Understanding the concepts of immunoprecipitation by performing double immunodiffusion (Ouchterlony method). Principles, working methods and applications of Lateral Flow Test and Plate/ Dot ELISA. Performance of Plate/ Dot ELISA, and Lateral Flow Test using any diagnostic kit.

Essential/recommended readings

Theory:

1. Immunology: A short course by R. Coico. 8th edition. Wiley- BlackwellScientific Publication, UK. 2021
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman and S. Pillai. 10th edition.Elsevier, USA. 2021.
3. Kuby Immunology by J. Punt, S. Stranford, P. Jones and J. Owen. 8 th edition.
4. W.H. Freemanand Company, USA. 2018.
5. Roitt's Essential Immunology by P. Delves, S. Martin, D. Burton and I.M. Roitt. 13th edition.Wiley- Blackwell Scientific Publication, UK. 2017.
6. Janeway's Immunobiology by K. Murphy and C. Weaver. 9th edition. Garland Science Publishers, USA. 2016.
7. Basic and Clinical Immunology by M. Peakman and D. Vergani. 2nd edition. ChurchillLivingstone, UK. 2009.
8. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.

Practicals:

1. A Handbook of Practical and Clinical Immunology Volumes I & 2 by G. P. Talwar and S.K. Gupta. 2nd edition. CBS Publishers, India. 2017.
2. Practical Immunology, A Laboratory Manual by S. Balakrishnan, K. Karthik and S. Duraisamy. Lambert Academic Publishing, India. 2017.

3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 11th edition. Pearson Education, USA. 2016.
4. Laboratory Manual on Immunology and Molecular Biology by D. Dwivedi and V. Singh. Lambert Academic Publishing, India. 2013.
5. Practical Immunology by F.C. Hay, M.R. Olwyn and M.R. Westwood. 4th edition. Wiley Blackwell Publishing. 2002.

Suggestive readings

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: MEDICAL 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		
MICROB-DSC503: MEDICAL MICROBIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	None

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to introduce the students to the fundamental features of medical microbiology.
- Students will recognize the diversity of microbial pathogens and their virulence mechanisms. They will be introduced to specific infectious diseases of global relevance, diagnostic methods, and methods to manage infectious diseases.
- They will become familiar with the functional aspects of antimicrobial chemotherapy and anti- microbial resistance and will gain insights into the recent development of new molecular diagnostic methods as well as the global spread and emergence of infectious agents.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the terms in describing disease causalities, pathogenic features of microbial agents of disease, and their transmission, and will be able to describe the diverse nature of the human microbiome and its significance.
- Student will be able to describe the spectrum of diseases caused by bacterial pathogens, and the course of disease development and accompanying symptoms. Student will be able to to discuss the methods of transmission, epidemiological aspects, preventive measures, treatments.
- Student will be able to explain the human diseases caused by viruses including emerging viral pathogens, giving an understanding of the etiology, course of disease development, symptoms, diagnosis and management of these diseases.
- Student will be able to elaborate on the fungal and protozoan diseases with respect to their etiology, symptoms, transmission, diagnosis and control.
- Student will be able to explain the basic concepts of handling clinical specimens, and approaches used to aid in detection/ diagnosis of infectious agents using immunological and molecular biology-based methods.
- Student will be able to evaluate the mode of action of different antimicrobial agents, concept of antimicrobial resistance and immunization schedule followed in India.

SYLLABUS OF DSC-15

UNIT – I (7 hours)

Introduction to pathogenicity, infection and human microbiota: Commonly used terms and nomenclature: pathogen, infection, invasion, virulence and its determinants, endotoxins and exotoxins, carriers and their types. Opportunistic, nosocomial, acute, latent and chronic infections. Sepsis and septic shock. Modes of transmission of pathogens. Role of microbiome in human health. Factors governing the microbiota of skin, throat and upper respiratory tract, gastrointestinal tract, urogenital tract (with examples of microorganisms in each instance).

UNIT – II (12 hours)

Bacterial pathogens causing common diseases in humans: Symptoms, transmission, prophylaxis and treatment of the diseases caused by: Bacillus anthracis, Clostridium tetani, Clostridium difficile, Escherichia coli, Helicobacter pylori, Mycobacterium tuberculosis, Staphylococcus aureus, Salmonella enterica Typhi, Treponema pallidum, Vibrio cholerae

Unit III: (12 hours)

Viral diseases in humans: Etiology, symptoms, transmission, diagnosis, prophylaxis, and treatment of the following diseases: Polio, Chicken pox, Mumps, Measles, Herpes, Hepatitis, Rabies, AIDS, Influenza (swine flu and bird flu), Dengue, Japanese Encephalitis, Rota virus infections, COVID-19.

UNIT – IV (4 hours)

Protozoan and fungal diseases in humans: Etiology, symptoms, transmission, diagnosis and control of Malaria and Kala azar. Types of mycoses. Detailed study of certain mycoses. Cutaneous mycoses: Tinea pedis (Athlete's foot). Systemic mycoses: Aspergillosis. Opportunistic mycoses: Candidiasis, Mucormycosis.

UNIT – V (10 hours)

Diagnostics and therapeutics in infectious diseases:

Collection, transport and culturing of clinical samples. Principles of different diagnostic tests: Agglutination-based tests (Widal and VDRL test), lateral flow assay-based kits, immunofluorescence test for syphilis, Nucleic acid based diagnostic techniques: Rapid PCR and RT-PCR.

Anti-microbial chemotherapy: General characteristics and mode of action of anti-microbial agents. Antibacterial with one example each: inhibitor of nucleic acid synthesis, inhibitor of cell wall synthesis, inhibitor of cell membrane function, inhibitor of protein synthesis. Antifungal: mechanisms of action of amphotericin B, griseofulvin. Antiviral: mechanism of action of amantadine, tamiflu, acyclovir. Antimicrobial resistance: mechanisms of drug resistance, MDR, XDR, TDR, NDM-1, ESBL, MRSA, VRSA, ESKAPE pathogens.

Practical component

UNIT 1: (16 hours)

Identification and analysis of the cultural, morphological and biochemical characteristics of bacteria: E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus, Klebsiella (any three).

Study of the composition and use of important differential media for identification of bacteria: mannitol salt agar, deoxycholate citrate agar / Salmonella Shigella (SS) agar, MacConkey / EMB Agar.

Identification of bacteria based on biochemical characteristics: IMViC (Indole test, Methyl Red test, Voges-Proskauer test, Citrate test), Triple Sugar Iron (TSI) test, nitrate reduction test, urease test and catalase test.

Group project: Study of skin microbiome: Study of the bacterial flora of skin by swab method: Isolation of bacteria from skin on general purpose media (nutrient agar) and/or selective media (mannitol salt agar). Study of colony characteristics of the obtained isolates followed by Gram staining and microscopy to determine the gram character, shape and arrangement of cells.

Unit 2: (14 hours)

Study of antibiotic sensitivity and rapid detection of infectious diseases: Principle and performance of antibacterial sensitivity test by Kirby-Bauer method. Concept of MIC values. Determining MIC of any two antibiotics for any two bacteria.

Principles and working of rapid antigen tests. Demonstration of lateral flow kit for rapid antigen detection of COVID19. Principle and working of antibody detection test: Dengue test / Widal test for typhoid.

Essential/recommended readings

Theory:

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
3. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition. Universities Press, India. 2017.
4. Jawetz, Melnick and Adelberg's Medical Microbiology by K.C. Carroll, S.A. Morse, T.A.Mietzner and S. Miller. 27th edition. McGraw Hill Education. 2016.
5. Microbiology: An Introduction by G.J. Tortora, B.R. Funke and C.L. Case. 9thedition.Pearson Education, USA. 2007.
6. DNA microarrays for the diagnosis of infectious diseases by E. Donatin E and M. Drancourt. Med Mal Infect. 2012; 42(10):453-459. Doi:10.1016/j.medmal.2012.07.017

Practicals:

1. A Handbook of Practical and Clinical Immunology Volumes I & 2 by G. P. Talwar and S.K. Gupta. 2nd edition. CBS Publishers, India. 2017.
2. Practical Immunology, A Laboratory Manual by S. Balakrishnan, K. Karthik and S. Duraisamy. Lambert Academic Publishing, India. 2017.
3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 11th edition. Pearson Education, USA. 2016.
4. Laboratory Manual on Immunology and Molecular Biology by D. Dwivedi and V. Singh. Lambert Academic Publishing, India. 2013.
5. Practical Immunology by F.C. Hay, M.R. Olwyn and M.R. Westwood. 4th edition. Wiley Blackwell Publishing. 2002.

Suggestive readings

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

SEMESTER-VI

B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 16: PRINCIPLES OF MOLECULAR BIOLOGY-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		
MICROB-DSC601: PRINCIPLES OF MOLECULAR BIOLOGY-II	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	Principles of Molecular Biology-I

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is for the student to gain comprehensive knowledge of the basic concepts of molecular biology.
- The student will become familiar with DNA-related cellular processes and will become aware of the central dogma of molecular biology, learning about the propagation of information through DNA replication and the unidirectional flow of information from DNA to RNA to proteins through transcription and translation.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain RNA processing events including capping, polyadenylation and splicing. Can discourse on the concepts of RNA interference through siRNA and miRNA.
- Student will be able to discuss the mechanisms of translation of proteins in both prokaryotes and eukaryotes, and convey information about the inhibitors of protein synthesis.
- Student will be able to analyze and explain various mechanisms of gene regulation in prokaryotes and eukaryotes at the level of transcription and post-transcriptional

processes, as well as epigenetic mechanisms of gene regulation through chromatin modifications, the role of lncRNAs in gene regulation.

- Student will be able to demonstrate the procedure of isolation and analyze RNA by colorimetric and spectrophotometric methods, resolve proteins by electrophoresis on SDS-PAGE.

SYLLABUS OF DSC-16

UNIT – I (15 hours)

RNA processing and its applications: Difference in structure of prokaryotic and eukaryotic mRNA. Split gene theory, introns and exons. Processing of eukaryotic mRNA: capping and polyadenylation mechanisms and enzymes involved. RNA splicing: Group I and Group II introns and the mechanisms of splicing linked to them. Spliceosome machinery. Concepts of alternative splicing and trans-splicing. Processing of rRNA. RNA interference and its significance. Brief overview of siRNA and miRNAs.

UNIT – II (14 hours)

Translation in prokaryotes and eukaryotes: Translational machinery: ribosome structure in prokaryotes and eukaryotes, tRNA structure, aminoacyl tRNA synthetases and charging of tRNA. Mechanism of initiation, elongation and termination of polypeptide synthesis in prokaryotes and eukaryotes, highlighting the differences in the processes between the two groups of organisms. Mechanisms for maintaining the fidelity of translation.

UNIT – III (16 hours)

Regulation of gene expression in prokaryotes and eukaryotes: Principles of transcriptional regulation in prokaryotes: negative versus positive regulation using lac, trp and ara operons as examples. Gene regulation during sporulation in Bacillus. Yeast mating-type switching. Mechanisms of epigenetic regulation of gene expression: regulation of gene expression by DNA methylation, histone acetylation and histone methylation. Regulation of gene expression by DNA methylation in prokaryotes versus in eukaryotes. Histone methylation as both, positive as well as negative regulator of gene expression. Gene regulation by long noncoding RNAs (lncRNAs).

Practical component

UNIT 1: (15 hours)

Analysis of RNA and its applications:

RNA isolation and estimation: Total RNA isolation from yeast / bacterial cells. Colorimetric analysis of RNA with yeast tRNA as standard, using orcinol reagent or UV spectrophotometry. Northern blot analysis of processed RNA through virtual lab.

Student group research study project: use of mRNA in vaccines – case study of the COVID19 mRNA vaccines: CCMB vaccine technology/platform (based on Pfizer-

BioNTech/Moderna technology) versus Gennova vaccine technology/platform (based on HDT Bio Corp technology)
or
Student group research study project: trans-splicing in trypanosomatids.

Unit 2: (15 hours)
Analysis of proteins:
Analysis of total cell protein of bacteria by SDS-PAGE.
Student group research study project: drugs that inhibit protein translation and their mechanism of action.

Essential/recommended readings

Theory:

1. Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 4th edition. Jones andBartlett Publishers, USA. 2020.
2. Karp's Cell and Molecular Biology by G. Karp, J. Iwasa and W. Marshall. 9th edition. Wiley, USA. 2019
3. Molecular Biology by D. Clark, N. Pazdernik and M. McGehee. 3rd edition. Academic Cell, USA. 2018.
4. Lewin's Genes XII by J. Krebs, E. Goldstein and S. Kilpatrick. 12th edition. Jones and BartlettLearning, USA. 2017.
5. Becker's World of the Cell by J .Hardin and G.P. Bertoni. 9th edition. Pearson, USA. 2015.
6. Principles of Genetics by D.P. Snustad and M.J. Simmons. 7th edition. Wiley and Sons, UK. 2015.
7. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2014.
8. Cell and Molecular Biology by E.D.P. De Robertis and E.M.F. De Robertis. 8th edition. Lippincott Williams and Wilkins, USA. 2006.

Practicals:

1. Molecular Cloning: A Laboratory Manual by M. Green and J. Sambrook Volumes 1-3. 4th edition. Cold Spring Harbor Laboratory Press, USA. 2012.
2. An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.

Suggestive readings

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: ADVANCES IN 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/ Practice		
MICROB-DSC602: **ADVANCES IN IMMUNOLOGY**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**Basic concepts of Immunology**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to provide a detailed insight to the student about crucial roles played by human immune system in generation of an optimum immune response as well as in serious conditions arising by immune dysfunction such as infections, hypersensitivity, immunodeficiency and autoimmunity.
- Also the importance of immune system in cases of cancer and organ transplant. The course further enhances the student's understanding of how various immunodiagnostics and other advances in immunology have changed the face of modern medicine.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss the generation of humoral and cell-mediated immune response and the killing mechanisms available within the host body.
- Student will be able to describe immunity disorders like hypersensitivity, autoimmunity and immunodeficiency.
- Student will be able to explain organ transplantation and the role of the immune system in acceptance or rejection of the grafts, and ways to manage it.
- Student will be able to describe types of cancers, the antigens and immune response involved, tumor evasion mechanisms, diagnosis and treatment.
- Student will be able to describe vaccine formulation and its types, adjuvants, and National Immunization Schedule.

SYLLABUS OF DSC-17

UNIT – I (12 hours)

Generation of Immune Response: B cell development, generation of humoral immune response, primary and secondary immune response, generation of cell-mediated immune response (TCR, Self MHC restriction, T cell activation, co-stimulatory signals), killing mechanisms by CTL and NK cells.

UNIT – II (12 hours)

Immune Dysfunction: Types of hypersensitivities with one examples each, mechanism, manifestations and detection of type I hypersensitivity; Autoimmunity: types and mechanisms (Hashimoto's thyroiditis, Goodpasture's syndrome, IDDM, Rheumatoid arthritis, Multiple sclerosis, SLE); Immunodeficiency: Animal models (nude and SCID mice), disorders (SCID, DiGeorge syndrome, Chediak- Higashi syndrome, LAD, CGD).

UNIT – III (8 hours)

Transplantation Immunology: Types of grafts (autograft, isograft, allograft & xenograft), HLA typing, immunologic basis of graft rejection (sensitization & effector stages), role of T cells in graft rejection, GVHD, clinical manifestations of graft rejection (hyperacute, acute and chronic rejection), immunosuppressive therapies (general and specific), immunoprivileged sites

UNIT – IV (8 hours)

Cancer Immunology: Immune surveillance, types of cancers, malignant transformation of cells, tumor antigens (TATA and TSTA), immune response to cancer, tumor evasion, immunodiagnosis and cancer immunotherapy

UNIT – V (5 hours)

Vaccines: Active immunization, designing vaccines, boosters, types of vaccines: live attenuated, toxoid, conjugate/ multivalent, subunit, peptide, recombinant (vector based), DNA and RNA vaccines, use of adjuvants, National Immunization Schedule (NIS).

Practical component

UNIT 1: (20 hours)

Immunological techniques based on antigen - antibody interactions: Principles, working methods and applications of the following immunological techniques: ELISPOT, western blotting, immunofluorescence, flow cytometry, immunoelectron microscopy. Performance of SDS-PAGE to separate the different types of immunoglobulins. Detection of Type I hypersensitivity by RIST and RAST. MLR and Microcytotoxicity tests for HLA typing using pictures.

Unit 2: (12 hours)

Student group research studies:

Student group research project I: Experimental Systems in Immunology: Primary lymphoid cell culture systems. Animal models: Nude mouse, SCID mouse, SPF (Specific Pathogen Free) colony mice, dirty mice.

Student group research project II: short-term and long-term immune response to COVID-19 vaccines: case study of Covaxin.

Essential/recommended readings

Theory:

1. Immunology: A short course by R. Coico. 8th edition. Wiley- BlackwellScientific Publication, UK. 2021
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman and S. Pillai. 10th edition.Elsevier, USA. 2021.
3. Kuby Immunology by J. Punt, S. Stranford, P. Jones and J. Owen. 8 th edition.
4. W.H. Freemanand Company, USA. 2018.
5. Roitt's Essential Immunology by P. Delves, S. Martin, D. Burton and I.M. Roitt. 13th edition.Wiley- Blackwell Scientific Publication, UK. 2017.
6. Janeway's Immunobiology by K. Murphy and C. Weaver. 9th edition. Garland Science Publishers, USA. 2016.
7. Basic and Clinical Immunology by M. Peakman and D. Vergani. 2nd edition. ChurchillLivingstone, UK. 2009.
8. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.

Practicals:

1. A Handbook of Practical and Clinical Immunology Volumes I & 2 by G. P. Talwar and S.K. Gupta. 2nd edition. CBS Publishers, India. 2017.
2. Practical Immunology, A Laboratory Manual by S. Balakrishnan, K. Karthik and S. Duraisamy. Lambert Academic Publishing, India. 2017.
3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 11th edition. Pearson Education, USA. 2016.
4. Laboratory Manual on Immunology and Molecular Biology by D. Dwivedi and V. Singh. Lambert Academic Publishing, India. 2013.
5. Practical Immunology by F.C. Hay, M.R. Olwyn and M.R. Westwood. 4th edition. Wiley Blackwell Publishing. 2002.

Suggestive readings

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: INDUSTRIAL 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		
MICROB-DSC603: INDUSTRIAL MICROBIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	None

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to give students an overview of the applications of fermentation processes in industry.
- The students will gain in-depth knowledge of different types of fermentation processes, fermenter designs and operations. They will become aware of large scale culturing methods of microorganisms for production of bioactives of industrial importance.
- Students will also gain an insight into steroid biotransformation and enzyme immobilization

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe important developments in industrial microbiology and explain different types of fermentation processes.
- Student will be able to discuss the design, operations and applications of different types of fermenters and the measurement and control of fermentation parameters.
- Student will be able to demonstrate use of various methods to isolate, screen, preserve and maintain industrially important microbial strains, the different types of media used in fermentation processes.
- Student will be able to demonstrate use of various techniques for the recovery and purification of industrial products produced by microorganisms.
- Student will be able to explain the principles of large-scale microbial production and recovery of industrial products.
- Student will be able to demonstrate microbiological transformations of steroids and use the methods of enzyme immobilization to exploit their advantages and applications in the industry.

SYLLABUS OF DSC-18

UNIT – I (7 hours)

Development of industrial microbiology: Important developments in industrial microbiology and contribution of following scientists: Louis Pasteur, Carl Wilhelm Scheele, Casimir Funk, Alexander Fleming, Selman A. Waksman, Howard W Florey and Ernst B Chain. Types of fermentation processes: aerobic and anaerobic fermentations, solid-state and liquid-state (stationary and submerged) fermentations, batch, fed-batch and continuous fermentations

UNIT – II (10 hours)

Bioreactors and analysis of fermentation parameters: Parts of a typical fermenter. Types of bioreactors and their applications: Laboratory, pilot-scale and production fermenters, continuously stirred tank reactor, air-lift fermenter. Measurement and control of parameters: pH, temperature, dissolved oxygen, foaming and aeration.

UNIT – III (7 hours)

Selection of industrially important microbial strains: Sources of industrially important microorganisms, their isolation and screening (primary and secondary). Preservation and maintenance of stock and working cultures. Crude and synthetic fermentation media, inoculum and production media. Crude media components: molasses, corn-steep liquor, sulphite- waste liquor, whey, yeast extract. , peptone and tryptone.

UNIT – IV (4 hours)

Recovery methods for fermentation products: Physiochemical and biological methods for cell disruption, centrifugation, batch filtration, precipitation, solvent-solvent extraction spray drying and lyophilization.

UNIT – V (17 hours)

Upstream and downstream processing of microbial products, steroid biotransformation and enzyme immobilization: Citric acid, ethanol, glutamic acid, Vitamin B12, Wine (white, rose & red), beer, antibiotics (penicillin,streptomycin) and enzymes (amylase, protease, lipase and glucose oxidase). Microbiological transformation of steroids and its applications. Methods of enzyme immobilization: cross linking, entrapment, adsorption and covalent bonding. Advantages and applications of immobilized enzymes: glucose isomerase and penicillin acylase

Practical component

UNIT 1: (18 hours)

Aerobic fermentation processes: Microbial production of enzymes (amylases/lipase/protease) by liquid-state static /submerged fermentation and its detection by plate-assay method using an agar-based medium. Estimation of enzyme activity spectrophotometrically. Production of amino acids (glutamic acid /lysine) using a suitable bacterial culture, its detection by paper chromatography and its

colorimetric estimation using buffered ninhydrin reagent. Microbial production of citric acid by solid-state /liquid state fermentation using Aspergillus niger, its detection by chromatographic techniques and its quantitative estimation by titration.

Unit 2: (12 hours)

Anaerobic fermentation processes: Ethanol production by submerged fermentation using Saccharomyces cerevisiae, its detection by qualitative tests and its estimation spectrophotometrically using a suitable reagent.

A visit to any educational institute/industry to understand different types of fermenters/ bioreactors: laboratory-scale, pilot-scale and production fermenter, and their components (spargers, baffles, impellers etc

Essential/recommended readings

Theory:

1. Industrial Microbiology by A.H. Patel. 2nd edition. Laxmi publication Pvt Ltd/Trinity Press. 2022.
2. Industrial Microbiology by L.E. Casida. 2nd edition. New Age International publisher. 2019.
3. Modern Industrial Microbiology and Biotechnology by N. Okafor and B.C. Okeke. 2nd edition. CRC press, UK. 2018.
4. Crueger's Biotechnology: A Textbook of Industrial Microbiology by W. Crueger,

A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.

5. Biotechnology Industrial Microbiology. A textbook by W.Clarke. CBS Publishers, India.2016.
6. Industrial Microbiology by K.L. Benson. CBS Publishers & Distributors. 2016.
7. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rd edition. Elsevier Science Ltd, Netherlands. 2016.
8. Microbial technology. Vol I- Microbial processes and Vol II -Fermentation technology edited by H.J. Peppler and D. Perlman. 2nd edition. Academic Press, USA. 2009.
9. Industrial Microbiology: An Introduction by M.J. Waites, N.L. Morgan, J.S . Rockey and G.Higton. Wiley –Blackwell. 2001.
10. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer and H.Nikaido. 1st edition. W.H. Freeman and Company, UK.1995.

Practicals:

1. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
2. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2nd edition. Scientific International Pvt. Ltd., Delhi. 2018.
3. Manual of Industrial Microbiology and Biotechnology edited by R.H. Baltz, A.L. Demain, and J.E. Davies. 3rd edition. American Society for Microbiology. 2010.
4. Microbial technology. Vol I- Microbial processes and Vol II -Fermentation technologyedited by H.J. Peppler and D. Perlman. 2nd edition. Academic Press, USA. 2009.

Suggestive readings

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

SEMESTER -IV

DEPARTMENT OF ELECTRONIC SCIENCE

Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 10: Electrical 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		
Electrical Technology	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Circuit Theory & Network Analysis (DSC-2, Sem I), Basic Instrumen-tation & Measure-ment Techniques (DSC-4, Sem II)

Learning Objectives

The Learning Objectives of this course are as follows:

The paper deals with Electrical and Electronic systems viz.; Working, construction and principle of DC and AC machines, transformers and polyphase circuits. The paper covers the related concepts such as control of speed, generation of Torque, various losses, efficiency and breaking mechanisms of various commonly used electromechanical systems such as stepper, induction and universal motors. The understanding of mathematical relations between the various parameters, imparts enough knowledge to optimize the output response under a given condition.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Discuss the working principle of a Transformer and analyze its specifications
- Understand the working of DC Machines, DC Generators and DC Motors
- Classify Induction motors into Polyphase and single phase motors and understand their working
- Evaluate the working of Synchronous generators and synchronous motors and their comparative study with induction motors

SYLLABUS OF ELDSC-10 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)

Transformers: Overview of types of transformers, EMF equation, Transformer Losses, No load operation, Operation under load, Phasor diagram, Equivalent circuit of transformer, Voltage regulation, Condition for maximum efficiency, All day efficiency, short circuit and open circuit tests.

Polyphase Circuits: Line and phase relations in three phase circuits.

DC Machines: Overview of Basic constructional features and physical principles involved in electrical machines, lap and wave connections.

UNIT – II (13 Hours)

D.C. Generators: Principle of operation, Concept of armature reaction and commutation, E.M.F. Equation, Methods of excitation, Characteristics of separately excited and Self excited (Shunt, Compound and Series) generators, Losses and efficiency.

D.C. Motors: Comparison of generator and motor action, Principle of operation, Back EMF, Maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors, Losses & efficiency, Three-point starter, Factors affecting speed of DC motors.

UNIT – III (12 Hours)

Poly Phase Induction Motors: General constructional features, Types of rotors, Rotating magnetic field (single phase, two phase and three phase), Ferrari's Principle, Production of torque, Slip, Starting Torque, Running Torque, Torque equation, Torque-slip characteristics (Breakdown Torque), factors affecting speed of Induction motor.

Single Phase Induction Motors: General constructional features, Study and applications: Split phase motors, Capacitor start & run motor, Reluctance Motor, Stepper Motor, Universal motor

UNIT – IV (10 Hours)

Synchronous Machines: Principle of operation and construction features of Alternators (synchronous generators), E.M.F. equation, Principle of synchronous motor, methods of starting, Power developed in Synchronous motor, factors for failure to start, applications, comparison of synchronous and induction motor

Practical component (if any) – Electrical Technology

(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the working of DC series, shunt and Induction motors
- Study the working of transformer
- Study of Stepper motor, Universal motor
- Write a technical report on the experiment performed.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study of characteristics of DC Series motor.
2. Study of characteristics of DC Shunt motor.
3. Study of control of DC motor using SCR.
4. Study of characteristics of single-phase induction motor.
5. Study of Stepper motor.
6. Study of Universal motor.
7. Study of Open Circuit Test on single phase transformer.
8. Study of Short Circuit Test on single phase transformer.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. B.L. Thareja, A.K. Thareja, A Textbook of Electrical Technology-Vol-II, S.Chand
2. J.B. Gupta, Electrical Technology (Electrical Machines), Katsons
3. I. J. Nagrath and D. P. Kothari, Electrical Machines, Tata McGraw Hill
4. H. Cotton, Advanced Electrical Technology, CBS Publishers and Distributors, New Delhi
5. S. Ghose, Electrical Machines, Pearson Education

Suggestive readings

1. G. Mc. Pherson, An introduction to Electrical Machines & Transformers, John Wiley & Sons
2. N. K. De and P. K. De, Electric Drives, Prentice Hall of India

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: Microprocessor

CREDIT 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		
Microprocessor	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Digital Electronics (DSC 5, Sem II)**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand basic architecture of 8085 microprocessor.
- To understand the instruction set and write programs in assembly language.
- To interface 8085 microprocessor with common Programmable Peripheral Devices.
- To understand the differences in the architecture and addressing modes of 8 bit and 16 bit Microprocessor.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic blocks of microcomputers i.e. CPU, Memory, I/O and architecture of microprocessors.
- Acquiring skills in writing assembly language program for 8085 microprocessor.
- Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory, I/O and programmable peripheral interface devices with 8 bit microprocessor.
- Derive specifications of an 8 bit microprocessor based system as per required application.

SYLLABUS OF ELDSC-11 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to Microprocessor: Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used)

Microprocessor 8085: Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.

UNIT – II (12 Hours)

8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.

UNIT – III (11 Hours)

Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay.

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts.

UNIT – IV (11 Hours)

Programmable Peripheral Interface (PPI): 8255- I/O interface, 8253/8254- Timer interface, 8259- Priority Interrupt Controller.

Designing of a microprocessor based system: Traffic Light Controller using PPI.

Comparison of 8085 Microprocessor with 8086 Microprocessor (Internal Architecture, Data Addressing Mode).

Practical component (if any) – Microprocessor

(Hardware and Assembly Language)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Proficient in use of IDE's for designing, testing and debugging microprocessor based system.
- Interface various I/O devices and design and evaluate systems that will provide solutions to real-world problem.

- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

8085 Assembly language programs:

1. Program to transfer a block of data.
2. Program for multibyte addition/subtraction.
3. Program to multiply two 8-bit numbers.
4. Program to divide a 16 bit number by 8 bit number.
5. Program to search a given number in a given list.
6. Program to generate terms of Fibonacci series.
7. Program to find minimum and maximum among N numbers.
8. Program to find the square root of an integer.
9. Program to find GCD of two numbers.
10. Program to sort numbers in ascending/descending order.
11. Program to verify the truth table of logic gates.
12. Interfacing using PPI 8255/8253/8259.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven with hardware interfacing.

Essential/recommended readings

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, Wiley Eastern Limited- IV Edition.
2. 8085 Microprocessor : Programming and Interfacing, N. K SRINATH, PHI Learning(2014).

Suggestive readings

1. 8085 Microprocessor and its Applications, A Nagoor Kani, Tata Mcgraw Hill, Third Edition.

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: Communication 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		
Principles of Communication Systems	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Circuit Theory & Network Analysis (DSC-2, Sem I), Analog Electronics-I(DSC-6, Sem II) and Signals & Systems (DSC-9, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce concepts of various analog modulation techniques used in communication systems and analyse their comparative performance.
- To understand Pulse analog modulation and Pulse digital transmission techniques

Learning outcomes

The Learning Outcomes of this course are as follows:

- Be conversant with the requirements and the protocols employed in the fundamental components of a communication network.
- Understand the concept and basic circuits used in Continuous Wave analog modulation
- Understand the Principles of Sampling and Pulse Communication
- Insight on Digital Transmission.

SYLLABUS OF ELDSC-12 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals. Block diagram of Transmitter and Super Heterodyne Receiver. Concept of Noise and Signal to noise ratio.

UNIT – II (11 Hours)

Amplitude Modulation: Concept of modulation index and frequency spectrum and Power Relations in AM. Generation of AM by Square Law and Collector Modulator, Diode Detection, Concept of Double side band suppressed carrier, Single side band suppressed carrier by Filter Method, Pilot Carrier Modulation, Vestigial Side Band modulation, and Independent Side Band Modulation.

UNIT – III (11 Hours)

Angle modulation: Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (Block diagram of direct and indirect methods), FM detector (PLL). Concept of Pre-emphasis and De-emphasis. Comparison between AM, FM and PM.

UNIT – IV (12 Hours)

Pulse Analog Modulation: Sampling theorem, Aliasing and Aperture Effect, PAM, PWM, PPM -Generation and detection techniques, Multiplexing-TDM and FDM.

Pulse Code Modulation: Need for digital transmission, Block Diagram of PCM, Uniform and Non- uniform Quantization, Quantization Noise, Companding, Line Coding. Introduction to Delta Modulation and DPCM.

Practical component (if any) – Principles of Communication Systems
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basic elements of a communication system.
- Analyse the baseband signals in time domain and in frequency domain.
- Build understanding of various analog (CW) and Pulse modulation and demodulation techniques
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

The practical needs to be performed on Scilab/ MATLAB/Multisim or any other equivalent software besides hardware.

1. Study of Amplitude Modulation.

2. Study of Frequency Modulation.
3. Study of AM Transmitter and Receiver.
4. Study FM Transmitter and Receiver.
5. Study of Pulse Amplitude Modulation
6. Study of Pulse Width Modulation
7. Study of Pulse Position Modulation.
8. Study of Pulse Code Modulation
9. Study of Delta Modulation

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Electronic Communication Systems Fourth Edition by George Kennedy and Bernard Davis.
2. Principles of Electronic Communication Systems Second Edition by Taub and Schilling.
3. Electronic Communication Systems Fifth Edition by Wayne Tomasi.

Suggestive readings

1. Principles of Electronic Communication Systems by Louis E. Frenzel
2. Communication Systems (Analog and Digital) by R.P.Singh and S.D.Sapre

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (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		
Internet of Things	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Digital Electronics (DSC-5 , Sem II) , Basic Instrumentation & Measurement Techniques (DSC-4, Sem 2)

Learning Objectives

This course describes the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Broad objectives are:

- To introduce the terminology, technology and its applications
- To introduce the concept of M2M (machine to machine) with necessary protocols
- To introduce the Python Scripting Language commonly used in IoT devices/systems
- To introduce the Arduino / Raspberry Pi platform, widely used in IoT applications
- To introduce the implementation of web-based services on IoT devices

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand internet of Things, its hardware and software components and the IoT value chain structure (device, data cloud).
- Interface I/O devices, sensors & communication modules.

- Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules
- Remotely monitor data and control devices and develop real life IoT based projects.

SYLLABUS OF ELDSE-2A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to Internet of Things - Definition and Characteristics of IoT, Architectural overview (cellular, star, mesh, ring)

Physical design of IoT: Things in IoT, IoT protocols in Link Layer, Network/Internet Layer, Transport Layer, Application Layer (with specific reference to Communication protocols as MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP, WebSocket etc.,), Basics of Networking, Security aspects in IoT.

Logical design of IoT: Functional blocks, Communication Models, Communication APIs, Enabling Technologies, IoT levels and deployment templates, Design principles

IoT and M2M- Definitions, differences between M2M & IoT systems, Software defined networks (SDN), network function virtualization (NFV), difference between SDN and NFV for IoT, Basics of IoT System Management with SNMP, NETCONF -YANG

UNIT – II (11 Hours)

Transducers, Sensors and Actuators: Review of Transducers, Concept of Sensing and Actuation, Sensor characteristics (static/dynamic), Sensor classification (passive/active, analog/digital, scalar/vector), Actuator classification (Electric/Fluid Power/ Linear Chain /Manual / Linear vs Rotary)

Types of Sensors: Contact and Proximity, Position, Velocity, Force, Humidity, Tactile unipolar and bipolar Stepper motors Sensors- Light sensor, temperature sensor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor etc.

Selection of Transducers for various IoT applications, Wireless Sensor Networks

UNIT – III (12Hours)

Computing (using Arduino, Raspberry Pi), I/O interfaces.

Software components- Programming API's (using Python/Node.js/Arduino). Introduction to Arduino/Raspberry Pi- Installation, Interfaces (serial, SPI, I2C)

Raspberry Pi: Communication with devices through the pins of the Raspberry Pi, RPi. GPIO library, Python Functions, setting up the pins, General purpose IO Pins, Protocol Pins, GPIO Access, applying digital voltages, and generating Pulse Width Modulated signals, Tkinter Python library, accessing pins through a graphic user interface

OR

Arduino: Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Arduino board main components, inputs, and outputs. Arduino Integrated Development Environment (IDE), Compiling Code, Arduino Shields and Libraries.

Basics of C programming, composition of an Arduino programs, Arduino tool chain, Arduino IDE, basic structure of a sketch, including the use of the setup() and loop() functions. Accessing the pins from a sketch for input and output, introduction on debugging embedded software on an Arduino, UART communication protocol, Synchronization, parity and stop, the use of the Serial library to communicate with the Arduino through the serial monitor.

Programming – Python programs with Arduino/Raspberry Pi with focus on interfacing external gadgets, controlling output, reading input from pins

Note: It is optional to choose either Arduino or Raspberry Pi environment

UNIT – IV (11 Hours)

IoT Physical Devices and Endpoints, Domain specific IoTs, IoT Physical Servers and Cloud Offerings

Cloud Computing: Characteristics, Introduction to Cloud Service models (SaaS, PaaS, IaaS, XaaS etc.,) Deployment models, Cloud storage APIs, IoT-Cloud convergence, Communication Enablers

Webservices – Web server for IoT, Python-Web frameworks, RESTful Web API, ThingSpeak API, MQTT, IoT security, Basics of symmetric and non-symmetric encryption standards

IoT Application Development - Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration

Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies based on Smart Environment, Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Practical component (if any) – Internet of Things

Learning outcomes

The Learning Outcomes of this course are as follows:

- Interfacing of various sensors using Arduino/Raspberry Pi
- Interfacing using Bluetooth, Web server, TCP, ThinkSpeak Cloud, MQTT broker

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Connect an LED to GPIO pin 24 and a Switch to GPIO 25 and control the LED with the switch. The state of LED should toggle with every press of the switch.
2. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
3. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.

4. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
5. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
6. Create a traffic light signal with three colored lights (Red, Orange and Green) with a duty cycle of 5-2-10 seconds.
7. Create an application that has three LEDs (Red, Green and white). The LEDs should follow the cycle (All Off, Red On, Green On, White On) for each clap (use sound sensor).
8. Write a program on Arduino/Raspberry Pi to upload/retrieve temperature and humidity data using ThingSpeak cloud.
9. Write a program on Arduino/Raspberry Pi to publish/subscribe temperature data using MQTT broker.
10. To install MySQL database on Raspberry Pi and perform basic SQL queries.
11. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
12. Create a web application for the above applications wherever possible with functionalities to get input and send output.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven.

Essential/recommended readings

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895
5. Adrian McEwen, "Designing the Internet of Things", Wiley

Suggestive readings

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 Editors Ovidiu Vermesan
2. Peter Friess,'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
3. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Operating Systems	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Programming Fundamentals using Python (DSC-1, Sem I)/ Algorithm Design and Analysis(DSE-1B, Sem III)**

Learning Objectives

COURSE OVERVIEW: Operating systems course is intended as a general introduction to the techniques used to implement operating systems and related kinds of systems software. The topics covered will be functions and structure of operating systems, process management (creation, synchronization, and communication); processor scheduling; deadlock prevention, avoidance, and recovery; main-memory management; virtual memory management (swapping, paging, segmentation and page-replacement algorithms); control of disks and file-system structure and implementation.

The Learning Objectives of this course are as follows:

- To explain main components of OS and their working
- To familiarize the operations performed by OS as a resource Manager
- To introduce various scheduling policies of OS.
- To teach the different memory management techniques.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn multiprogramming, multithreading concepts for a small operating system.
- Create, delete, and synchronize processes for a small operating system.
- Implement simple memory management techniques.
- Implement CPU and disk scheduling algorithms.
- Use services of modern operating system efficiently

- Learn basic file system.

SYLLABUS OF ELDSE-2B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Overview: Introduction, Computer-System Organization and Architecture, Multiprocessor and Clustered Systems, OS Operations, Multiprogramming and Multitasking, Resource management- process management, memory management, file-system management, Mass- storage management, I/O System management systems, protection and security. Virtualization, Distributed systems, Real Time Embedded Systems, Free and Open source Operating systems and Operating system services.

UNIT – II (12 Hours)

Process management: Basic concepts, Scheduling Criteria, Scheduling algorithms- FCFS, SJF, Priority, RR and Multilevel Queue. Process synchronization.

Concurrency and Synchronization: The Critical-section problem, Semaphores, Deadlock Characterization, Prevention, Avoidance, Detection and Recovery.

UNIT – III (12 Hours)

Memory management: Basic hardware, Address binding, Physical and Logical address space, Swapping, Memory allocation strategies -Fixed and Variable Partitions, Fragmentation, Paging, Segmentation, Demand Paging and virtual memory, Page Replacement Policies - FIFO, OPR, LRU.

UNIT – IV (10 Hours)

File system: Concept of a file, access methods, directory structure, file system mounting, file sharing, protection, file system structure, file system implementation, Directory implementation, allocation methods, free-space management, efficiency and performance, Disk scheduling algorithms- FCFS, SSTF, SCAN and C-SCAN.

Practical component (if any) – Operating Systems
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement various process scheduling algorithms
- Implement various priority based scheduling algorithms
- Implement various page replacement algorithms
- Implement various disk scheduling algorithms

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Write a program to implement FCFS scheduling algorithm.
2. Write a program to implement Round Robin Process scheduling algorithm.

3. Write a program to implement SJF Process scheduling algorithm.
4. Write a program to implement non-preemptive priority-based scheduling algorithm.
5. Write a program to implement preemptive priority-based scheduling algorithm.
6. Write a program to implement SRJF scheduling algorithm.
7. Write a program to implement first-fit, best-fit and worst-fit allocation strategies.
8. Write a program to implement FIFO Page replacement algorithm.
9. Write a program to implement OPR Page replacement algorithm.
10. Write a program to implement LRU Page replacement algorithm.
11. Write a program to implement SCAN Disk Scheduling algorithm.
12. Write a program to implement SSTF Disk Scheduling algorithm.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven.

Essential/recommended readings

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating Systems Concepts", Tenth Edition, John Wiley & Sons, 2018, ISBN:978-1-118-06333-0.
2. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.

Suggestive readings

1. Andrew S Tanenbaum, Herbert Bos "Modern Operating Systems" , Fourth Edition, Pearson Education India, 2016. ISBN 978-9332575776.
2. William Stallings, "Operating Systems Internals and Design Principles", Seventh Edition, Pearson Education, 2018. ISBN 978-9352866717.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", Third Edition, Pearson Education.
4. Deitel & Deitel (2008), Operating systems, 3rd edition, Pearson Education, India
5. Achyut S Godbole, Atul Kahate, "Operating Systems", 3rd Edition, Tata McGraw Hill, 2011.

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Network Synthesis	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Circuit Theory & Network Analysis (DSC-2, Sem I), Engineering Mathematics DSC(7, Sem III)/Signals and Systems (DSC-9, Sem III)**

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic frequency domain techniques and two port network parameters.
- To study the elements of network synthesis.
- To study and synthesise the one port networks with two kinds of elements.
- To study the synthesis of transfer function.
- To study and design the filters

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of frequency domain techniques and two port network parameters.
- Understand the basic concepts of network synthesis.
- Synthesise the one-port networks and transfer function.
- Determine the frequency response of filters.

SYLLABUS OF ELDSE-2C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Circuit Analysis: Concept of Poles and Zeros in complex frequency/s-plane, Initial and Final Value Theorem, Representation of Circuit Elements in s-domain, Circuit Analysis using Laplace Transform Method, The System Function for R-C and R-L Networks and their Impulse and Step Responses.

Two Port Network Parameters: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters, Hybrid (h) Parameters.

UNIT – II (10 Hours)

Elements of Network Synthesis: Causality and Stability, Hurwitz Polynomial, Sturm's Theorem, Positive Real Functions, Basis Synthesis Procedures.

UNIT – III (11 Hours)

Synthesis of One Port Networks with Two Kinds of Elements: Properties of L-C Immittance Functions, Synthesis of L-C Driving-Point Immittances, Properties of R-C Driving Point Impedances, Synthesis of R-C Impedances or R-L Admittances, Properties of R-L Impedances and R-C Admittances, Synthesis of R-L-C Functions.

UNIT – IV (12 Hours)

Transfer Function Synthesis: Properties of Transfer Functions, Synthesis of L-C Ladder Network with a 1-ohm Resistive Termination, Synthesis of Constant-Resistance Networks (Bridge and Lattice Type).

Filter Design: Ideal Filters, Low Pass Filter Design using Butterworth and Chebyshev approximation and Comparison between them.

Practical component (if any) – Network Synthesis
(Hardware/Software/Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Verify the operation and response of typical electrical circuits.
- Determine the various parameters for two-port networks.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Mesh and Node Analysis of circuits using AC Sources.
2. Computation and plot of Poles, Zeros and Stability of a Function.
3. Study of step response of RC Network.

4. Study of step response of RL Network
5. Computation and plot of Inverse-Laplace Transform of a Function.
6. Determination of Impedance (Z) and Admittance (Y) parameters of Two-Port Network.
7. Determination of ABCD Parameters of Two-Port Network.
8. Determination of Hybrid (h) Parameters of Two-Port Network.
9. Designing of a Low Pass Filter (Butterworth Approximation) and study of its Frequency Response.
10. Designing of a Low Pass Filter (Chebyshev Approximation) and study of its Frequency Response.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Kuo, F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India (2013).
2. M. E. Van Valkenburg, "Introduction to Modern Network Synthesis", Wiley Eastern (1984).

Suggestive readings

1. Aatre, V. K., "Network Theory and Filter Design", 3rd Ed., New Age International (2014).

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 OFFERED BY THE DEPARTMENT

GENERIC ELECTIVES (GE-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		
Instrumentation	4	3	-	1	Class XII passed with Maths/Applied Maths	Idea about basic circuit elements like R, C and L, Ammeter, Voltmeter

Learning Objectives

The Learning Objectives of this course are as follows:

- Explain the importance and working principle of different electronic measuring instruments.
- Use the complete knowledge of various instruments and transducers to make measurements in the laboratory.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with the working principle of different measuring instruments
- Understand measuring instruments used in the laboratory like oscilloscopes, signal generators
- Understand working principle of transducers
- Familiarize with the working principle of data acquisition devices and biomedical instruments.

SYLLABUS OF ELGE-4A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (10 Hours)

DC and AC indicating Instruments: Accuracy and precision, Types of errors, PMMC galvanometer, sensitivity, Loading effect , Conversion of Galvanometer into ammeter, Voltmeter and Shunt type ohmmeter, Multimeter.

UNIT – II (12 Hours)

Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, DSO :Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, risetime).

Signal Generators: Function generators.

UNIT – III (10 Hours)

Transducers: Basic requirements of transducers, Transducers for measurement of nonelectrical quantities: Types and their principle of working , measurement of Linear displacement, Acceleration, Flow rate, Liquid level, strain, Force, Pressure, Temperature.

UNIT – IV (13 Hours)

Data acquisition systems: Block diagram, brief description of preamplifier, signal conditioner, instrumentation amplifier, A/D and D/A converter blocks, computer-controlled test and measurement system.

Bio-medical instrumentation: Bio-Amplifiers: Different types of Bio-OP-Amps, Electrodes for ECG , block diagram of ECG system, brief analysis of graphs.

Practical component (if any) – Instrumentation
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- To measure various electrical parameters.
- To measure characteristics of various sensors and transducers.
- Understand ECG pattern.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Design of ammeter and voltmeter using galvanometer.
2. To determine the Characteristics of resistance transducer - Strain Gauge
3. To determine the Characteristics of LVDT.
4. To determine the Characteristics of Thermistors and RTD.
5. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.

6. Characterization of bio potential amplifier for ECG signals.
7. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
8. Study of pulse rate monitor with alarm system.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
2. Handbook of biomedical instrumentation: Khandpur R S, TMH
3. Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
4. Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.
5. Mechatronics – principles and applications, Godfrey C Onwubolu, Elsevier, 2006

Suggestive readings

1. Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies
2. Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
3. Instrumentation devices and systems: Rangan, Sarma, Mani, TMH
4. Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH

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

GENERIC ELECTIVES (GE-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		
Mobile Application Development	**4**	**1**	**-**	**3**	**Class XII passed in any stream**	**Idea about the Computer System Configuration like processor, RAM, ROM, different Operating Systems etc.**

Learning Objectives

In this course, student will be developing foundational programming skills to support graphical element presentation and data manipulation from basic functions through to advance processing. You will continue to build your skill set to use and apply core graphics, touch handling and gestures, animations and transitions, alerts and actions as well as advanced algorithms, threading and more. By the end of this course, you will be able to develop a more advanced, fully functioning app. currently this course is taught using Flutter UI SDK.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the concepts on: Elements of user interface, Model-View-Controller architecture, Data persistence and storage, Multithreading, Mobile web vs. mobile app, Services, broadcasts and notifications, Sensor management and location-based services.
- Describe different mobile application models/architectures and patterns.
- Familiarize with data type, data operators, exception handling and file management
- Describe the components and structure of a mobile development framework (Flutter SDK) in the development of a mobile application

SYLLABUS OF ELGE-4B Total Hours- Theory: 15 Hours, Practicals: 90 Hours

UNIT – I

Introduction: What is mobile Application Programming, Different Platforms, Architecture and working of Android, iOS and Windows phone 8 operating system, Comparison of Android, iOS and Windows phone 8.

About Flutter: Understanding Flutter, Flutter framework, Introduction to Android studio, Flutter SDK - Installing and Configuring, Introduction to Dart writing Dart code, Dart Pad, Installing Dart SDK.

UNIT – II

Basic DART Programming Concepts: Introduction, Main () function, Dart variables, Dart Data Types, Dart Conditional Operators: - if- Else statements, Loop operators, Break statements, switch case statements.

Dart Functions & Object -Oriented Programming: Functions- its structure, creating a function, function Return Data Types, Void function, variable scope, OOP- Objects and classes, creating a Class, Adding Methods to classes, Providing constructors for classes, Class – Getters and Setters, Class Inheritance, Abstract Class, Dart Project Structure and Dart Libraries.

UNIT – III

Flutter Widgets Fundamentals: Scaffold, Image, Container, Column and Row, Icon Widgets, Layouts, Card Widgets, App Icon for iOS and Android apps, Hot reload and Hot Restart, Stateful and Stateless Widgets, Using custom Font.

Navigation and Routing: Button, Floating Action Button

Visual, Behavioral and Motion- Rich Widgets Implementation: Bottom Navigation Bar, ListTile, ListView, Drawer, DataTable, Selectable Text, Stack, Input and Selections, Text field, Checkbox group and Radio Button, Date Picker, Time Picker, Slider, Switch, Dialogs, Alerts and Panels.

UNIT – IV

App testing & Publishing: Testing and feedback for your App, setting up a test environment, Usability Testing, starting your Test Session, Analyzing your Test, Publishing Flutter Apps, Publishing Android App on Google Play store.

Understanding Flutter Versions, Flutter macOS Setup, macOS development Environment, Publishing iOS app on Apple store.

Practical component (if any) – Mobile Application Development
(Flutter and Dart Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Proficient in use of IDE‘s for designing and development of various android based applications.
- Design and developed various applications using various components GUI component, GPS, SD card.
- Prepare the technical report on the projects carried

LIST OF PRACTICALS (Total Practical Hours- 90 Hours)

1. Develop an application that uses GUI components, Font and Colors.
2. Develop an application that uses Layout Managers and event listeners.
3. Develop a native calculator application.
4. Write an application that draws basic graphical primitives on the screen.
5. Develop an application that makes use of database.
6. Implement an application that implements multi-threading.
7. Develop a native application that uses GPS location information.
8. Implement an application that writes data to the SD card.
9. Implement an application that creates an alert upon receiving a message.
10. Write a mobile application that creates alarm clock.
11. Develop an application for working with Menus and Screen Navigation.
12. Develop an application for working with Notifications

List of Projects: -

1. Counter App
2. Calculator App
3. Audio recorder App
4. Voice to text Converter
5. Tic-tac-toe Game

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven and Projects less than four.

Essential/recommended readings

1. Flutter for Beginners: A Genius guide to flutter App development, Edward Thornton.
2. Beginning App Development with Flutter Book, Rap Payne.
3. Quick Start Guide to Dart Programming, Sanjib Sinha, Apress Publication.
4. Dart Apprentice: Beginning Programming with Dart, Jonathan Sande and Matt Galloway.

Suggestive readings

1. Flutter Complete Reference: Create beautiful, fast and native apps for any device, Alberto Miola.
2. Beginning Flutter: A Hands-on Guide to App Development, Marco L. Napoli.

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

SEMESTER-V
DEPARTMENT OF ELECTRONIC SCIENCE
Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 13: Embedded System

CREDIT 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		
Embedded System	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Microprocessor (DSC 11, Sem IV)

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to the fundamental understanding of an embedded system. It is designed to make student familiar with the features, architectures and design issues involved in embedded system. The course focuses both on hardware and software components. Important serial communication protocols are also included. Syllabus covers microcontroller programming in C, which is platform independent.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the fundamental concepts and features related to embedded systems .
- Understand the AVR RISC architecture and Instruction set.
- Interface I/O devices with microcontroller using parallel ports, serial ports, ADC etc.
- Learn the concepts of hardware & software interrupts and Timer

- Design simple embedded systems including their hardware as well as software.

SYLLABUS OF ELDSC-13 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Overview of Embedded Systems, Requirements and Applications, Introduction to microcontrollers, Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers.

AVR Microcontroller: ATMega32 AVR RISC microcontroller architecture, Status Register, General Purpose Register file, Program memory and data memory organisation, Reset sources (Power-on, Brownout & Watchdog Timer).

UNIT – II (11 Hours)

Instruction Set: Addressing Modes, Data Transfer Instructions, Arithmetic and Logic Instructions, Branch Instructions, Bit and Bit-test Instructions, MCU Control Instructions., Introduction to AVR Programming in C, C datatypes, operators for AVR, simple programs for control, loop, arithmetic & logical operations and bit manipulation.

UNIT – III (12 Hours)

Peripheral I: Configuring I/O ports, Pull-up resistors, reading and writing data to I/O ports. Introduction to Interrupts, interrupt vector address and priority, ISR, External Interrupts. Introduction to Timers, Timers as delay generators and event counters, Timer0 modes of operation.

UNIT – IV (11 Hours)

Peripheral II: Analog-to-Digital Converter (ADC), Basics of Serial Communication, Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART), Serial Peripheral Interface (SPI), Two Wire Interface (TWI) / I2C bus.

Practical component (if any) – Embedded System

(Hardware and AVR studio or similar IDE Software)

(Students are required to perform listed experiments and make a Mini Project)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to program AVR microcontrollers using AVR studio/similar IDE.
- Learn different interfacing techniques and standards to control various input output devices with the microcontroller.
- Student will be equipped with sufficient knowledge to implement mini projects.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. (i) Blink LED at a constant rate.
   (ii) Blink LED at linearly increasing rate until the LED appears always on.
2. Use LFSR (linear feedback shift register) based random number generator to generate a random number and display it.
3. To interface 4 Keys with Port A and Port B each. Write a program to read the data from Port A and Port B and display its sum (and other arithmetic & logical operations) on output device.
4. To interface a LED/Buzzer with an o/p pin of AVR microcontroller. Write a program to blink the LED / Beep the Buzzer at (i) a constant rate (ii) linearly increasing rate using Timer.
5. To interface a 4x4 Keypad/push button keys with I/O pins of AVR microcontroller. Write a program to display the number of the key pressed in Binary number format on LED array or decimal number format on 7-segment LED or text display on an LCD or Serial Monitor.
6. To interface a potentiometer with ADC of AVR microcontroller. Write a program to display the dc input voltage on an output device (LED array / 7-segment LED / LCD / Serial Monitor).
7. To control the intensity of an LED/pitch of buzzer using PWM mode of Timer 0.
8. To interface a DC motor or Stepper motor and to write a program to control its speed.

Mini Project

(Any one of the following mini project or on similar concepts incorporating data acquisition from sensors/ input device, data analysis & control and display of result on any output device) (individual project only)

Project Idea 1: Weather Monitoring System -
Input - Temperature, humidity, wind speed etc.
Output - Display instantaneous values, average value, MAX / MIN value and predicted value for the next hour

Project Idea 2: Electronic Voting Machine -
Input - 8 Voting keys, Control Keys (Master Clear, Display Result, etc)
Output - Display device showing instructions, messages and results in accordance to the key pressed

Project Idea 3: Health Monitoring System -
Input – Pulse rate, Blood Pressure, SpO2, etc.
Output - Display device showing results

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven and make a Mini Project.

Essential/recommended readings

1. “AVR Microcontroller and Embedded Systems: Using Assembly and C”, Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, PHI,2013
2. “Programming and Customizing the AVR Microcontroller”, D V Gadre, McGraw- Hill,2000
3. “Atmel AVR Microcontroller Primer: Programming and Interfacing”, Steven F. Barrett, Daniel J. Pack, Morgan & Claypool Publishers,2012
4. “Embedded system Design”, Frank Vahid and Tony Givargis, John Wiley, 2002

Suggestive readings

1. “An Embedded Software Primer”, David E Simon, Addison Wesley,1999
2. AVR Microcontroller Datasheet, Atmel Corporation, www.atmel.com

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: Electromagnetics

CREDIT 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		
Electromagnetics	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/ Applied Mathematics + Chemistry OR Physics + Mathematics/ Applied Mathematics + Computer Science/ Informatics Practices**	**Engineering Mathematics (DSC 7, Sem III)**

Learning Objectives

The Learning Objectives of this course are as follows:
The syllabus of the paper is very carefully framed with the objective to well verse the students of the programme about

- Ability to apply knowledge of mathematics in solving electromagnetic problems.
- To understand the concept of electromagnetic waves in low frequency and high frequency applications.
- This paper is the backbone in the development of new integrated devices and applications of electromagnetic principles in various allied disciplines such as communications, microwaves, radar, electromagnetic interference & electromagnetic compatibility, remote sensing and fibre optics.
- Basic laws of electromagnetics required for any student who wants to pursue his career in research

Learning outcomes

The Learning Outcomes of this course are as follows:

- Getting familiar with vector algebra, coordinate system and coordinate conversion
- Understanding electrostatic fields and magnetostatic fields.
- A balanced presentation of static and time-varying fields.

- Physical interpretation of Maxwell's equation and problem solving in different media
- Understanding of propagation of an electromagnetic wave.

SYLLABUS OF ELDSC-14 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (14 Hours)

Vector Analysis: Scalars and Vectors, Vector Algebra, Rectangular (Cartesian) Coordinate System, Vector Components and Unit Vector, Vector Field, Products, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector ,Divergence and Stokes Theorem, the Laplacian.

Electrostatic Fields: Coulomb's Law and Electric Field, Electric Potential, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation, Electric dipole. Electric Fields in Conductors, Current and Current Density, Continuity of Current, Metallic Conductor. Dielectric materials, Polarization in Dielectrics, Dielectric Constant, Isotropic and Anisotropic dielectrics. Electrostatic Energy, Boundary Condition, Poisson equation and Laplace equation, Uniqueness Theorem.

UNIT – II (10 Hours)

Magnetostatics: Biot Savert's law, Magnetic dipole, Ampere's Circuital Law, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic materials. Magnetic Energy, Boundary Conditions

UNIT – III (10 Hours)

Time-Varying Fields and Maxwell's Equations: Faraday's Law of Electromagnetic Induction, stationary and moving loop in time varying magnetic field, Displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations. Time varying potential, Lorentz condition for potential. Wave Equation for Potentials. Time Harmonic Electromagnetic Fields and use of Phasors

UNIT – IV (11 Hours)

Electromagnetic Wave Propagation: The Electromagnetic Spectrum, Wave Equation in a source free isotropic homogeneous media, Uniform Plane Waves propagation in Lossless and Lossy unbounded homogeneous media, Plane Wave Propagation in Good conductor, wave Impedence, Skin Depth and skin effect, Wave Polarization: Linear, elliptical and Circular. Flow of Electromagnetic Power and Poynting Vector.

Practical component (if any) – Electromagnetics
(using Scilab/MATLAB/ any other similar freeware)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the plotting of vectors, and transformation among various coordinate systems in 2D and 3D.
- Understand the graphical representation of scalar and vector fields including gradient, divergence and curl.
- Understand the graphical representation of electric and magnetic fields for various types of charge and current distributions respectively.
- Understand the flow of energy and power associated with electromagnetic waves.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Understanding and Plotting Vectors.
2. Point to point and Vector Transformation from Cartesian to cylindrical co-ordinate system and vice versa.
3. Point to point and Vector Transformation from Cartesian to Spherical co-ordinate system and vice versa.
4. Point to point and Vector Transformation from Cylindrical to Spherical co-ordinate system and vice versa.
5. Representation of the Gradient of a scalar field, Divergence and Curl of Vector Fields.
6. Plots of Electric field due to charge distributions.
7. Find the Magnetic field from a given Electric field for a Uniform plane wave.
8. Find a Poynting Vector for a given electromagnetic field at a given point.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. Murray. R. Spiegel, Vector Analysis, Schaum series, Tata McGraw Hill (2006)
2. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
3. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
4. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
5. Introduction to Electrodynamics, D.J. Griffiths, Pearson Education (2012)
6. Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)

Suggestive readings

1. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
2. W. H. Hayt and J. A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)

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: Basic VLSI Design

CREDIT 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 VLSI Design	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semiconductor Devices(DSC 3, Sem I), Digital Electronics(DSC 5, Sem II)

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to basic principle of MOS Transistor operation, SPICE model, MOS transistor and Inverter layout, CMOS layout, Inverter design, CMOS inverter, inverter characteristics and specifications. Static and Sequential MOS Logic design, pass transistor logic, static & dynamic latches, flip flops, static & dynamic registers, Monostable sequential circuits. MOS memory design, RAM & ROM cells, Logic families performance.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the concept of models of MOS devices and their implementation in designing of CMOS inverter
- Measure the performance parameters like threshold voltage, noise margins, time delays etc.
- Familiarize with the techniques and components involved in combinational MOS circuit designs.
- Describe the various types of semiconductor memories and issues involved in them

SYLLABUS OF ELDSC-15 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Metal Oxide Semiconductor (MOS): Introduction to basic principle of MOS transistor, large signal MOS models (long channel) for digital design. MOS SPICE model, MOS Transistor layout(PMOS and NMOS)

UNIT – II (12 Hours)
MOS Inverter: Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, Dynamic behaviour, Propagation Delay and Power Consumption.

UNIT – III (11 Hours)
Combinational MOS Logic Design: Static MOS design, Pass Transistor logic, complex logic circuits.
Sequential MOS Logic Design - Static latches, Flip flops & Registers, Dynamic Latches & Registers, Monostable sequential circuits.

UNIT – IV (10 Hours)
Memory Design: ROM & RAM cells design. Dynamic MOS design- Dynamic logic families and performances.
Design for testability: Introduction, Fault types and models, Controllability and observability, AdHoc Testable design techniques, Scan –based techniques.

Practical component (if any) – Basic VLSI Design
(PSpice/other Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Reproduce the characteristics of digital circuits like inverter and other logic gates based on CMOS technology.
- Design the digital circuit components like latches, multiplexers etc.
- Perform experiments and the circuit design and collect and analyse the data
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To plot the (i) output characteristics & (ii) transfer characteristics of an n-channel and p-channel MOSFET.
2. To design and plot the static and dynamic characteristics of a digital CMOS inverter.
3. To design and plot the output characteristics of a 3-inverter ring oscillator.
4. To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
5. To design and plot the characteristics of a 4x1 digital multiplexer using pass-transistor logic.
6. To design and plot the characteristics of a positive and negative latch/master-slave edge triggered registers based on multiplexers.

7. To prepare layout for given logic function and verify it with simulations.
   To measure propagation delay of a given CMOS Inverter circuit.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than six.

Essential/recommended readings

1. Weste and Eshraghian, —Principles of CMOS VLSI design, Addison-Wesley, 2002.
2. Basic VLSI design: Douglas A Pucknell, Kamran Eshraghian, PHI, 3rd edition

Suggestive readings

1. Kang & Leblebigi —CMOS Digital IC Circuit Analysis & Design- McGraw Hill, 2003.
2. Rabey, —Digital Integrated Circuits Design, Pearson Education, Second Edition, 2003.

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

CREDIT 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		
Computer Networks	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Programming Language (DSC 1, Sem I)/ Algorithm Design and Analysis(DSE 1B, Sem III), Operating System(DSE 2B, Sem IV)

Learning Objectives

The course objectives include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience. This course introduces the student to the fundamental understanding of the architecture and principles of today's computer networks. It introduces various protocols and their functionalities. This course will help to understand The Internet and its impact on the computer network architecture**.**

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describing computer network in terms of a layered model.
- Implementing data link, network, and transport layer protocols in a simulated networking environment
- Determine different types of errors and data flow within networks.
- Planning logical sub-address blocks with a given address block.
- Describing the standard protocols involved with the INTERNET, TCP/IP, based communications.

SYLLABUS OF ELDSE-3A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Network Basics and Physical layer: Data Communication- Components, Network topologies, OSI Reference Model, Internet (TCP/IP) Model, Digital Signals, Digital-to-Digital Encoding, Transmission Media- Guided and Unguided, Addressing, Transmission Impairment, Nyquist Bit rate, Shannon Capacity and Line Codling Schemes, Switching-Circuit Switching, Message Switching and Packet Switching, Network Connecting Devices- Repeaters, Hubs, Switches, Bridges, Routers and Gateway.

UNIT – II (12 Hours)

Data Link Layer and MAC: Character and Bit Oriented Framing, Flow and Error Control, Error Detection and Correction Codes- Parity, Hamming Code, Cyclic Redundancy Check and Checksum, Stop and Wait Protocol, Sliding Window Protocol and Piggybacking, Go-Back-N ARQ, Selective Repeat ARQ. Random Access Protocols-ALOHA, CSMA, CSMA/CD, CSMA/CA, Controlled Access Protocols- Reservation, Token Passing and Polling, Channelization Protocols-FDMA, TDMA and CDMA.

UNIT – III (12Hours)

Network Layer: IPV4 Addresses- Classful and Classless, Subnet Addressing, NAT, Datagram Format, Internet Control Protocols- ARP, RARP and ICMP, Routing algorithms - Shortest Path and Distance Vector, Approaches to Congestion Control, IPV4 issues, Need for IPV6,IPv6 Packet Format, IPV6 Unicast and Multicast Addressing

UNIT – IV (10 Hours)

Transport and Application Layer: Transport Services, Connection management, TCP and UDP protocols, Congestion Control and Quality of Service, Application Layer-DNS, FTP, WWW and HTTP.

Practical component (if any) – Computer Networks

(The practical will need to be Simulated on Cisco Packet Tracer or an equivalent platform. All Programming experiments to be done with Python)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement a simple network with hubs and switches.
- Understand the various LAN topologies
- Describe how packets are delivered in the Internet.
- Describe what classful addressing scheme is.
- Grasp the error detection and correction algorithms

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Create a simple network with a switch and two end devices in Cisco Packet Tracer. Configure the PCs, set their IP address and capture Ping from one PC to the other and vice versa.. Mention the uses of PING command.
2. Study Network Commands: tracert, ipconfig and ipconfig/all.
3. Implement MESH/STAR/RING/BUS topology in Packet tracer.
4. Write a program to add a parity bit to a 7 bit data input by a user/ add redundant bits to a 7 bit data using Hamming Code to be implemented at the sender's site.
5. Write a program to detect and correct a single bit error while transmitting a 7-bit Hamming Code word to be implemented on the receiver side.
6. Write a program to implement CRC at the sender's site.
7. Write a program to show Byte and Bit stuffing in a frame.
8. Set a six-computer network with a switch using Packet Tracer and show Unicast and Broadcast addressing.
9. Connect two different networks using a router in Packet tracer and show movement of packets from one to the other.
10. Write a program to determine the class of the given IPV4 Address in Dotted Decimal or Binary Notation.
11. Implement FTP Server in Packet Tracer and show transfer of data.
12. Study HTTP /DNS on the Packet Tracer.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eleven.

Essential/recommended readings

1. Behroz A. Forouzan, " Data Communication and Networking", TMH, 5th Edition.
2. A.S.Tanenbaum, " Computer Network", Pearson Education, 4th Edition.

Suggestive readings

1. James Kurose , "Computer Networking: A Top-Down Approach", Pearson Education, 7th Edition.
2. Douglas E. Comer, "Internetworking with TCP/IP Principles, Protocol and Architecture Volume 1" , 6th Edition
3. Peterson and Davis, "Computer Networks: A Systems Approach", Pearson, 5th edition
4. Fall Kevin and W. Richard Stevens , "TCP/IP Illustrated: The Protocols" Volume 1.
5. William Stallings, "Data and Computer Communication", Tenth Edition.

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Quantum and Spintronics Devices	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semiconductor Devices(DSC 3, Sem I), Engineering Mathematics (DSC 7, Sem III)

Learning Objectives

The objective of the course is to make the students understand the inadequacies of Classical Physics and know the basic postulates of Quantum Mechanics. Spintronics, a portmanteau meaning "spin transport electronics", where both charge and spin degrees of freedom of electrons are employed simultaneously to produce a device with new functionality, is a fascinating and promising field of research. It has the potential to revolutionize the field of electronics. Two physical bases of Spintronics, i.e., GMR and TMR have already been commercialized in read heads of the hard disk drive. It is extremely important and necessary to have a clear concept of spintronics so that students get exposure to such modern-day cutting-edge technology. Students will also learn general concepts about Spin-based quantum computing which is a leading technology for the realization of scalable quantum computers and other sectors too.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the limitation of classical physics and basic concepts of quantum Mechanics
- Understanding the concept of spintronics and spin-orbit
- Comprehend the spin relaxation and transport
- Design the spintronics devices using the laws
- Know the basic principles of various spintronic devices (sensors, memories, etc.)

SYLLABUS OF ELDSE-3B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to Quantum Mechanics: Inadequacies of Classical physics, Wave-particle duality, de Broglie waves, Schrödinger equation, expectation values, Uncertainty principle.

Basics of Quantum Mechanics: Solutions of the one-dimensional Schrödinger equation for a free particle, particle in a box, particle in a finite well. Reflection and transmission by a potential step and by a rectangular barrier. Basic understating of the Linear algebra of quantum computing.

UNIT – II (12 Hours)

History & Background of spintronics : GMR, Datta-Das, Spin relaxation, Spin injection, Spin detection

Electron Spin in Solids: Quantum Mechanics of spins, Pauli equation, Spin-Orbit coupling, Zeeman splitting, Current density, Magnetization, Bloch states with SO coupling, Electronic structure of GaAs, Dresselhaus and Rashba spin splitting, Optical orientation and spin pumping, Stern-Gerlach experiments with electron spins, Detection of free electron spin

UNIT – III (11 Hours)

Transport in magnetic materials and Spin injection: Materials for spin electronics, Nanostructures for spin electronics, Spin-polarized transport, Electrochemical potential, Spin accumulation, Spin diffusion, FN junction, Rashba formalism of linear spin injection, Equivalent circuit model, Silsbee-Johnson spin-charge coupling

UNIT – IV (11 Hours)

Spintronic Devices: Datta-Das spin-FET, P-N junctions, Magnetic bipolar diode, Magnetic bipolar transistor, Magnetic tunneling devices, MRAM, New memory technologies

Practical component (if any) – Quantum and Spintronics Devices
Hardware and Simulation-Based Lab Experiments
(Scilab/MATLAB/SPICE/Verilog A)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform lab experiment on splitting of atomic energy levels under magnetic field by Zeeman Effect
- Perform simulations to under spin phenomenon using transport and magnetic elemental modules using Scilab/MATLAB/SPICE/Verilog A

- Extending use of elemental modules to build Spin Circuit Models for complex structures

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Study of Zeeman Effect

Simulation using Transport and Magnetic Elemental Modules to understand Spin Phenomenon and build Spin Circuit Models using Scilab/MATLAB/SPICE/Verilog A (https://nanohub.org/groups/spintronics) for the following

2. Non Magnet
3. Ferromagnet
4. Magnetic Tunnel Junction
5. Rashba Spin Orbital
6. Giant Spin Hall Effect
7. Spin Pumping
8. Pure Spin Conductor
9. Magnetic Coupling

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Beiser, Concepts of Modern Physics, McGraw-Hill Book Company (1987)
2. Sadamichi Maekawa, —Concepts in Spin Electronics, Oxford University Press (2006).
3. Bandyopadhyay S, Cahay M. Introduction to Spintronics. CRC press; 2015.

Suggestive readings

1. Isaac Chuang and Michael Nielsen, Quantum Computation and Quantum Information, Cambridge University Press, 2000.
2. Supriyo Bandyopadhyay and Marc Cahay, Introduction to Spintronics, CRC press, 2008

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Telecommunication Switching Systems and Networks	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Principles of Communication System(DSC 12, Sem IV)**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce and develop a conceptual understanding of telecommunication networks.
- To develop an understanding of basic traffic engineering and get familiar with the basics of modern telephone networks and data networks.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basics of various Switching Systems.
- Learn in detail about Time Division Switching.
- Understand the basics of Traffic Engineering.
- Learn the fundamentals of Data Networks.
- Understand the functionality of Telephone Networks and gain familiarity with ISDN.

SYLLABUS OF ELDSE-3C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Evolution of Telecommunications, Simple Telephone Communication, Manual Switching System, Major Telecommunication Networks, Strowger Switching System, Crossbar Switching.
Electronic Space Division Switching: Stored Program Control, Centralized SPC, Distributed SPC, Enhanced Services, Multi-stage Switches.

UNIT – II (12 Hours)
Time Division Switching: Time Multiplexed Space Switching, Time Multiplexed Time Switching, Combination Switching, Three-stage Combination Switching, *n*-stage Combination Switching.
Traffic Engineering: Network Traffic Load and Parameters, Grade of Service and Blocking Probability, Modelling Switching Systems, Incoming Traffic and Service Time Characterization, Introduction to Blocking Models, Loss Estimates and Delay Systems.

UNIT – III (11 Hours)
Data Networks: Block diagram, features and working of EPABX systems. Data Transmission in PSTNs, Data Rates in PSTNs, Modems, Switching Techniques for Data Transmission, Circuit Switching, Store and Forward Switching. Data Communication Architecture, ISO-OSI Reference Model, Link to Link layers, Physical Layer, Data Link Layer, Network Layer, End to End Layers, Transport Layer, Session Layer, Presentation Layer, Satellite Based Data Networks, LAN, Metropolitan Area Network, Fibre Optic Networks, and Data Network Standards.

UNIT – IV (11 Hours)
Telephone Networks and ISDN: Subscriber Loop Systems, Switching Hierarchy and Routing, Transmission Plan, Transmission Systems, Numbering Plan, Charging Plan, Signalling Techniques, Inchannel Signalling, Common Channel Signalling, Cellular Mobile Telephony.
Integrated Services Digital Networks (ISDN): ISDN services, Network and Protocol Architecture, Transmission Channels.

Practical component (if any) – Telecommunication Switching Systems and Networks ***(MATLAB/SCILAB /Any other softwares)***

Learning outcomes

The Learning Outcomes of this course are as follows:

- To learn about the various switching networks.
- To learn about traffic in the context of Telecommunication Network.
- To design and study a Local Area Network.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Simulation of Basic Switching Systems.

2. Simulation of TDMA.
3. Simulation of basic traffic parameters.
4. Simulation of PCM.
5. To study and perform TDM-PCM.
6. Study of EPABX System and its features
7. Study of LAN Trainer Kit.
8. Study of Optical Fiber Communication System.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. Thiagarajan Viswanathan, Manav Bhatnagar, 'Telecommunication Switching Systems and Networks', Prentice Hall of India Learning Pvt. Ltd., 2015
2. J. E Flood, 'Telecommunications Switching, Traffic and Networks', Pearson Education, 2006
3. John C Bellamy, Digital Telephony, John Wiley International Student Edition, 3rd Edition, 2000
4. Tomasi, Introduction to Data Communication and Networking, Pearson Education, 1st Edition, 2007

Suggestive readings

1. Behrouz A. Forouzan, Data Communications and Networking, TMH, 2nd Edition, 2002

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 OFFERED BY THE DEPARTMENT

GENERIC ELECTIVES (GE-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		
Fundamentals of 8085 Microprocessor	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Working of different logic gates**

Learning Objectives

The Learning Objectives of this course are as follows:

- Various kinds of number systems and their basics.
- Fundamental understanding of the operations of microprocessors
- Assembly language programming
- Interfacing microprocessor with the real world.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Convert various number systems and operations thereof.
- Draw block diagrams after familiarization with internal architecture of 8085 microprocessor, its instruction set and basic programming.
- Write assembly language programs for 8085 microprocessor.
- Acquire skills in memory and peripheral interfacings to solve real world problems..

SYLLABUS OF ELGE-5A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Number systems: Binary, Hexadecimal - Conversion from Binary to Decimal and vice-versa, Binary to Hexadecimal and vice-versa, Decimal to Hexadecimal and vice versa, Addition and Subtraction of Binary Numbers and Hexadecimal Numbers. Subtraction using 2's Complement, Signed Number Arithmetic.

Introduction to Microprocessors: Introduction to Microprocessors, Microcontrollers and Microcomputers, Basic Block Diagram, Speed, Word Size, Memory Capacity, Classification of Microprocessors, Computer languages, Tri-state Logic, Address bus, Data bus and Control bus.

UNIT – II (12 Hours)

Microprocessor 8085: Features, Architecture, Pin Diagram, Block Diagram, Internal Registers, Microprocessor Operations – Microprocessor Initiated Operations, Internal Data and Peripheral or Externally Initiated Operations. Demultiplexing of Multiplexed Address and Data bus, Generation of Control Signals.

Interfacing of Memory Chips: Basic concepts in Memory Interfacing Structures, Address Allocation Technique, Address Decoding Techniques, Memory Map. Interfacing of I/O Devices with 8085, LEDs and Toggle-switches as examples, Memory-Mapped I/O and Peripheral-mapped I/O**.**

UNIT – III (11 Hours)

8085 Instructions: Instruction Set, Instruction Classification, Addressing Modes.

Data Transfer Instructions, Arithmetic Instructions, Increment & Decrement Instructions, Logical instructions, Branch instructions and Machine Control Instructions. Concept of Timing Diagram, Instruction cycle, Machine cycle and T- state. Assembly Language Programming Examples.

UNIT – IV (11 Hours)

Stack Operations: Stack, Subroutine, Call and Return operations, Advanced Subroutine Concepts.

Delay Loops: Looping, Counting and Indexing using Data Transfer, use of Counters. Time Delay Routines, Debugging Counter and Time Delay Programs.

Interrupt Structure of 8085 Microprocessor: Concept of Interrupt Mechanism, Hardware and Software Interrupt of 8085, Interrupts and Vector Locations, RST Instructions, Interrupt Related Instructions, SIM and RIM.

Introduction to Peripheral Programmble Interfacing Devices

Practical component (if any) – Fundamentals of 8085 Microprocessor
(Assembly Language Programming)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Write simple programs to understand the instruction set of 8085 microprocessor.
- Interface various I/O devices with microprocessor.
- Prepare the technical report on the experiments carried out.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to transfer a block of data.
2. Program for multibyte addition.
3. Program for multibyte subtraction.
4. Program to multiply two 8-bit numbers.
5. Program to divide two 8-bit numbers.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find the square root of an integer.
9. Program to sort numbers in ascending/descending order.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Microprocessor 8085 and Its Interfacing, Sunil Mathur, PHI Learning Pvt. Ltd.

Suggestive readings

1. Fundamentals of Microprocessor & Microcomputer: B. Ram, Dhanpat Rai Publications.
2. Microcomputers and Microprocessors by John E Uffenbeck

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

GENERIC ELECTIVES (GE-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		
Artificial Intelligence and Machine Learning	**4**	**3**	**-**	**1**	**Class XII passed with Maths/Applied Maths**	**Python Programming fundamentals**

Learning Objectives

Artificial Intelligence (AI) has emerged as one of the most rapidly growing technology sectors in today's time. This fascinating technology area which deals with designing 'machines which can think' is finding widespread application in almost every industrial and domestic sector. Rapid advancement in the field of AI has also led to complete revolution in the other technology areas including Robotics, embedded systems and Internet of Things.

This course will give an opportunity to gain knowledge in some of the fundamental aspects of AI. The main objective of this well-structured classroom program is to cover all the main topics related to designing machines which can replicate human intelligence and its applications in industry, defence, healthcare, agriculture, and other areas. This course will give the students advanced and professional graduate-level foundation in Artificial Intelligence.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Build intelligent agents for search and games
- Solve AI problems through programming with Python
- Learning optimization and inference algorithms for model learning
- Design and develop programs for an agent to learn and act in a structured environment

SYLLABUS OF ELGE-5B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Concept of AI, history, current status, scope, Modeling Techniques: Turing Test Approach, Cognitive Modeling Approach, Rational Agent Approach and Laws of Thought Approach, AI System Architecture: Concept of Agent & Environment, Types of Agents: Reactive Agent, Model based Reflex Agent, Omniscient Agent, Goal

Based Agent, Utility based Agent and Learning Agent, Types of Environment, PEAS representation of Intelligent Agents.

UNIT – II (12 Hours)

Problem Solving Agents: AI Problem Formulation, State space representation, Problem Solving Search Algorithms: Uninformed Search Algorithms: Breadth first search, Depth First Search, Depth Limited Search, Uniform Cost Search and Bidirectional Search, Heuristic Search Algorithms: concept of Heuristic Function, Greedy Best First Search and A* search algorithm.
Simple AI problems (such as Water Jug Problem, Maze Problem, 8-Tile Puzzle problem, Traveling Salesman Problem).

UNIT – III (11 Hours)

Game Search Algorithms: Minimax Search Algorithm and Alpha-Beta Pruning.
Probabilistic Reasoning Model: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability, Markov Model and Hidden Markov model.

UNIT – IV (11 Hours)

Introduction to Machine Learning: Overview of types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Passive and Active Reinforcement Learning
Markov Decision Process Model: MDP formulation, utility theory, utility functions, value iteration, policy iteration and Q- Learning. Elements of MDP Model, concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world

Practical component (if any) – Artificial Intelligence and Machine Learning
(Algorithms to be implemented in Python programming language)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement AI algorithms to solve single player puzzles (problems)
- Implement Adversarial (Game search) to design an intelligent game playing system
- Apply Bayesian statistics to apply probabilistic reasoning models
- Analyze the given data sets using basic machine learning algorithms

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Program to solve the given search tree using Breadth First Search
2. Program to solve the given search tree using Depth First Search
3. Program to solve the given search tree using Depth Limited Search
4. Program to solve the given search tree using Uniform Cost Search
5. Program to solve the given search tree using Greedy Best First Search

6. Program to solve the given search tree using A* Search
7. Program to solve the given game search tree using Minimax Search
8. Program for construction and inference of a Bayesian network
9. Write a Program to perform Regression on given data sets

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Essential/recommended readings

1. Stuart Russell and Peter Norvig, —Artificial Intelligence: A Modern Approach , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, —Artificial Intelligence, Tata McGraw Hill
3. Trivedi, M.C., —A Classical Approach to Artificial Intelligence, Khanna Publishing House, Delhi.
4. Introduction to Machine Learning with Python, by Andreas C. Müller, Sarah Guido, O'Reilly Media, Inc., 2016

Suggestive readings

1. David Poole and Alan Mackworth, —Artificial Intelligence: Foundations for Computational Agents, Cambridge University Press 2010
2. Saroj Kaushik, —Artificial Intelligence, Cengage Learning India, 2011

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

SEMESTER-VI
DEPARTMENT OF ELECTRONIC SCIENCE
Category I

(B.Sc. Honours in Electronics)

DISCIPLINE SPECIFIC CORE COURSE – 16: Digital Signal 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		
Digital Signal Processing	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Signals and Systems (DSC 9, Sem III)

Learning Objectives

The Learning Objectives of this course are as follows:
To introduce the techniques of modern digital processing that are fundamental to a wide variety of application areas. Special emphasis is placed on the basic concepts related to discrete-time signals and systems, the analysis of signals in time and frequency using Fourier and Z transform. Introduction to techniques involved in the architecture and design of digital filters.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Grasp fundamentals of discrete time signals, linear time-invariant systems, Z-transform and Fourier transform
- Analyze linear time-invariant systems using Fourier and Z transform

- Understand the Design techniques of Digital FIR and IIR filters using direct methods and methods involving conversion of the analog filter into the digital filter by various transformations.
- Use DFT to perform frequency analysis of signals and application of FFT algorithms.

SYLLABUS OF ELDSC-16 **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)

Discrete Time Sequences and Systems: Introduction to Discrete Time sequences, Properties of DT systems.

Fourier Transform: Fourier Transform, Properties of Fourier Transform, Inverse Fourier Transform, Transfer Function of LSI systems.

UNIT – II (12 Hours)

Z-Transform: Definition, Unilateral Z- transform, Region of Convergence and its properties, Properties of Z-Transform, Initial and final value theorem.

Inverse Z Transform: Long division, Partial fraction, and Residual methods. Parseval's Theorem and applications.

System Function: Linear constant coefficient difference equation, Representation and analysis of Discrete Time Systems, Stability, Causality, Realisation of Digital Linear Systems: Block diagram, signal flow graph, structure for IIR and FIR systems

UNIT – III (12 Hours)

Discrete Fourier Transform: DFT assumptions and Inverse DFT, magnitude and phase representation Matrix relations, relationship with Fourier Transform, Linear and circular convolution, properties of DFT, Computation of DFT. FFT Algorithms- Decimation in time FFT. Decimation in frequency FFT, FFT using radix 2 FFT — Butterfly structure, Concept of Gibb's phenomenon and word length effects.

UNIT – IV (11 Hours)

Digital Filters: Comparison of Analog and Digital Filters, Types of Digital Filters: FIR and Hanning, Hamming, Blackman, Design of IIR Filters by Approximation of Derivates, Impulse Invariant Method, Bilinear Transformation, Butterworth Filter.

Practical component (if any) – Digital Signal Processing
(Scilab/MATLAB/Python other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Simulate, synthesize and process signals using a software tool.

- Apply transform methods for representing signals and systems in the time and frequency domain.
- Simulation and design of FIR and IIR Filters

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to generate discrete time Unit Sample, Unit Step, Unit ramp and Sinusoidal sequences.
2. Write a program to find the Fourier Transform of a sequence.
3. Write a program to find the pole-zero plot of a function.
4. Write a program to find a function's Z transform and inverse Z transform.
5. Write a program to find the circular convolution of two sequences.
6. Write a program to find the DFT of a sequence using the direct method.
7. Write a program to find the DFT of a sequence using FFT.
8. Magnitude Response of Low Pass Filter and High Pass Filter.
9. Design FIR Filter using Window Function.
10. Convert Analog Filter to Digital IIR Filter

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1999.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 2007.

Suggestive readings

1. S. Salivahanan, Digital Signal Processing, McGraw Hill, 2015.
2. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015.
3. Monson Hayes, Digital Signal Processing: Second Edition, Schaum's Outline Series

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: Photonics

CREDIT 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		
Photonics	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Electro-magnetics (DSC 14, Sem V)**

Learning Objectives

The Learning Objectives of this course are as follows:

- This course introduces the student to the fundamental understanding of light as an electromagnetic wave and various phenomenon like interference, diffraction and polarization and their applications.
- Interaction between a photon and electron and its relevance to laser and various other optoelectronic devices.
- Understand the propagation of wave in planar optical waveguides and optical fibers.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Describe the optics and simple optical systems.
- Understand the concept of light as a wave and its propagation in optical fibres, and relevance of this to optical effects such as interference , diffraction, polarization and hence to lasers, holography and optical waveguides.
- Use mathematical methods to predict optical effects with e.g. light-matter interaction, wave propagation in guided media, dispersion, wave optics

SYLLABUS OF ELDSC-17 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Light as an Electromagnetic Wave: Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law.
Interference : Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings.
Diffraction: Fraunhoffer Diffraction by a single slit, double slit, Diffraction grating: Resolving power and Dispersive power

UNIT – II (11 Hours)
Holography: Basic Principle , Construction and reconstruction of hologram.
Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Half wave and quarter wave plates. Electro optic Effect, Faraday Rotation
Liquid Crystal Displays: Types, Working Principle.

UNIT – III (11 Hours)
Light Emitting Diodes: Construction, materials and operation.
Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, Laser cavity , Examples of common lasers. The semiconductor injection laser diode.
Photodetectors: Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

UNIT – IV (11 Hours)
Guided Waves and the Optical Fibre: Maxwell's Equations, TE modes in symmetric step index planar slab waveguides, effective index, field distributions, Step index optical fibre, total internal reflection, single mode and multimode fibres, attenuation and dispersion in optical fibres.

Practical component (if any) – Photonics
(Hardware Lab augmented with virtual lab)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform experiments based on the phenomenon of light/photons.
- Measure the parameters such as wavelength, resolving power, numerical aperture etc. using the appropriate photonic/optical technique.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To determine Brewster's angle.
2. To determine wavelength of sodium light using Newton's Rings.
3. To determine the resolving power and Dispersive power of Diffraction Grating.
4. Diffraction experiments using a laser.

5. Viewing of different types of holograms.
6. To verify the law of Malus for plane polarized light.
7. Study of Faraday Rotation.
8. Study of Electro-optic Effect.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

In addition to the above hardware lab , teaching learning process can be further augmented using following/any other ONLINE virtual labs:

- Amrita Vishwa Vidyapeetham Virtual Lab https://vlab.amrita.edu/
- Virtual Labs ofcvlab.vesit.ves.ac.in

Essential/recommended readings

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. Ghatak A.K. and Thyagarajan K., —Introduction to fiber optics, Cambridge Univ. Press. (1998)

Suggestive readings

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)

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: Semiconductor Device 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		
Semiconductor Device Technology	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Semi-conductor Devices (DSC 3, Sem I)**

Learning Objectives

The Learning Objectives of this course are as follows:

- The course deals with properties of materials required for Semiconductor Devices
- It deals with various processing steps
- It gives an account of how the Semiconductor Devices are fabricated (with details of all processes involved)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Summarize the developments in the field of microelectronics technologies
- Describe the crystal growth, diffusion, oxidation, lithography, etching and various film deposition processes.
- Explain the process sequence for PN junction, BJT, CMOS and BiCMOS fabrication

SYLLABUS OF ELDSC-18 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Semiconductor materials: Single crystal, polycrystalline and amorphous forms. Properties of Silicon and Gallium Arsenide. Materials used for doping Silicon and Gallium Arsenide

Crystal growth techniques: Starting material (SiO_2), MGS, EGS, Growth of bulk Silicon single crystals using Czochralski (CZ) technique, Doping while crystal growth (Distribution of dopants, Effective Segregation Coefficient), Float Zone (FZ) technique, GaAs bulk single crystal growth by LEC technique, Bridgman-Stockbarger technique.
Wafer Cleaning Technology : Basic Concepts, Wet cleaning, Dry cleaning

UNIT – II (12 Hours)
Epitaxy Deposition: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Growth of GaAs films by MOCVD.
Oxidation: Importance of Silicon Dioxide in Silicon, Thermal Oxidation Process, Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities on oxidation rates, Impurity redistribution during Oxidation, Oxide Quality, Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow

UNIT – III (11 Hours)
Diffusion: Thermal Diffusion, Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation, and its comparison with Thermal Diffusion.
Lithography: Clean room, Optical Lithography, Electron beam lithography, Photoresist, Photo masks, Wet Chemical Etching, Common etchants

UNIT – IV (11 Hours)
Metallization: Filament evaporation, e-beam evaporation, sputtering techniques used for metals (Aluminium, Gold, Copper etc..) deposition on Silicon and GaAs
Process Integration (IC): Isolation techniques. Fabrication of Monolithic Resistor, Inductor, Capacitor. PN junction, BJT, NMOS, PMOS, CMOS structures.
Concept of Bipolar Technology and MOSFET Technology for Devices

Practical component (if any) – Semiconductor Device Technology
(Scilab/MATLAB/other Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Operate the advanced computer simulations tools as well as visit research laboratories for better understanding of semiconductor fabrications processes.
- Perform the simulation of semiconductor crystal growth and device fabrication processes like oxidation and diffusion.
- Perform experiments to calculate the electronic parameters like resistivity, mobility, carrier concentration and band gap etc in semiconductors.
- Operate the deposition system for fabrications of thin films

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To measure the resistivity of semiconductor crystal with temperature by four – probe method.

2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. CZ technique Simulation
4. Float zone technique Simulation
5. Oxidation process Simulation
6. Diffusion Process Simulation
7. To design a pattern using photolithographic process and its simulation
8. Process integration simulation
9. Determination of Optical Bandgap through transmission spectra.
10. Visit to Research Lab/institutions to see the live demonstrations of the processes and preparation of a report.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Gary S.May and S.M.Sze , Fundamentals of Semiconductor Fabrication, John Wiley& Sons(2004)

Suggestive readings

3. Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press (1986).

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

CREDIT 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		
Medical Electronics & Instrumentation	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Basic Instrument-ation & Measure-ment Techniques (DSC 4, Sem II), Micro-processor (DSC 11, Sem IV)**

Learning Objectives

- This course introduces the student to the fundamental understanding of various types of Biomedical Signals and their physiological aspects.
- The students analyse the various types of Biomedical instruments and their working and practical implementation.
- Learn about Modern Imaging systems like CT and MRI techniques and various other cardiac instruments.
- Learn about Instrumentation for clinical lab: blood cell counter, oximeter, blood gas and blood ph analyser.
- Learn about the emerging fields like EEG, ECG, EMG etc.
- To learn about patient safety and precaution for instruments and electrodes.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic knowledge of physiology and generation of bio electric signals (ECG, EMG, EEG etc.) in humans.
- Describe cardio vascular monitoring systems , Bed side monitor, ECG-Telemetry.
- Describe the basic knowledge on respiratory and pulmonary measurements.
- Describe modern methods of imaging techniques like CT, X-Ray, NMR and MRI.

- Describe conditions for patient safety
- Describe instrumentation for clinical Lab like Blood cell counters, oximeter, blood gas and blood pH analyser..

SYLLABUS OF ELDSE-4A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (10 Hours)
Biomedical signals and transducers
Physiological systems of human body: Introduction, Origin of biomedical signals, Use of microprocessors, Microcontrollers and computers in medical instruments, **Transducers:** Ultrasound transducer, Radiation and chemical thermometry, optical fibre sensor, biosensors, optical glucose sensor, Electrodes & its types: for ECG, EMG & EEG
.
UNIT – II (12 Hours)
Cardiovascular monitoring systems: Patient cardiovascular Monitoring systems Cardiovascular System, blood pressure measurement, cardiac rate and output measurement, Cardiac monitor- Waveforms, ECG amplifier, phonocardiography, Ballisto cardiography, Eco-Cardiograph, Bed side monitor –block diagram- measuring parameters-cardiac tachometer-Alarms-Lead fault indicator-central monitoring. Telemetry – modulation systems – choice of carrier frequency – single channel telemetry systems, Cardiac pacemakers: Introduction, Cardiac defibrillators

UNIT – III (12Hours)
Imaging Systems
X-rays: Properties and production, Block diagram of x-ray machine, Diagnostic radiology, Dental X-ray, Basic principle and components of X-Ray Computed Tomography (CT)
MRI: Principle and NMR imaging components
Introduction to Ultrasonic imaging system.

UNIT – IV (11 Hours)
Patient's safety: Precaution, safety codes for electro medical equipment, Electric safety analyser, Testing of biomedical equipment.
Instrumentation for Clinical Laboratory: Blood cell counters, Oximeter, Blood flow meter, Blood gas analysers, Blood pH analyser.
Measurement in Respiratory system: Physiology of respiratory system, Measurement of breathing mechanics Spiro meter, Respiratory therapy equipment Inhalators ventilators & Respirators, Humidifiers, Nebulizers Aspirators.

Practical component (if any) – Medical Electronics & Instrumentation

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with functioning of biomedical instrumentation
- Perform experiments on the biomedical instruments, collect & analyze the data
- Prepare the technical report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To simulate Bio potential Amplifier.
2. Study on ECG simulator.
3. Study on EEG simulator.
4. Study on EMG simulator.
5. Study of various leads and electrode position for ECG and EEG.
6. Study of pulse rate monitor (Pulse oximetry).
7. To simulate defibrillator.
8. Measurement of heart sound using electronic stethoscope.
9. Simulation of blood cell counter.
10. Study of NMR using virtual lab.
11. Visit to a Diagnostic lab/Pathology lab/Hospital to understand working of various instruments and preparation of a report.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than ten.

Essential/recommended readings

1. Khandpur R. S. - Handbook of Biomedical Instrumentation, TMH.
2. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, Pearson.
3. Shakti Chatterjee, —Textbook of Biomedical Instrumentation System‖, Cengage Learning.
4. Prof. S.K.VenkataRam-Bio-Medical Electronics and Instrumentation, Galgotia Publications.

Suggestive readings

1. Bertil Jacobson & John G. Webster - Medicine and Clinical Engineering, PHI.

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Advance Computer System Architecture	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Microprocessor (DSC 11, Sem IV) or equivalent to Computer System Architecture, Operating system(DSE 2B, Sem IV)**

Learning Objectives

- To give the students an elaborate idea about the different memory systems and buses.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multicomputer.
- To study about data flow computer architectures
- To make students know about the Parallelism concepts

Learning outcomes

The Learning Outcomes of this course are as follows:

- Demonstrate concepts of parallelism in hardware/software.
- Discuss memory organization and mapping techniques.
- Describe architectural features of advanced processors.
- Interpret performance of different pipelined processors.
- Explain data flow in arithmetic algorithms
- Development of software to solve computationally intensive problems.

SYLLABUS OF ELDSE-4B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (10 Hours)

Computer Architecture & Organization: Instruction codes, Computer instructions, Basics of Input/Output & Interrupts, Complete computer description & design of basic

computer. Control Unit: Hardwired vs. Micro programmed control unit. Flynn's classification.

UNIT – II (11 Hours)

Memory Hierarchy: Hierarchical memory organization, Types of Cache Memory, Memory Interleaving, Replacement algorithms + write policy, Concept of Virtual Memory and Virtual Machine.

Parallel Processing: Definition, Theory of Parallelism. Parallel Computer Models, Implicit Parallelism vs. explicit parallelism, Levels of parallelism. Software Parallelism, Hardware Parallelism.

UNIT – III (12 Hours)

Pipelining: Basic Concepts of pipelining, Linear pipeline processor, Asynchronous and Synchronous models, speed up, Efficiency, Throughput, Instruction pipeline. Pipeline hazards and their Resolution Mechanisms like data forwarding, Delayed Branch, Branch Prediction, Dynamic Branch Prediction, Concept of Vector processing.

UNIT – IV (12 Hours)

Instruction Level Parallelism (ILP) Instruction-level Parallelism: Introduction, Challenges, Limitations, Basic Compiler Techniques for ILP, Branch Prediction, Out of order execution, Dynamic Scheduling, Limitations of ILP. Introduction to Thread Level Parallelism (TLP) and Data Level Parallelism (DLP). Introduction to Virtualisation Architecture, Virtualisation as a concept of Cloud Computing.

Practical component (if any) – Advance Computer System Architecture
(FPGA/Virtual Lab/Tejas Architecture Simulator)

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. To design a 4-bit common bus using 4:1 mux to transfer data from register to bus.
2. To design a 2-bit combinational shifter circuit which implements the logical shift, circular shift, arithmetic shift for both direction.
3. To design 2 bit arithmetic circuit which performs the following arithmetic operations add, add with carry, subtract, subtract with borrow, increment and decrement.
4. Design of Arithmetic Logical Unit ALU
5. Design of Memory: Design of a RAM cell
6. Design of Memory: Design of a 4X4 RAM
7. Design of Direct Mapped Cache
8. Design of Associative Cache
9. Using Architectural Simulator Tejas as
    a. Emulator
    b. Transfer Engine

c. Translational Modules
d. Micro architectural Simulation

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight, experiment no. 9 is compulsory.

Essential/recommended readings

1. “Computer Architecture: A Quantitative Approach”, by John L. Hennessy and David A. Patterson, Morgan Kaufmann, 5th edition, 2011, ISBN: 9780123838728.
2. “Computer System Architecture” by M. Morris Mano (Pearson Publication)

Suggestive readings

1. “Computer Organization and Architecture”, William Stallings, Prentice Hall, 10th edition, 2015, ISBN-10: 013293633X, ISBN-13: 978-0132936330
2. "Advanced computer architecture", Kai Hwang, TMH. 2000

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

DISCIPLINE SPECIFIC ELECTIVES (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		
Transmission Lines, Antenna and Wave Propagation	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Electromagnetics (DSC 14, Sem V)**

Learning Objectives

The Learning Objectives of this course are as follows:

- Fundamentals of propagation of electromagnetic waves.
- Basics of transmission lines along with its parameters.
- Wave propagation in different modes of the waveguides.
- Antenna parameters and its radiation mechanism.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand reflection and transmission of uniform plane wave.
- Explain the functioning of transmission line and its performance parameters.
- Understand wave propagation in waveguides and different modes of propagation.
- Explain the radiation mechanism and characteristics of an antenna.

SYLLABUS OF ELDSE-4C **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Electromagnetic Wave Propagation: Plane Wave reflection at Oblique Incidence:- Laws of Reflection, Snell's Law of Refraction, Parallel and Perpendicular polarisations, Fresnel's Equations and Brewster Angle, Wave propagation in dispersive media, Concept of phase velocity and group velocity

UNIT – II (11 Hours)

Transmission Lines: Typical Transmission lines- Coaxial, Two-Wire, Microstrip and Coplanar, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines:- lossy, lossless and Distortionless lines, Input Impedance, Standing Wave Ratio, Power, Shorted Line, Open-Circuited Line and Matched Line, Quarter wave transformer as transmission line application.

UNIT – III (11 Hours)

Waveguides: Introduction to Parallel plate waveguide, Rectangular waveguide, Transverse Electromagnetic (TEM), Transverse Magnetic (TM) and Transverse Electric (TE) modes, cutoff frequency and dominant mode, Intrinsic Impedance, Power transmission and attenuation:- conductor loss and dielectric loss and Rectangular cavity resonator and its resonant frequency.

UNIT – IV (12 Hours)

Antenna: Concept of retarded potentials, Radiation Mechanism, types of antennas, power radiated by Hertzian dipole and its radiation resistance, qualitative analysis of half-wave dipole and quarter-wave monopole antenna, Antenna characteristics, Radiation Pattern, Beamwidth, Bandwidth, Radiation Intensity, Directive Gain, Directivity, Power Gain, Radiation Efficiency, Input Impedance, Effective Area and the Friis Transmission Equation.

Practical component (if any) – Transmission Lines, Antenna and Wave Propagation
(MATLAB/SCILAB /Any other softwares)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the phasor and its graphical representation for electromagnetic fields.
- Learn reflection and transmission of plane electromagnetic wave.
- Represent graphically various parameters of transmission line.
- Plot field configuration for different modes of the waveguide.
- Understand the radiation pattern and other characteristics of an antenna.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a plane wave
3. Program to find the electric and magnetic fields of reflected and transmitted wave at the interface of different types of media
4. Program to find the characteristic impedance and the phase constant of a distortionless line
5. Program to find the power dissipated of the lossy transmission line
6. Program to find the total power transmitted through the lossless transmission line
7. Program to plot the field configuration for TE and TM modes in waveguide
8. Program to determine the operating range of frequency for TE10 mode of air filled rectangular waveguide
9. Program to determine Directivity, Bandwidth and Beamwidth of an antenna.
10. Program to plot the radiation pattern of a Hertzian dipole and calculate its radiation resistance.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press (2001)
2. Karl E. Longren, Sava V. Savov, Randy J. Jost., Fundamentals of Electromagnetics with MATLAB, PHI
3. J. A. Edminister, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
4. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
5. G. S. N. Raju, Antennas and Propagation, Pearson Education (2001) Transmission Lines,

Suggestive readings

1. W. H. Hayt and J.A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
2. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)

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 OFFERED BY THE DEPARTMENT

GENERIC ELECTIVES (GE-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		
Microcontroller Systems	**4**	**3**	**-**	**1**	**Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices**	**Basic C language program-ming**

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand architecture of Microcontroller.
- Write assembly language / C programs for the microcontroller.
- Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory and I/O.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the concepts related to architecture of microcontrollers
- Demonstrate knowledge of the development tools for a microcontroller, and write assembly language code according to specifications
- Design systems for common applications like general I/O, counters, data acquisition etc.
- Interfacing the external devices to the controller according to the user requirements to create novel products and solutions for the real - time problems.

SYLLABUS OF ELGE-6A **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Introduction to microcontroller: Introduction to Microcontroller based system, Difference between Microprocessor and Microcontroller, Classification of microcontrollers based on architecture and Instruction Set (Overview of Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers), Microcontroller Features - Brown out Detector, Watch Dog Timer.

UNIT – II (12 Hours)

Architectural Overview of AVR Microcontroller: Block diagram description of ATMEGA32, Pin Description of ATMEGA32, AVR status register, General Purpose Register File, X, Y & Z registers, Stack Pointer, System Clock and Clock Options in AVR, System Control and Reset, Sleep Modes, AVR ATmega32 Memories: Flash Program Memory, SRAM Data Memory, EEPROM Data Memory & I/O Memory.

UNIT – III (11 Hours)

Instruction set of AVR Microcontroller: Addressing modes, Instruction set of AVR microcontroller, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, Bit manipulation instructions, MCU Control Instructions, Simple programs in Assembly Language / C Language

UNIT – IV (11 Hours)

AVR on-chip peripherals: General purpose I/O Ports, AVR I/O Port Programming, Introduction to interrupts, External interrupts, 8 and 16-bit Timers, Timer programming.

Practical component (if any) – Microprocessor System
(Hardware and AVR Studio/ Other suitable IDE)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Be proficient in use of IDE‘s for assembly/ C programming for the microcontroller.
- Interface various I/O devices to provide solutions to real-world problems.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to transfer a block of data.

2. Program to find the sum/subtraction of two 8-bit numbers.
3. Program to find the sum of N 8-bit numbers.
4. Program to find multiplication/ Division of two 8-bit numbers.
5. Program to find smallest of N numbers
6. Program to find the square root of 8-bit number.
7. Program to sort the numbers in ascending/ descending order.
8. Flash LED at observable rate.
9. Interface Input Switches and output LEDs.
10. Interface 7 segment display.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Programming and Customizing the AVR Microcontroller, By Dhananjay Gadre, McGraw Hill Education

Suggestive readings

1. The AVR Microcontroller and Embedded Systems Using Assembly and C, By Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Pearson Education.
2. AVR ATmega32 data sheet- ATMEL Corporation

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

GENERIC ELECTIVES (GE-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		
Arduino/ Rpi App Development	4	2	-	2	Class XII passed with Maths/Applied Maths	Basic C language programming

Learning Objectives

This course introduces the student to the fundamental understanding of Arduino/Rpi processors. After completion of this course students should be well versed in programming the microcontroller. They should be able to use various sensors and make microcontroller respond to the external environment.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concepts of Arduino Uno / Raspberry Pi and the programming environments.
- Understand digital and analog ports of a microcontroller and their usage.
- Understand the working of various sensors and their application in robotics.
- Design different circuits and display their outputs using LCD and other indicator

SYLLABUS OF ELGE-6B Total Hours- Theory: 30 Hours, Practicals: 60 Hours

UNIT – I (8 Hours)

Basic functionality of the Arduino/ Rpi board and its processor, Setting and configuring the board: Pin diagram of Arduino/Rpi development board, Integrated Development Environment (IDE), IDEs like AVR Studio, WIN AVR, ARM 11, Installing and configuring for Robot programming, In System Programmer (ISP), loading programs on Robot, Differentiating Arduino board from Rpi board.

UNIT – II (8 Hours)

Introduction of Embedded C Programming and programming concepts for Arduino/ LINUX for Rpi, Digital Ports: Data Read and Write, Interfacing LEDs, Buzzer, Switches, 7 segment displays, LED dot matrix, Traffic lights, Introduction to 2 x 16 Characters LCD, Basic LCD control, Displaying message on LCD.

UNIT – III (6 Hours)

Sensors: IR range sensor of different range, Analog IR proximity sensors, Ultrasound scanner, LDR, Gyroscope and Accelerometer, Magnetometer, GPS receiver.

UNIT – IV (8 Hours)

Communication with Arduino/ Raspberry Pi : Wired RS232 (serial) Communication, Wireless ZigBee Communication, USB Communication, Simplex infrared Communication (IR remote to robot), Reading and writing to SD card.

Practical component (if any) – Arduino/Rpi App Development
(Supporting IDE)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with the Arduino/Rpi microcontroller development boards.
- Understand interfacing of various display devices viz. 7-segment display, LED dot matrix, LCD.
- Understand various sensors, their applications and designing control experiments using

LIST OF PRACTICALS (Total Practical Hours- 60 Hours)

1. To blink an LED/interface a Buzzer using a digital pin of the processor.
2. To display binary count on LEDs using digital port of the processor.
3. To display decimal count on a 7-segment display.
4. To read data from a digital port of the processor and then display it on other digital port.
5. To print a message on LCD.
6. To display different patterns on LED dot matrix.
7. To read the voltage of a potentiometer using analog port of the processor and depict the variation on LEDs/LCD.
8. To interface IR proximity sensor to determine if some obstacle is nearby.
9. To interface Ultrasonic sensor to determine if some object is in the facing direction.
10. To interface LDR and display if its dark or bright on 7 segment/LCD.
11. To design a Traffic Light System
12. To design a Voice Control Home Automation
13. To design a PWM based variable system
14. To design a wireless appliance controlling system.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than twelve.

Essential/recommended readings

1. Michal Mc Roberts “Beginning Arduino” Second Edition, Technology in Action
2. Massimo Banzi, “Getting started with Arduino” 2nd Edition, Orelly 2011
3. Richard Blum, “ Arduino Programming in 24 Hours”, Pearson Education, 1st edition, 2015.

Suggestive readings

1. Simon Monk, “Raspberry Pi Cookbook: Software and Hardware Problems and Solutions”, O'Reilly Reprints; Second edition 2016

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

SEMESTER-IV
DEPARTMENT OF INSTRUMENTATION
Category I

(B.Sc. Honours in Instrumentation)

DISCIPLINE SPECIFIC CORE COURSE – 10: Biomedical Instrumentation (INDSC4A)

CREDIT 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		
Biomedical Instrumentation (INDSC4A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Sensors and Transducers

Learning Objectives

The Learning Objectives of this course are as follows:

- To identify and describe various biomedical signals.
- To describe the origin of biopotentials and explain the role of biopotential electrodes.
- To understand the synchronization between the physiological systems of the body.
- To understand the basic measurement principles behind biomedical instrumentation.
- To realize the working principle of numerous biomedical imaging techniques.
- To analyze the applications of biosensing in different domains of healthcare.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Analyze the origin of various bioelectric signals (ECG, EEG) and the method of recording using different types of electrodes.
- Develop basic knowledge about the Cardiovascular, respiratory and nervous systems.

- Develop an understanding of the measurement principles of medical instrumentation including measurement of respiratory function, cardiac variables, blood pressure as well as medical devices.
- Design various biomedical instruments with the help of respective transducers.

SYLLABUS OF DSC-10

Unit-1 **(10 Hours)**

Biopotentials, Bio amplifiers, and Bioelectrodes: Introduction to bio-electric potential, bio- amplifier, components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms, and transducers to measure various physiological events, types of bio-potential electrodes (Body surface electrodes, Internal electrodes, Microelectrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes

Unit-2 **(13 Hours)**

Cardiac vascular system & measurements: ECG: origin, Instrumentation, the bipolar system lead system I, II, III, Einthoven's triangle, Augmented lead system, unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Pacemakers- Internal, External

Unit-3 **(11 Hours)**

Respiratory Measurement Systems: Types of volume, types of measurements, Instrumentation of respiratory system, principle & types of pneumograph, Spirometer, pneumotachometers, nitrogen washout technique

Unit-4 **(11 Hours)**

Nervous system: Action potential of the brain, brain wave, Instrumentation of Electroencephalography (EEG), electrodes used for recording EEG analysis. Conventional X-ray, properties, generation of X-ray, Thermal imaging system, working, IR detectors, applications.

Practical component: **(30 hours)**

1. Characterization of biopotential amplifier for ECG signals.
2. Study on ECG simulator.
3. Recording of EEG.
4. Measurement of blood pressure and measurement of heart sound using a stethoscope.
5. Study of pulse rate monitor with alarm system.
6. Determination of pulmonary function using a spirometer.
7. Measurement of respiration rate using thermistor /other electrodes.
8. Study of Respiration Rate monitor/ apnea monitor.

Essential/recommended readings

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, 2nd Edition, Prentice Hall (2010).
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education Inc (2010).
3. Khandpur R.S., Handbook of Biomedical Instrumentation, 2nd Edition, Tata McGraw-Hill Publishing (2009).
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2015), 4th edition, Volume 1.

Suggestive readings

1. Richard Aston, Principles of Biomedical Instrumentation & Measurement, 1st edition, Merrill Publishing Company (1990).
2. Mandeep Singh, Introduction to Biomedical Instrumentation, 2nd Edition, PHI learning private limited (2014).

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: Machine Learning (INDSC4B)

CREDIT 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		
Machine Learning (INDSC4B)	**04**	**02**	**-**	**02**	**Class XII passed with Physics + Mathematics /Applied Mathematics + Chemistry/ Computer Science/Informatics Practices**	**Understanding of Mathematics & programming language**

Learning Objectives

The Learning Objectives of this course are as follows:

- Students have an understanding of issues and challenges of Machine Learning.
- Students should be able to select data, model selection, model complexity etc.
- Understanding of the strengths and weaknesses of many popular machine learning approaches.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Understand machine learning techniques and computing environments that are suitable for the applications under consideration .
- Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.
- Implement various ways of selecting suitable model parameters for different machine learning techniques.
- Integrate machine learning libraries, and mathematical and statistical tools with modern

- technologies like hadoop distributed file system and mapreduce programming model
- Familiarize with Simple Linear Regression and Logistic Regression.
- Appreciate the various nuances of Multiple Regressions and Model Building.
- Identify and apply the Classification algorithms.
- Apply the Clustering algorithms for developing applications

SYLLABUS OF DSC-11

UNIT – 1 **(8 hours)**

Introduction to Machine Learning: varieties of machine learning, Supervised Learning, Unsupervised Learning, Reinforcement Learning. Dimensionality Reduction, Subset Selection, Shrinkage Methods, Principal Components Regression: Linear Classification, Logistic Regression, Linear Discriminant Analysis, Optimization, Classification-Separating Hyperplanes Classification.

UNIT – 2 **(8 hours)**

Learning input/output functions, sample application. Boolean functions and their classes, CNF, DNF, decision lists and Bias – Variance, Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods.

UNIT – 3 **(8 hours)**

Artificial Neural Networks (Early models, Back Propagation, Initialization, Training & Validation) Parameter Estimation (Maximum Likelihood Estimation, Bayesian Parameter Estimation) Decision Trees: ID4, C4.5, CART, Evaluation Measures, Hypothesis Testing.

UNIT – 4 **(6 hours)**

Clustering, Gaussian Mixture Models, Spectral Clustering, Ensemble Methods Learning Theory, Graphical Models.

K-Nearest Neighbors: Computational geometry; Voronoi Diagrams; Delaunay Triangulations K-Nearest Neighbor algorithm; Wilson editing and triangulations. Aspects to consider while designing K-Nearest Neighbor, Support Vector Machines and its classifications. Linear learning machines and Kernel space, Making Kernels and working in feature space.

Practical component: **(60 hour)**

Hardware requirement: i5 Processor, 8GB RAM, Internet Connection

Software Environment: IDE recommended PYCHARM (Recommended), JUPYTER, VISUAL STUDIO

1. Introduction to pandas and NumPy
2. Prediction based on different dataset: Vegetable Quality Prediction, Housing Price Prediction, Air Quality Prediction, Car Price Prediction

3. Prediction of diseases e.g. Liver Disease Prediction, Heart Disease Prediction, Crop disease.
4. Credit Default Prediction, Airline Passengers Prediction, Stock Price Prediction.
5. Bank Marketing, Media Content Problem, Online Retail Case Study
6. Energy Efficiency Analysis, Movie Sentiment Analysis, Car Evaluation
7. Program to demonstrate Simple Linear Regression
8. Program to demonstrate Logistic Regression using SCIKIT learn
9. Program to demonstrate Logistic Regression
10. Program to demonstrate k-Nearest Neighbor flowers classification
11. Program to demonstrate Decision Tree – ID3 Algorithm
12. Program to demonstrate Naïve- Bayes Classifier
13. Program to demonstrate Back-Propagation Algorithm
14. Program to demonstrate k-means clustering algorithm
15. Program to demonstrate K-Means Clustering Algorithm on Handwritten Dataset
16. Program to demonstrate K-Medoid clustering algorithm
17. Program to demonstrate DBSCAN clustering algorithm
18. Program to demonstrate SVM based classification
19. Program to demonstrate PCA on face recognition
20. Program to demonstrate PCA and LDA on Iris dataset
21. Mini Project works shall be given with a batch of four students considering different datasets such as digit dataset, face dataset, flower dataset and micro-array dataset.

Essential/recommended readings

1. Introduction to Machine learning, Nils J.Nilsson
2. Pattern Recognition and Machine Learning. Christopher Bishop. First Edition, Springer, 2006.
3. Pattern Classification. Richard Duda, Peter Hart and David Stock. Second Edition, Wiley-Interscience, 2000.
4. Machine Learning. Tom Mitchell. First Edition, McGraw-Hill, 1997.
5. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.

Suggestive readings

1. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.
2. Tom M. Mitchell, “Machine Learning”, McGraw-Hill, 2010
3. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995.

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: Optical Instrumentation (INDSC4C)

CREDIT 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		
Optical Instrumentation (INDSC4C)	**04**	**03**	**-**	**01**	**Class XII passed with Physics + Mathematics/ Applied Mathematics + Chemistry/ Computer Science/Informatics Practices**	**Optics and Electronics**

Course Learning Objectives

The Learning Objectives of this course are as follows:

- To understand concepts of light and optical effects
- To impart in-depth knowledge of opto-electronic devices and optical measurements
- To provide basic knowledge of interferometry and refractometers
- To introduce the concept of optical fiber-based sensing and measurements

Course Learning Outcomes

The Learning Outcomes of this course are as follows:

- Explain different light phenomenon, optical effects and their applications
- Design photo detector circuits using LED and Lasers as sources
- Understand the optical measurements using interferometers
- Analyze Fiber optic fundamentals and Measurements

SYLLABUS OF DSC-12

Unit-1 **(12 hours)**

Light as Source and optical effects: Concept of light, coherent and incoherent light sources, classification of different light phenomenon (interference, diffraction and polarization), Diffraction grating, Electro-optic effect, Acousto-optic effect and Magneto-optic effect.

Unit-2 **(12 hours)**

Opto–Electronic Devices: Light emitting diode (LED), Materials used to fabricate LEDs, Characteristics of LEDs, LED based optical communication, Lasers: Concept of laser (Spontaneous emission, stimulated emission and stimulated absorption), Ruby laser, He-Ne laser, semiconductors laser. Detectors: Photo diode, PIN diode, Photo-conductors, Solar cells.

Unit-3 **(10 hours)**

Interferometry for optical measurements: Michelson's Interferometer and its application, Rayleigh's interferometers, Abbe Refractometer, Fabry-Perot Interferometer, Holography: Concept of holography in brief (Recording and reconstruction).

Unit-4 **(11 hours)**

Optical Fiber for sensing and measurements: Step index and graded index fibers, Single and multi-mode fibers, Characteristics of optical fiber, Fiber losses, Fiber optic communication system, Dispersion measurement, Active and passive optical fiber sensors, Single mode fiber sensor, Fiber-optic refractive index sensor

Practical component: **(30 hours)**

1. To study characteristics of LED
2. To determine the slit width using He-Ne laser
3. To determine the wavelength of monochromatic source using Michelson interferometer.
4. Determine the numerical aperture and bending loss of optical fiber
5. To find the wavelength of a laser using transmission diffraction grating
6. To measure the intensity pattern of a single slit using He-Ne laser
7. To find the I-V characteristics of a solar cell
8. To measure the refractive index of the prism using a spectrometer.

Essential/recommended readings

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2008)
2. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)
3. E. Hecht, Optics, Pearson Education Ltd. (2002)
4. Rajpal S. Sirohi, Wave Optics and its Application, 1st ed. (2001)
5. Pollock, Fundamentals of OPTOELECTRONICS, (1994)
6. Photonic Devices and Systems –by Robert G. Hunsperger, Taylor & Francis, 1994,
7. G. Hebbar, "Optical Fiber Communication", Cengage

Suggestive reading

1. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice H. India (1996)

2. Ghatak A.K. and Thyagarajan K., “Introduction to fiber optics,” Cambridge Univ.Press. (1998)
3. 10. A. Yariv, Optical Electronics/C.B.S. College Publishing, New York, (1985)

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVE: Linear Integrated Circuits (INDSE4A)

CREDIT 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		
Linear Integrated Circuits(INDSE4A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics+ Chemistry / Computer Science/Informatics	Understanding of Analog electronics & Operational Amplifiers

Learning Objectives

The Learning Objectives of this course are as follows:

- Familiarity and designing of various non-linear circuits using op-amp
- Familiarity and designing of multivibrators using 555 timer.
- Use of op-amp in designing of D/A and A/D convertors.
- Familiarity with different Linear ICs like 380, 555, 565, 566, 78xx and 79xx.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Design and explain the working of log & anti-log amplifier, analog multiplier and precision rectifier using op-amp.
- Design and explain the working of D/A and A/D convertors using op-amp.
- Design and explain the working of different types of multivibrators using IC 555.
- Use the regulator ICs for regulation purposes.

SYLLABUS OF DSE-2

UNIT – 1 **(12 hours)**

Sample and hold circuits, logarithmic amplifiers, antilogarithmic amplifiers, analog multipliers, Precision rectifier circuit: Half wave rectifier, full wave rectifier, bridge rectifier, peak rectifier, clipper, clamping, and applications of precision rectifier circuits.

UNIT – 2 **(12 hours)**

D/A convertor: Binary weighted resistors, R/2R resistor. A/D convertor: Successive approximation.

Power Amplifiers: Monolithic power amplifier (IC 380), use of power boosters (IC 3329/03), application of power amplifiers

UNIT – 3 **(12 hours)**

Multivibrators (IC 555): Pin and block diagram, Astable and monostable multivibrator circuit, applications of astable and monostable multivibrators.

Phase locked loops (PLL): Block diagram, operating principle, phase detector types, monolithic phase locked loops (IC565). Application of PLL IC 565: Frequency multiplier and frequency shift keying. Voltage controlled oscillator (IC 566).

UNIT – 4 **(9 hours)**

Voltage Regulators IC: Fixed voltage regulator (IC 78xx and IC 79xx), adjustable voltage regulator (IC 317 and IC 337), switching regulator (IC 1723) and special regulator.

Practical component: **(30 hours)**

1. Designing of precision half wave rectifier circuit.
2. Designing of precision full wave rectifier circuit.
3. Designing of precision positive and negative clipper circuit.
4. Designing of precision positive and negative clamper circuit.
5. Designing of binary weighted D/A convertor OR R/2R resistor D/A convertor
6. Design an astable multivibrator using IC 555.
7. Design a monostable multivibrator using IC 555.
8. Design a voltage regulator circuit using voltage regulator IC.

Essential/recommended readings

1. Skoog &Lerry, Instrumental Methods of Analysis, Saunders College R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education 4th Edition, May 2015.

2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2001).
3. J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).
4. A.S. Sedra and K.C. Smith, Microelectronics Circuit, Oxford (2011).

Suggestive readings

1. A.P.Malvino, David J Bates, Electronic Principals, 7th Edition, Tata McGraw-Hil Education, (July 2017).

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

DISCIPLINE SPECIFIC ELECTIVE: Statistical Tools and Techniques (INDSE4B)

CREDIT 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 Tools and Techniques (INDSE4B)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics/Biology+ Chemistry / Computer Science/Informatics	Class X Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the students' ability to deal with numerical and quantitative issues in industries.
- To enable the use of statistical, graphical, and algebraic techniques wherever relevant.
- To have a proper understanding of Statistical applications in different fields.
- To identify and discuss critically, the uses and limitations of statistical analysis.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- Describe and discuss the key terminology, concepts tools, and techniques used in statistical analysis
- Understand the concept of probability and sampling distributions

- Perform different parametric and non-parametric tests for various statistical analysis.

SYLLABUS OF DSE-02

Descriptive statistics: Graphical and Tabular representation of data. Measures of Central Tendency, Measures of Dispersion, Measures of Skewness and Kurtosis.

Unit-1 **(13 hours)**

Correlation and Regression: Linear Regression and Correlation.

Unit-2 **(12 hours)**

Probability and Distributions: Introduction to probability, Experiment, sample space, event, probability, conditional probability, Baye's Theorem, Random Variables, Probability Distributions- Normal, Binomial, Poisson, Mathematical Expectation.

Unit-3 **(10 hours)**

Sampling and Sampling Distributions: Sampling distributions and Standard errors. One and two-sample estimation of means and proportions. One and two-sample tests of hypothesis- means, proportions and variances, t-test, Chi-square test.

Unit-4 **(10 hours)**

Nonparametric Statistics: Nonparametric tests, Sign test, Signed-Rank test, Rank-Sum test, Kruskal-Wallis test, Runs test.

Practical component: **(30 hours)**

1. Collection, tabulation, and statistical interpretation of data.
2. To study measures of central tendency- mean, median, mode.
3. To study measures of dispersion- range, standard deviation, variance.
4. To study the coefficient of variation.
5. To study measures of skewness.
6. To study the continuous and discrete distribution.
7. To study nonparametric tests.

Essential/recommended readings

1. Probability and Statistics for Engineers and Scientists by Walpole, Myers, Myers and Ye, 9th Edition, Pearson Education, 2012.
2. Mathematical Statistics and Applications by John E. Freund, 8th Edition, Prentice Hall, India, 2014.
3. Introduction to Statistical Quality Control by Montgomerry, 8th Edition, John Wiley and Sons, 2019.

Suggested Books:

4. Principles of Biostatistics by M. Pagano and K. Gauvrean: Thompson learning (2nd edition); 2018.
5. Biostatistics: A Foundation for Analysis in the Health Sciences by W. W. Daniel and Chad L. Cross; John Wiley and Sons Inc (11th edition); 2018 .

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

DISCIPLINE SPECIFIC ELECTIVE: Virtual Instrumentation (INDSE4C)

CREDIT 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		
Virtual Instrumentation Techniques and Applications (INDSE4C)	04	02	-	02	Class XII passed with Physics + Mathematics/Applied Mathematics+ Chemistry / Computer Science/Informatics	Electronic Instruments & programming language

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the importance of Virtual Instrumentation and study its applications.
- To learn the basic programming concepts in LabVIEW.
- To understand the basics of data acquisition for designing a Virtual Instrument.
- To recognize the various building blocks of Virtual instrumentation and use them for PC-based Measurement.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the importance and applications of Virtual Instrumentation.
- Learn the basic programming concepts in LabVIEW.
- Recognize the components of Virtual instrumentation and use them for PC Based Measurement.

SYLLABUS OF DSE-02

Unit 1 **(6 hours)**

Introduction to Virtual Instrumentation: Historical perspective, advantages, Block diagram and Architecture of a Virtual Instrument, Data Flow Techniques, Graphical programming in the data flow, comparison with Conventional programming.

Unit 2 **(10 hours)**

LabVIEW Programming Environment: Basic operations, Controls/ Indicators, Auto indexing, Debugging, Timing issues (counters).

VI Programming Techniques: Modular programming: VIS and sub-VIS, loops, Arrays, Clusters, Graphs, Charts, Case & Sequence structures. Formula nodes, Local and Global variables, String & file input.

Unit 3 **(10 hours)**

Instrument Control: GPIB Communication, Instrument I/O Assistant, Virtual Instrument Software Architecture (VISA), Instrument Drivers, Serial Port Communication

Data Acquisition Basics: Signals Handling and Classification, Signal Conditioning, Analog Interfacing (I/O), Counters & Timers, Digital (I/O) - DAQ Hardware, DAQ Software Architecture, DAQ Assistant

Unit 4 **(4 hours)**

Developing applications on LabVIEW: Process control, Waveform generator, Motion control using a stepper motor.

Practical Components **(60 hours)**

1. The length and breadth of a rectangle and the radius of a circle are inputs. Build a VI to calculate the area and perimeter of the rectangle and the area and circumference of the circle.
2. Convert a binary number to a decimal number.
3. Compute the equations (X1 + 2)*3 and 5 + X2*log(X2) using functions, Expression node, and Express Formula for the given inputs X1 and X2.
4. Build a VI to find the factorial of a number.
5. Create a VI to find the sum of first n natural numbers using a While Loop with a feedback node.
6. Write a program in LabVIEW to read a positive number n and to generate the following number series using (a) a For Loop and (b) a While Loop
   1, 22, 32, 42, …, n2
   0, 2, 4, 6, …, n
7. Create a VI to compare the element of two clusters if the value of the corresponding element is the same switch on LED in the output cluster.
8. Build an array of cluster controls in which each cluster consists of a numeric control and a 1D numeric array (with 5 elements). This forms a database of marks of students. The numeric control indicates the roll number and the array indicates the test marks of five subjects. Build logic to modify the mark in a particular subject of a particular student. Input the roll number, the subject in which the mark is to be changed, and the new marks. Display the changed database on a separate array indicator.
9. Create a 1D numeric array that consists of ten elements and rotate it ten times. For each rotation display the equivalent binary number of the first array element in the

form of a Boolean array. Also, display the reversed Boolean array. Provide delay to view the rotation.

10. Create two 2D numeric arrays and add them. Change the number of rows and number of columns of each array and see the result.
11. Create a 1D array and find its reverse.
12. Build a VI to plot a circle in the XY graph using a For Loop.
13. Build a VI that generates a 1D array of random numbers and sort the ascending descending array and also find the max. and min. value array element.
14. Build a cluster control that consists of a seven-segment LED display, a switch, a string control, and numeric control. Split the cluster elements using the Unbundle function and alter the values of some of the cluster controls. Bundle them again and display them in a cluster indicator.
15. Using a for loop determines the number of odd numbers between a range of numbers entered by the user.
16. Write a for loop which takes the given values of u from a numeric control labeled coefficient of kinetic friction. Calculate f‟ from theta=0 to 90 degree in 1-degree increment then display the resulting array f‟ values on a waveform graph.
17. Create a VI to check whether the cluster elements are in range or not. Specify the upper and lower limits. Display the coerced output and a cluster of LEDs to indicate whether a particular cluster element is in the range or not.
18. Split an input string into two outputs with reference to a separating character. Find the length of the input string and reverse the string.
19. Write a program to solve x2+bx+c=0.
20. Build a VI to generate two waveforms of different amplitude and frequency add the signal to find the resultant and plot it on the separate waveform graph.

Essential/recommended readings

1. John Essick , Hands-on Introduction to LabVIEW for Scientists and Engineers, 3rd Edition, 2015.
2. Gary Johnson, LABVIEW Graphical Programming, McGraw Hill, 4th Edition, 2006.
3. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI, 3rd Edition, 2006.
4. James K, PC interfacing and data acquisition, 2002.
5. Skolkoff, Basic concepts of LABVIEW 4, PHI, 1998.

Suggested Books

1. Technical Manuals for DAS Modules of Advantech and National Instruments. L.T. Amy, Automation System for Control and Data Acquisition, ISA, 4thEdition, 1992.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2nd Edition, 1994.

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 OFFERED BY THE DEPARTMENT

GENERIC ELECTIVE: Signal and image processing (INGE4A)

CREDIT 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		
Signal and image processing (INGE4A)	04	03	-	01	Class XII passed with Mathematics/ Applied Mathematics/ Computer Science/Informatics Practices	Engineering Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the fundamental concepts of signal and Image processing.
- To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
- To apply processing techniques on 1-D and Image signals.
- To apply signal and image processing techniques for edge detection.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the concept of DT Signal and DT Systems.
- Classify and analyze discrete time signals and systems
- Implements Digital Signal Transform techniques DFT and FFT.
- Use the enhancement techniques for digital Image Processing
- Differentiate between the advantages and disadvantages of different edge detection techniques
- Develop small projects of 1-D and 2-D Digital Signal Processing.

SYLLABUS OF GE-4

UNIT – 1 **(12 hours)**

Discrete Time Signals and Systems: Introduction, discrete time sequences, Examples of sequences – step, impulse, ramp, sine and exponential, properties of signals and sequences, interpolation and decimation, linear time invariant systems and their properties, stability, causality, system responses, convolution and correlation, sum, solutions of system using difference equations, ZIR, ZSR, natural and forced responses. Z-Transform.

UNIT – 2 **(11 hours)**

Discrete Fourier Transform: Introduction to DTFT and DFT, Relation between DFT and DTFT, IDFT, Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties. Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT.

UNIT – 3 **(11 hours)**

Fast Fourier Transform: Need of FFT, Radix-2 DIT-FFT algorithm, DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm. Spectral Analysis using FFT. FIR and IIR filter.

Representation of Digital Image, Image File Formats, Fundamental steps in Digital Image Processing, Elements of visual perception, Image sensing and Acquisition, Image Sampling and Quantization, Imaging geometry.

UNIT – 4 **(11 hours)**

Image Enhancement:

Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations Histogram Processing – Smoothing spatial filters- Sharpening spatial filters.

Frequency Domain: Smoothing frequency domain filters- sharpening frequency domain filters Homomorphic filtering, Image Compression and Image Segmentation

Practical component: **(30 hours)**

1. (a) Represent basic signals like:Unit Impulse, Ramp, Unit Step, Exponential.
   (b) To generate discrete sine and cosine signals with a given sampling frequency.
2. (a) To represent complex exponentials as a function of real and imaginary parts.
   (b) To determine impulse and step response of two vectors using MATLAB.
3. (a) To perform convolution between two vectors using MATLAB.
   (b) To perform cross correlation between two vectors using MATLAB.

4. To compute DFT and IDFT of a given sequence using MATLAB.
5. To perform linear convolution of two sequences using DFT using MATLAB.
6. (a) To determine z-transform from the given transfer function and its ROC using MATLAB.
   (b)To determine rational z-transform from the given poles and zeros using MATLAB.
7. To determine partial fraction expansion of rational z-transform using MATLAB
8. Implementation of Image negative, Gray level Slicing and Thresholding
9. Implementation of Contrast Stretching, Dynamic range compression & Bit plane Slicing
10. Implementation of Histogram Processing, Image smoothing/ Image sharpening

Essential/recommended readings

1. John G. Proakis, Dimitris and G.Manolakis, 'Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, 'Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009.
4. S. Sridhar, 'Digital Image Processing', Oxford University Press, Second Edition, 2012.

Suggestive readings

1. Sanjit K Mitra, 'Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
2. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, 'Digital Signal Processing', Tata McGraw Hill Publication 1st Edition (2010).
3. S. Jayaraman, E. Esakkirajan and T. Veer Kumar, 'Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
4. Anil K. Jain, 'Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

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

GENERIC ELECTIVE : Nuclear and Biomedical Instrumentation (INGE4B)

CREDIT 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 Biomedical Instrumentation (INGE4B)	04	03	-	01	Class XII passed with Physics+ Mathematics/Applied Mathematics/ Biology + Chemistry	Chemistry & Analog Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To gain the basic technical knowledge of biomedical instrumentation.
- To familiarize with various bioelectric signals and understand their source of generation.
- To understand the working principle and applications of medical imaging instruments and the modalities involved in each technique.
- To apprehend the essential operation of the nuclear medicine system.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn the technical vocabulary associated with basic instrumentation and design and fundamental signal analysis
- Develop a clear understanding of the various bioelectric signals produced by the body which could be obtained and analyzed using the basic implementation of Instrumentation
- Explain and compare the origin, instrumentation, and analysis of biological signals produced by the cardiovascular, respiratory, and nervous system

- Understand the basic difference between the working principle, instrumentation, and application of different medical imaging systems such as ultrasound, X-ray, and Computed tomography
- Infer the measurement principle and operating conditions of various detectors used in a nuclear medicine system

SYLLABUS OF GE-4

UNIT – 1 **(7 hours)**

Introduction to bioelectric potential, bio-amplifier, components of man Instrument system, design factors of biomedical instruments, types of biopotential electrodes.

UNIT – 2 **(14 hours)**

Measurement of Biopotentials: Cardiac vascular system, Origin of (Electrocardiography) ECG signals, Instruments of ECG, bipolar system lead system I, II, III, Einthoven's triangle, Augmented lead system, unipolar chest lead system, types of display.

The nervous system, Action potential of the brain, brain wave, Instrumentation Electroencephalography (EEG).

Measurement of Physiological Parameter: Respiratory system, Types of volume, types of measurements, Instrumentations of the respiratory system, pneumograph, principle & types of pneumograph, Spirometer.

UNIT – 3 **(14 hours)**

Medical Imaging System: Ultrasound, properties, beam width, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, and M Scan

Radiography: Conventional X-ray, properties, generation of X-ray, X-ray Computed Tomography (CT scanner), and Computer-aided tomography (CAT).

UNIT – 4 **(10 hours)**

Medicine System: Introduction to nuclear medicine system, safety aspects, Nuclear detectors, Gas filled detectors: Ionization, Proportional, and Geiger Muller (GM) Counter, Scintillation counter – principle, operating condition.

Practical component: **(30 hours)**

1. Characterization of biopotential amplifier for ECG signals.
2. Study on ECG simulator.
3. Recording of EEG.
4. Heart sound measurement using an electronic stethoscope.
5. Study of pulse rate monitor with alarm system.
6. Determination of pulmonary function.
7. Study on ultrasound transducers based on the medical systems.
8. Study of Respiration Rate monitor/ apnea monitor.
9. Study of conventional X-ray and CT film.

Essential/recommended readings

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall, 2nd edition, 2010.
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education, Inc, 4th edition, 2010.
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing, India, 2nd edition, 2009.
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, 4th Edition (2015), Volume 1, IEEE Press.

Suggestive readings

1. Richard Aston, Principles of Biomedical Instrumentation & Measurement, 1st edition, Merrill Publishing Company (1990).
2. Mandeep Singh, Introduction to Biomedical Instrumentation, 2nd Edition, PHI learning private limited (2014).

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

SEMESTER-V
DEPARTMENT OF INSTRUMENTATION
Category I

(B.Sc. Honours in Instrumentation)

DISCIPLINE SPECIFIC CORE COURSE – 13: Advance Biomedical Instrumentation (INDSC5A)

CREDIT 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		
Advance Biomedical Instrumentation (INDSC5A)	04	02	-	02	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Biomedical & Electronic Instrumentation

Learning Objectives

The Learning Objectives of this course are as follows:

- To realize the importance of the instruments used in critical care units of the hospital.
- To understand the principle behind the measurement of biochemical signals.
- To understand the concept of instruments used in medical imaging diagnostics and therapeutics.
- To appreciate the efficiency of the surgical and diathermy apparatus in the medical incision.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand instruments used in critical care and operating units of hospitals
- Gain knowledge of the instruments used for biochemical analysis in healthcare
- Understand the concepts of various medical imaging techniques and their applications

- Understand instruments used for medical assistance and therapy

SYLLABUS OF DSC-13

Unit-1 **(8 Hours)**

Ventilators: Basic principles and types of ventilators.

Anaesthesia Machine: Need of anaesthesia, anaesthesia delivery system, breathing circuits. **Clinical Laboratory Instruments**: General principle and working of Blood Gases Analyzer, Auto-analyser, Blood Cell Counters, ELISA reader.

Unit-2 **(8 Hours)**

Medical Imaging System: Ultrasound, properties, its generation & detection, types of transducers, real-time ultrasonic imaging, linear array scanners, X-ray computed tomography (CT Scanner) principle, contrast scale, scanning system, processing Unit, viewing, storage. Magnetic Resonance Imaging: Basic principle, working and construction.

Unit-3 **(6 Hours)**

Nuclear Medicine System: radioactive emissions, gamma camera, imaging system, ECT (emission coupled tomography) and its different approaches: positron emission tomography (PET), Single-photon emission computed tomography (SPECT).

Unit-4 **(8 Hours)**

Surgical Scopy and Diathermy Equipments: Fibre Optics- Endoscopes -light sources, video processors, camera, and fibre optic cable, Principles and applications. Diathermy: Working Principle, Construction, and different types (Infrared radiation (IR), ultraviolet (UV), short wave, microwave, ultrasonic, and Surgical Diathermy).

Practical component: **(60 Hours)**

1. Study of ultrasound transducers based on the medical system.
2. Study of vital organs (such as Heart, Kidney, liver, etc) using Ultrasonography.
3. Demonstration of X-ray/Computed Tomography/nuclear imaging.
4. Experiment based on clinical instruments such as Blood cell counter/ ELISA reader.
5. Estimation of serum total protein using a spectrometer.
6. Estimation of sodium and potassium in blood serum or urine sample.
7. Project based on designing and applications of Biomedical Instrumentation.

Essential/recommended readings

1. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2010), 2nd edition
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata McGraw- Hill Publishing (2009), 2nd edition

3. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2015), 4th edition, Volume 1.
4. Richard Aston, Principles of Biomedical Instrumentation & Measurement, Merrill Publishing Company, (1990), 1st edition
5. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2014), 2nd Edition.
6. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2nd Edition.

Suggestive readings

1. John G Webster, Medical Instrumentation Applications and Design, John Willey, 5th Edition, 2020.
2. L A Geddes, L E Baker, Principles of Applied Medical Instrumentation, John Wiley, Edition 3, 1989.

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: Essentials of microprocessor 8085 & 8086 (INDSC5B)

CREDIT 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 microprocessor 8085 & 8086 (INDSC5B)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Digital Electronics

Learning Objectives

- To understand the general architecture of a microcomputer system
- To comprehend the architecture and organization of 8085 and 8086 microprocessor
- To learn the Interfacing of 8-bit microprocessor with memory and peripheral chips involving system design
- To interpret and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming
- To understand difference between RISC and CISC based microprocessors

Learning outcomes

- Describe the general architecture of a microcomputer system
- Understand the architecture and organization of 8085 and 8086 microprocessor
- Learn the Interfacing of 8-bit microprocessor with memory and peripheral chips involving system design
- Interpret and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming
- Differentiate between RISC and CISC based microprocessors

- Understand the architecture and operation of Programmable Interface Devices and realize the programming & interfacing of it with 8085 microprocessor

SYLLABUS OF DSC-14

Unit-1 **(15 hours)**

8085 Microprocessor: Introduction to Microprocessor 8085, Pin description of 8085, Architecture, registers of 8085, addressing modes. Instruction Type and Instruction Set, Machine Cycle, Instruction Cycle, Timing Diagram, Memory System, Hardware Interfacing or Types of I/O Addressing-Interfacing Memory and Peripheral (I/o Mapped I/O and memory mapped I/O)

Unit-2 **(10 hours)**

Programming: Assembly Language Programming, Stacks and Subroutine

Interrupts of 8085: Hardware and Software interrupts, Difference between RISC and CISC Processor

Unit-3 **(10 hours)**

Interfacing ICs: Programmable Peripheral Interface: 8255, 8253

Unit-4 **(10 hours)**

Introduction to 8086 Microprocessor: Introduction to microprocessor 8086: Architecture of 8086, Pin Diagram, Physical memory organization, Memory Segmentation (8086), General bus operation, Minimum and Maximum Mode, Addressing modes (8086), Difference between microprocessor and microcontroller.

Practical component: **(30 hours)**

1. To write an assembly language program to perform-addition, subtraction.
2. To write an assembly language program to find count of even numbers/odd numbers from given block of data.
3. To write an assembly language program to find largest/smallest number in given block of data.
4. To write an assembly language program to perform-multiplication, division.
5. To write an assembly language program to convert a number from one number system to another.
6. To perform addition/subtraction by interfacing 8085 with 8255 in simple I/O and polling mode.
7. To generate a square/rectangular wave by interfacing 8253 with 8085.
8. To write an assembly language program to generate first N terms of an A.P. series.
9. To write an assembly language program to generate first N terms of Fibonacci series.
10. To write an assembly language program to arrange the given list of number in ascending / descending order.

Essential/recommended readings

1. Ramesh Gaonkar, Microprocessors architecture, programming and Applications, WileyEastern Ltd. (2013), 6th Edition.
2. P.K Ghosh & P.R Sridhar, 0000 to 8085 microprocessor, John Wiley & Sons, 2nd Edition.
3. Liu Gibson, Microprocessor Systems: The 8086/8088 family Architecture, Programming&Design, PHI, 2015, 2nd Edition.
4. K. Udaya Kumar & B.S. Uma Shankar, The 8085 Microprocessor: Architecture, Programming, and Interfacing", Pearson Education, 1st Edition, 2008.
5. Barry B. Brey and C R Sarma, The Intel Microprocessors 8086/8088, 80186/80188, 80286,80386, 80606, Pearson Education Limited, 8th Edition, 2005.
6. K. M. Bhurchandi, *Advanced Microprocessors & Peripherals*. Tata McGraw-Hill Education, 2013.

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: Power devices and Electrical Machines (INDSC5C)

CREDIT 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		
Power devices and Electrical Machines (INDSC5C)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Semiconductor devices

Learning Objectives

The Learning Objectives of this course are as follows:

- Use of electronics for control and conversion of electrical power.
- To learn various high-power devices, their construction, and their applications.
- To understand the working, construction, and principle of DC and AC machines.
- To provide the clear understanding of working and construction of Transformer
- To give knowledge about different types of Power Supply.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand different power devices and study their construction, characteristics and turning on circuits.
- Understand the analysis of controlled rectifiers for different loads, inverters, DC choppers and AC voltage controllers.
- Familiarize with the basics of DC Machines, Generators and Motors.
- Acquire knowledge about fundamental of Transformer.

SYLLABUS OF DSC-15

Unit-1 **(13 Hours)**

Power Devices and their applications: SCR, structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Factors affecting the characteristics/ratings of SCR, and Gate-triggering circuits. Applications of SCR: Basic series inverter circuit, Chopper

circuit – Basic concept, step up and step-down choppers. Diac and Triac: Basic structure, working and I-V characteristic of, application of a Diac as a triggering device for a Triac.

Unit-2 **(13 Hours)**

Types of Motor: Comparison of the generator and motor action & interchangeability, the principle of operation, the significance of back EMF, maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors & applications, losses & efficiency, the necessity of motor starters, Three-point starter, Speed control of DC motors. Induction Motors, Single and three phase Motors, Stepper Motors, and Servo Motors.

Unit-3 **(10 Hours)**

Transformer: Types of transformers, Transformer Construction, E.M.F. equation, Transformer Losses, Condition for maximum efficiency, all day efficiency, Auto transformers.

Unit-4 **(9 Hours)**

Supplies: Regulated power supply, Uninterrupted power supply (UPS) and Switched mode power supply (SMPS).

Practical Components **(30 Hours)**

1. Study of I-V characteristics of DIAC
2. Study of I-V characteristics of a TRIAC
3. Study of I-V characteristics of an SCR.
4. Study of Load characteristics of D.C. motor.
5. Study of Speed control of D.C. motor.
6. Study of Load characteristics of Servomotor.
7. Study of speed control and blocked rotor test on single phase Inductor motor.

Essential/recommended readings

1. Electrical Technology, 25th Edition (2017), B. L. Thareja and A. K. Thareja, S. Chand & Sons.
2. Power Electronics: Circuits, Devices and Applications, 3rd Edition (2014), M.H. Rashid, Pearson Education
3. Power Electronics, 2nd Edition (2007), M. D. Singh, K. B. Khanchandani, Tata McGraw Hill.
4. Electronic Principles, 7th Edition (2007), A. Malvino, D. J. Bates, Tata McGraw Hill.
6. Power Electronics, 4th Edition (2002), P. S. Bimbhra, Khanna Publishers.

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVE COURSE: Reliability and Quality Control (INDSE5A)

CREDIT 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		
Reliability and Quality Control (INDSE5A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics/ + Chemistry/Computer Science/Informatics Practices	Statistics & probability

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide the thorough understanding of concepts of reliability
- To clarify the basic knowledge of quality concepts and techniques for quality improvement
- To teach, how to use various control charts for improving the product quality
- To provide the clear understanding of different sampling plans and methods

Learning outcomes

The Learning Outcomes of this course are as follows:

- Acquire the basic knowledge of quality concepts and techniques for quality improvement
- Learn to use various control charts for improving the quality of products
- Describe and compare the different sampling plans and methods
- Understand the concepts of reliability

SYLLABUS OF DSE-3

UNIT – 1 **(12 hours)**

Quality Concepts: Meaning of Quality, Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques Pareto Diagrams, Cause-Effect Diagrams Quality Circles, Kaizen, six sigma.

UNIT – 2 **(11 hours)**

Control Charts: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, ARL, sensitizing rules for control charts, Control Charts for X-bar & R and control chart for attribute (p, np, c).

UNIT – 3 **(11 hours)**

Acceptance Sampling: Meaning, objective, and types of research, approaches, Principle of acceptance sampling, Producer's and consumer's risk. AOQL and LTPD, Sampling plans: single, double, OC curve.

UNIT – 4 **(11 hours)**

Reliability: Different types and modes of failure, causes of failure in electronic components, reliability theory, hazard rate, failure density function, availability, maintainability, mean time to failure and repair system structures: series, parallel, K-type, Fault tree analysis.

Practical component: **(30 hours)**

1. Descriptive statistics
2. Control charts for variable
3. Control charts for attribute
4. OC curve
5. Single sampling and double sampling
6. AOQ curve

Essential/recommended readings

1. D. C. Montgomery , Introduction to Statistical Quality Control, 8th edition, John Wiley and sons (2019).
2. Reliability Engineering by S.Shreenath, 4th Edition, East West Press (2008).
3. Statistical Quality Control by M. S. Mahajan, 1st Edition, Dhanpat Rai Publishing Co Pvt Ltd (2016).

Suggestive readings

1. Reliability Engineering and Quality Management by O.N. Pandey & Bhupesh Aneja, 1st Edition, 2011.
2. Modern Methods for Quality Control and Improvement, by Harrison M. Wadsworth, Kenneth S. Stephens, A. Blanton Godfrey, Second edition (17 May 2008)

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

DISCIPLINE SPECIFIC ELECTIVE COURSE : Communication Systems (INDSE5B)

CREDIT 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 Systems (INDSE5B)	04	03	-	01	Class XII passed with Physics + Mathematics/ Applied Mathematics+ Chemistry /Computer Science/Informatics	Analog and Digital Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand basic elements of a communication system.
- Analyze baseband signals in time and frequency domain.
- Understand various analog and digital modulation/demodulation techniques along with their performances in various transmission environments.
- To understand working of radio receivers and transmitters

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn in detail about the various components of communication systems like transmitter, modulator, channel, and receiver
- Gain in-depth knowledge of analog (amplitude, frequency, and phase) and digital modulation and demodulation techniques
- Understand different multiplexing techniques for efficient utilization of available bandwidth

SYLLABUS

Unit-1 **(10 hours)**

Basic communication system: Block diagram, Noise, Analog and digital communication, Types of communication systems: optical communication, cellular communication and satellite communication, LAN

Unit-2 **(11 hours)**

Amplitude Modulation, Frequency and phase modulation: Definition - AM waveforms - Frequency spectrum and bandwidth - Modulation index - DSB-SC, SSB-SC, Vestigial SB - Comparison and application of various AM schemes, Definition-Relationship between FM & PM - Frequency deviation - Spectrum and transmission BW of FM, comparison of AM and FM systems.

Unit-3 **(12 hours)**

Radio Transmitter and Receiver: AM transmitters-High level and low level transmitters - SSB transmitters - FM transmitters - Block diagram. AM receivers-operation - performance parameters - Communication Transceivers - Block diagram - SSB receiver - FM receivers - Block diagram.

Unit-4 **(12 hours)**

Digital Communication: Pulse Analog Modulation: Sampling theorem, Errors in Sampling. Pulse Amplitude Modulation (PAM), Time Division Multiplexing (TDM). Pulse Width Modulation (PWM) and Pulse Position Modulation(PPM). Generation and detection of PAM, PWM, PPM, PCM- Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Digital Formats. Decoding, Regeneration, Transmission noise and Bit Error Rate. Differential Pulse Code Modulation, Delta Modulation, Quantization noise, Adaptive Delta Modulation.

Practical component: **(30 hours)**

1. Study of Amplitude Modulation and Demodulation
2. Study of Frequency Modulation and Demodulation
3. Study of Single Side Band Modulation and Demodulation
4. Study of AM Transmitter and Receiver
5. Study FM Transmitter and Receiver
6. Study of Pulse Amplitude Modulation
7. Study of Pulse Width Modulation
8. Study of Pulse Position Modulation
9. Study of Pulse Code Modulation

Essential/recommended readings

1. Electronic communication systems- Kennedy, 3rd edition, McGraw international publications
2. Principles of Electronic communication systems – L. E. Frenzel, 3rd edition, McGraw Hill
3. Modern Digital and Analog Communication Systems, B. P. Lathi (2nd Edition).
4. Communication systems, R.P.Singh and S.D.Sapre 2nd edition TMH 2008
5. Advanced electronic communications systems – Tomasi, 6th edition, PHI
6. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education.
7. T. G. Thomas and S. Chandra Sekhar, Communication Theory, Tata McGraw Hill.

Suggestive readings

1. H. Taub and D. Schilling, Principles of Communication Systems, Tata McGraw Hill
2. W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education
3. S. Haykin, Communication Systems, Wiley 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 : Computer Aided Design (INDSE5C)

CREDIT 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		
Computer Aided Design (INDSE5C)	04	02	-	02	Class XII passed with Physics + Mathematics/Applied Mathematics+ Chemistry / Computer Science/Informatics	Analog and Digital Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize with MultiSim and PSPICE circuit simulation tools
- To verify response of various analog and digital circuits
- To provide knowledge of Industry standard TCAD simulation tools like Silvaco-ATLAS and and Synopsis-SENTAURUS

Learning outcomes

The Learning Outcomes of this course are as follows:

- Simulate and verify the functionality of diodes and transistor circuits using MultiSim and PSpice software
- Design and verify devices/ circuits using TCAD tools

SYLLABUS OF DSE-3

UNIT – 1 **(6 hours)**

Introduction to Multisim software: MultiSim Environment: Design Process, setting environment preferences, Multisim GUI, Schematic capture of circuits: Placing components, wiring components, Measuring instruments in MultiSim, simulation and result display in MultiSim

UNIT – 2 **(6 hours)**

Electronics circuit design using Multisim: Resistive circuits, Design of Bridge rectifier, Half-Wave rectifier, clippers and clampers using a diode, DC transfer curve analysis, Transient analysis, simulation of digital circuits.

UNIT – 3 **(8 hours)**

Introduction to PSpice software Understanding the SPICE Environment, Schematic Designing Brief Introduction of p spice simulator, Using Model Editor, Understanding the PSPICE Environment, Using Magnetic Parts Editor, Using Stimulus Editor, Drawing a Circuit Preparation for Simulation: Preparing schematic for simulation, Understand the sources for simulation, Understand different markers and errors

UNIT – 4 **(10 hours)**

Introduction to Industry standard TCAD tools, Silvaco- ATLAS device simulation software, Synosis-SENTAURUS. Online Simulation resources-NANOHUB. Simulation of n-channel MOSFET; Silicon on Insulator.

Practical component: **(60 hours)**

1. Designing RC Low pass filter using MULTISIM
2. Designing active RC Low pass filter (OpAmp based) using MULTISIM
3. Half wave rectifier using MULTISIM
4. Wein bridge Oscillator using MULTISIM
5. Simulating high pass filter Circuit using PSPICE
6. Designing active RC High pass filter (OpAmp based) using PSPICE
7. Half wave rectifier using PSPICE
8. Designing and Simulating Full wave rectifier using PSPICE
9. Output characteristics of MOSFET using SILVACO-ATLAS/ Synopsis TCAD
10. Transfer characteristics of MOSFET using SILVACO-ATLAS/ Synopsis TCAD

Essential/recommended readings

1. Introduction To PSpice Using OrCADfor Circuits and Electronics, Muhammad H. Rashid,Paperback – Import,3rd Edition, 2003.
2. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, PHI, 10th Edition, 2009.
3. https:i/nanohub.org/resources/tools
4. https ://www.silvaco. com/contenVkbase/device.pdf

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 OFFERED BY THE DEPARTMENT

GENERAL ELECTIVE COURSE : Industrial Safety Instruments (INGE5A)

CREDIT 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 Safety Instruments (INGE5A)	04	03	-	01	Class XII passed with Mathematics/Applied Mathematics/ Biology/+ Chemistry + Physics	Class XII Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide knowledge on design features for a process industry and safety in the operation of various equipment in industry.
- To understand the various hazards and prevention in the commissioning stage of industry.
- To recognise and identify the safe operation of equipment in the process industry.
- To plan and train for emergency planning in a process industry.
- To get fundamental knowledge on safe storage of chemicals.

Learning outcomes

The Learning Outcomes of this course are as follows:

- This course would make them familiar with safe design of equipment which are essential to the chemical industry and leads to the design of entire process industries.
- Students would understand the problems and find innovative solutions while industries facing problems in commissioning and maintenance stages.

- Students would understand the chemical plant operations.
- Students can prepare emergency planning for chemical industry problems.
- Students would be able to create safe storage systems

SYLLABUS OF GE-5

UNIT – 1 **(11 hours)**

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages. Design process, conceptual design and detail design.

UNIT – 2 **(11 hours)**

Personal protection in work environment

Personal protection in the work environment, Types of PPEs, Personal protective equipment respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

UNIT – 3 **(12 hours)**

Electrical safety and hazards

Introduction – electrostatics, electromagnetism, stored energy, energy radiation and electromagnetic interference –Indian electricity act and rules-statutory requirements from electrical inspectorate- international standards on electrical safety – first aid-cardiopulmonary resuscitation (CPR). Primary and secondary hazards - shocks, burns, scalds, falls - Human safety in the use of electricity - Classes of insulation-voltage classifications -current surges- over current and short circuit current-heating effects of current electrical causes of fire and explosion. Lightning hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

UNIT – 4 **(11 hours)**

Hazard and risk, Types of hazards Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS)

Practical component: **(30 hours)**

1. Conduct the inspection and evaluate the hazards using analytical instruments and methods.
2. Conduct unaided safety inspection of a workplace, identifying the more common hazards, deciding whether they are adequately controlled and, where necessary, suggesting appropriate and cost effective remedial action.
3. At the end of the course a safety assessment report can be added in the Mini project report along with Industry inspection report.

Essential/recommended readings

1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3. Krishnan, N.V. (1997). Safety management in Industry. Jaico Publishing House, New Delhi.
4. John V. Grimaldi and Rollin H.Simonds. (1989) Safety management. All IndiaTraveller Book Seller, Delhi.
5. Ronald P. Blake. (1973). Industrial safety. Prentice Hall, NewDelhi.

Suggested books

1. Alan Waring. (1996). Safety management system. Chapman & Hall, England.
2. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai
3. Montgomery, D.C., “Design and Analysis of experiments”, John Wiley and Sons, 8th edition, 2012.

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

GENERAL ELECTIVE COURSE : Instruments for chemical analysis (INGE5B)

CREDIT 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		
Instruments for chemical analysis (INGE5B)	04	03	-	01	Class XII passed with Mathematics/Applied Mathematics/ Biology/ + Chemistry + Physics	Analog electronics and Chemistry till class XII

Learning Objectives

- To understand the principle, instrumentation, characteristics and working mechanisms of common spectroscopic, chromatographic, and potentiometric instruments
- To learn about the applications of potentiometry, GC and HPLC in different industries (food, chemical, pharmaceutical, petroleum, etc.)
- To understand the concept of qualitative and quantitative analysis
- To understand the planar and column chromatography for different applications

Learning outcomes

At the end of this course, students will be able to

- Understand the principle, instrumentation, characteristics and working mechanisms of common spectroscopic, chromatographic, and potentiometric analytical instruments.
- Explore the potential of analytical techniques of potentiometry, GC and HPLC in different industries (food, chemical, pharmaceutical, petroleum, etc.
- Carry out the qualitative and quantitative analysis of a given sample.
- Utilize planar and column chromatography for different applications.

SYLLABUS OF GE-5

Unit-1 **(11 hours)**

Molecular Spectroscopy: Ultraviolet-Visible (UV-Vis) spectroscopy: principle, instrumentation, and applications. Infra-Red spectroscopy: principle, instrumentation, and applications

Unit-2 **(10 hours)**

Atomic spectroscopy: Theory, instrumentation and application of flame photometry and atomic-absorption spectroscopy.

Unit-3 **(14 hours)**

Planar chromatography: Theory and application of paper and thin layer chromatography. Column chromatography: Principle, instrumentation and application of Gas Liquid Chromatography and High-Performance Liquid Chromatography.

Unit-4 **(10 hours)**

Potentiometry: Introduction, reference and indicator electrodes, ion selective electrodes: glass electrode and its applications.

Practical component: **(30 hours)**

1. Verification of Beer's Law and determination of concentration of the unknown solution using colorimeter.
2. Spectrometric determination of iron using a double beam spectrophotometer.
3. To learn the operation of a pH meter and determine pKa value for bromophenol blue using a double beam spectrophotometer.
4. To study the effect of organic solvents on membrane permeability of beetroot using colorimeter/ spectrophotometer.
5. Determination of concentration of solutes in a mixture using colorimeter.
6. Spectrum analysis using FT-IR (Qualitative analysis).
7. Determination of concentration of sodium, calcium, lithium and potassium in sample using flame photometer.
8. Paper chromatographic separation of samples from different origins (Biological/pharmaceutical/food).
9. Thin layer chromatographic (TLC) separation of samples from different origin (Biological/pharmaceutical/food).
10. Qualitative and quantitative analysis of organic compounds using Gas chromatography.

Essential/recommended readings

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th edition, 1970.

2. H.H. Willard, L.L Merrit, J.A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 1988.
3. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 6th edition, 2007
4. James W. Robinson, Eileen Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, CRC Press, 7th edition, 2014
5. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 4th edition 1978.

Suggestive readings

1. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 1996.
2. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2006.
3. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition, 2011

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

Semester-VI
ELECTRONIC SCIENCE

DEPARTMENT OF INSTRUMENTATION
Category I

(B.Sc. Honours in Instrumentation)

DISCIPLINE SPECIFIC CORE COURSE – 16: Analytical Instrumentation II (INDSC6A)

CREDIT 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 Instrumentation II (INDSC6A)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Understanding of electronics and Chemistry till class XII

Learning Objectives

- To understand the perspective of different advanced analytical methods
- To understand the principle, instrumentation, and application of various electro analytical instruments
- To disseminate with principle and instrumentation of thermo analytical instruments along with their applications for analysing products of different origin
- To familiarize with detail principle, instrumentation, operation and applications of IR spectroscopy
- To differentiate between principle, instrumentation and operation of Atomic absorption and atomic emission spectroscopy.
- To understand the principle, instrumentation, and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)

Learning outcomes

At the end of this course, students will be able to

- Appreciate the potential of different analytical methods for resolving various scientific challenges.
- Describe the principle, instrumentation and application of electro analytical instruments.
- Understand the principle and instrumentation of thermo analytical instruments along with their applications for analyzing products of different origin.
- Understand the different terms, principle, instrumentation, operation, and applications of IR spectroscopy.
- Differentiate between principle, instrumentation and operation of atomic absorption spectroscopy and atomic emission spectroscopy.

SYLLABUS OF DSC-16

Unit-1 **(14 hours)**

Infrared Spectroscopy: Theory, diatomic molecule as a simple harmonic oscillator, instrumentation, sample handling techniques. Fourier Transform Infrared Spectroscopy (FTIR): instrumentation and advantages.

Atomic Spectroscopy: Principle, comparison of atomic and molecular spectroscopy, Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, atomization process, types of flames- fuel/ oxidant combinations, instrumentation, Interferences and applications. Introduction to Atomic absorption spectroscopy (AAS).

Unit-2 **(10 hours)**

Electro analytical Methods of Analysis: Potentiometry: Introduction, reference electrode, indicator electrodes, ion-selective electrodes: glass electrode and liquid membrane electrode and their applications, potentiometric titrations.

Unit-3 **(12 hours)**

Gas Chromatography (GC): Principle, Carrier gasses, different types of injection systems, columns, stationary phases, and detectors. Isothermal mode, temperature-programming mode, applications.

Unit-4 **(9 hours)**

High Performance Liquid Chromatography (HPLC): mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, detectors, and applications.

Practical component: **(30 hours)**

1. Determination of concentrations of sodium/calcium/lithium/potassium in sample using Flame Photometer.

2. Determination of concentration of sodium/calcium/lithium/potassium ions in sample by standard addition method using flame photometer
3. Spectrum interpretation using FTIR.
4. Qualitative/Quantitative analysis of samples using Gas chromatography.
5. Qualitative/Quantitative analysis of samples using High Performance Liquid Chromatography
6. Potentiometric titrations: (i) Strong acid with strong base (ii) weak acid with strong base and (iii) dibasic acid with strong base
7. Potentiometric titration of Mohr's salt with potassium dichromate
8. pH metric titrations of (i) strong acid and strong base (ii) weak acid and strong base

Essential/recommended readings

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th edition, 1970.
2. H.H. Willard, L.L Merrit, J.A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 1988.
3. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 6th edition, 2007
4. James W. Robinson, Eileen Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, CRC Press, 7th edition, 2014
5. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 4th edition 1978.

Suggestive readings

1. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 1996.
2. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2006.
3. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition, 2011

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: Analog Devices and Circuits (INDSC6B)

CREDIT 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		
Analog Devices and Circuits (INDSC6B)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Semiconductor devices

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce different types of diodes like Tunnel diode, Varactor diode, Schottky diode, Photodiode etc.
- To explain construction and characteristics of JFETs, MOSFETs and UJT
- The student should be able to explain and calculate small signal parameters of MOSFET.
- To learn the basics of MOSFET Circuits.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Explain the operation of Tunnel diode, Varactor diode, Schottky diode, Photodiode etc.
- Reproduce the I-V characteristics of JFET, MOSFET and UJT.
- Analysis of the operation of MOS transistor
- Ability to understand the fundamentals of MOSFET circuits.

SYLLABUS OF DSC-17

UNIT – 1 **(8 hours)**

Special purpose electronic devices: Principal of operation and Characteristics of Tunnel Diode, Varactor Diode, Schottky Diode, Photo diode, Photoconductive cells, IR emitter, Liquid crystal displays, Solar cells, and Thermistor.

UNIT – 2 **(12 hour)**

Junction Field Effect Transistors (JFET): JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. FET Amplifiers: FET Common source Amplifier, Common Drain Amplifier, Generalized FET Amplifier, FET biasing.

UNIT – 3 **(13 hours)**

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis.

UJT, Basic construction and working, Equivalent circuit, intrinsic Standoff Ratio, Characteristics, and Relaxation oscillator

UNIT – 4 **(12 hours)**

MOS Inverter: Introduction, Voltage Transfer Characteristic (VTC), Noise Immunity and Noise margins, Resistive-Load Inverter, CMOS Inverter, DC Characteristics of CMOS Inverter, Calculation of VIL, VIH, VOL, VOH and Vth, Design of CMOS Inverters, Supply Voltage Scaling in CMOS Inverters, Power, and Area considerations

Practical component: **(30 hours)**

1. To verify practically the response of various special purpose electronic devices.
2. To Study the I-V Characteristics of JFET.
3. To Study the I-V Characteristics of MOSFET
4. To obtain the frequency response of a MOSFET amplifier in common source configuration with given specifications.
5. To Study I-V Characteristics of the UJT.
6. NMOS inverter: (a)Transient analysis using Step input and Pulse input. (b) DC analysis (VTC).
7. CMOS inverter: (a)Transient analysis using Step input and Pulse input. (b) DC analysis (VTC).

Essential/recommended readings

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006)
2. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010)
3. Donald E. Neaman, “Electronic Circuit, Analysis and Design”, Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.
4. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
5. CMOS Digital Integrated circuits – Analysis and Design by Sung – Mo Kang, Yusuf Leblebici, TATA McGraw-Hill Pub. Company Ltd.

Suggestive readings

1. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
2. Michael Shur, “Physics of Semiconductor Devices,” Prentice Hall
3. Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edition, Pearson education, 2014.

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: Control Systems (INDSC6C)

CREDIT 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		
Control Systems (INDSC6C)	04	03	-	01	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry/ Computer Science/Informatics Practices	Engineering Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study how to interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- To help the students understand and practice feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
- To teach about how to solve the steady state and transient analysis of a system for standard inputs
- Introduce students how to compute stability of linear systems using the Routh array test and use this to generate control design constraints
- To teach students the use Evans root locus techniques in control design for real world systems

Learning outcomes

The Learning Outcomes of this course are as follows:

- Interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- Define and explain feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
- Solve the steady state and transient analysis of a system for standard inputs

- Compute stability of linear systems using the Routh array test and use this to generate control design constraints
- Use Evans root locus techniques in control design for real world systems
- Compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability

SYLLABUS OF DSC-18

UNIT – 1 **(11 hours)**

Introduction to Control System: Introduction of open loop and closed loop control systems, mathematical modelling of physical systems (Electrical, Mechanical), derivation of transfer function, Armature controlled and field controlled DC servomotors, block diagram representation & signal flow graph, reduction technique, Mason's Gain Formula, effect of feedback on control systems.

UNIT – 2 **(11 hours)**

Time Domain Analysis: Time domain performance criteria, transient response of first, second, steady state errors and static error constants, performance indices.

Concept of Stability: Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

UNIT – 3 **(12 hours)**

Frequency Domain Analysis: Frequency Domain Analysis: Correlation between time and frequency response, Polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using Nyquist criterion.

UNIT – 4 **(11 hours)**

State Space Analysis: Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties.

Controllers and Compensation Techniques: Basic Control Actions: Proportional, Integral and Derivative controls, response with P, PI and PID Controllers, Basic concept of compensation, Lag, Lead and Lag-Lead networks.

Practical component: **(30 hours)**

1. To study characteristics of :
   a. Synchro transmitter receiver
   b) Synchro as an error detector
1. To study position control of DC motor
2. To study speed control of DC motor
3. To find characteristics of AC servo motor
4. To study time response of type 0,1 and 2 systems
5. To study frequency response of first and second order systems

6. To study time response characteristics of a second order system.
7. To study effect of damping factor on performance of second order system
8. To study frequency response of Lead and Lag networks.
9. Study of P, PI and PID controller.

Essential/recommended readings

1. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2021, 7th Edition.
2. K. Ogata, Modern Control Engineering, Prentice Hall of India, 2015, 5th Edition.
3. B. C. Kuo , "Automatic control system", Prentice Hall of India, 2010, 9th Edition.
4. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi, 7th Edition.

Suggestive readings

1. N.K Jain, Automatic Control System Engineering, DhanpatRai Publication, 2019, Standard Edition.
2. Veenadevi S V and Sujatha Hiremath, Control System, I K International Publishing House Pvt Ltd, 2022.

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVE COURSE : Artificial Intelligence (INDSE6A)

CREDIT 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		
Artificial Intelligence (INDSE6A)	04	03	-	01	Class XII passed with Physics + Mathematics /Applied Mathematics + Chemistry / Computer Science/Informatics Practices	Class XII Mathematics, Any programming language

Learning Objectives

The Learning Objectives of this course are as follows:

- To realize the significance of Artificial Intelligence and expert systems in today‟s era
- To study neural networks and become able to design neural network based algorithms
- To study fuzzy logic and use it as an alternative tool for modeling.
- To study genetic algorithms and learn about optimizing solutions using genetic algorithms
- Become able to apply the knowledge of artificial control tools to any control application
- To be able to work with imprecise and uncertain solution data for solving problems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Realize the significance of Artificial Intelligence and expert systems

- Learn the neural network algorithms, modeling using fuzzy logic and optimizing
- solutions using genetic algorithms
- Apply the knowledge of artificial control tools to any control application
- Work with imprecise and uncertain solution data for solving problems

SYLLABUS OF DSE

UNIT – 1 **(12 hours)**

The concept and importance of Artificial Intelligence, human intelligence vs machine intelligence, General concept of knowledge, Acquisition, Knowledge representation and organization, Expert systems: advantages, disadvantages, Expert system architecture, functions of various parts, mechanism and role of inference engine, Role of expert systems in instrumentation and control.

UNIT – 2 **(11 hours)**

Neural Networks: Biological Neural-system, Mathematical Models of Neurons, ANN architecture, Artificial neuron models, Types of activation functions, Learning rules, Learning Paradigms-Supervised, Unsupervised and Reinforcement Learning, ANN training algorithms perceptron, training rules, Delta, Back Propagation Algorithm, parameters in BPN, Hopfield Networks, Recurrent networks, Associative Memories, Applications in identification, optimization, pattern recognition etc.

UNIT – 3 **(11 hours)**

Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Approximate reasoning, Aggregation, Fuzzy logic modeling and control, fuzzification, inferencing and defuzzification, Linguistic Variables, Arithmetic Operations on Intervals & Numbers. Applications of Fuzzy Logic in process Control and motion control.

UNIT – 4 **(11 hours)**

Genetic Algorithm: An Overview: Introduction and concept as a process modeling tool, creation of off-springs, encoding, fitness function, reproduction, cross over, insertion, deletion and mutation scaling, Fitness, Implementation of Genetic algorithm, applications.

Hybrid Systems: Introduction to Neuro-fuzzy systems, Fuzzy-Expert system, Fuzzy-GA systems.

Practical component: **(30 hours)**

1. Implementation of perceptron learning model
2. Pattern recognition using Hopfield network
3. Identification using associative memories
4. Implement fuzzy logic operations on fuzzy sets

5. Implement conversion of given crisp temperature into its equivalent fuzzy variable
6. Implement conversion of error into its equivalent fuzzy variable
7. Design model of fuzzy logic PID controller
8. Design fuzzy logic based temperature control system
9. Design fuzzy logic based washing machine/aircraft landing system

Essential/recommended readings

1. Ross Timothy. J, Fuzzy logic with Engineering Applications, McGraw Hill, New York, 3rd Edition.
2. Hagan M.T , Demuth H.B, Beale M.H, Neural Network Design, PWS Publishing Company, Thomson Learning, 1st Edition.
3. N.P.Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition.
4. Rajasekaran S., VijayalakshmiPai G. A., Neural Networks, PHI Learning Pvt. Ltd., 2003, 1st Edition.

Suggestive readings

1. Klir George J , Yuan B, Fuzzy Sets and Fuzzy Logic Theory and Applications, Prentice Hall PTR, 1st Edition.
2. J. Nilsson, “Artificial Intelligence: A new Synthesis”, Elsevier Publishers.

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

DISCIPLINE SPECIFIC CORE COURSE: Process Control Dynamics (INDSE6B)

CREDIT 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		
Process Control Dynamics (INDSE6B)	04	03	-	01	Class XII passed with Physics + Mathematics/ Applied Mathematics+ Chemistry / Computer Science/Informatics Practices	Control Systems and Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study about the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants
- To teach students about the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy
- To help students understand and discuss about the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units
- To study additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants
- Know about the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy

- Interpret the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units
- Understand additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

SYLLABUS OF DSE

UNIT – 1 **(12 hours)**

Introduction: Dynamics of Processes, Dead time processes, Inverse response behaviour of processes, Dynamic Behaviour of first and second order systems. Interacting and non-interacting Systems. Batch & Continuous Process, concept of self-regulation, Controller Principle, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID), Pneumatic, Hydraulic, Electronic controllers. Need for controller tuning.

UNIT – 2 **(11 hours)**

Controls: Cascade control, Selective control, Ratio Control, Split range control, feed forward control, Feed forward combined with feedback control, Inferential Control, dead time and inverse response compensators, selective control, Adaptive control, Examples from Distillation columns, Chemical Reactors, Heat Exchangers and Boiler.

UNIT – 3 **(11 hours)**

Discrete-State process control: Variables, process specification and event sequence description, Sampling and reconstruction, Transform analysis of sampled-data systems: z transform and its evaluation, inverse z transform, pulse transfer function, stability analysis in z-plane, implementation of digital controller. PLC Block Diagram, Scan cycle, memory organization, addressing, programming.

UNIT – 4 **(11 hours)**

Converters and Actuators: I/P, P/I converters, Final control elements, Pneumatic and electric actuators. Types of control valves, Valve positioner and its importance, Inherent and Installed characteristics of control valves.

Practical component: **(30 hours)**

1. Study of PID controller response and it‟s tuning
2. Study of ON-OFF and Proportional controller responses on temperature loop.
3. Analysis of Flow loop/Level loop/Temperature loop/Pressure loop.
4. Tuning of controllers on a pressure loop.
5. Control valve characteristics with and without positioner.
6. Study of cascade control
7. Study of ratio control/selective control
8. Study of feed forward control

9. Study of pneumatic/ hydraulic controllers
10. Problem solving/Ladder Programming in PLC.

Essential/recommended readings

1. Eckman. D.P, Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993, Original Edition.
2. Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition.
3. Bequette B. W., Process Control Modelling, Design and Simulation, PHI Learning, Original Edition.
4. Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition.
5. Kuo B. C. , "Automatic control system", Prentice Hall of India, 2010, 9th Edition.
6. Nagrath I. J. and Gopal M., Control System Engineering, New Age International,2021, 7th Edition.
7. Stephanopoulis G., Chemical Process Control, Prentice Hall of India, New Delhi, 1990, Original Edition.
8. Liptak B.G., Instrument Engineers Handbook, Process Control, Chilton Book Company, 3rd Edition.

Suggestive readings

1. Harriott P., Process Control, Tata McGraw Hill, Edition 1972.
2. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company 1980, 3rd Edition.
3. Pollard A., Process Control, Heinemann educational books, London, 1971, Original Edition.
4. Smith C.L. and Corripio A. B., Principles and Practice of Automatic Process Control, John Wiley and Sons, New York, 2nd Edition.
5. Shinskey, Process Control Systems, McGraw Hill, Singapore, 1996, 4th Edition.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE: Research Methodology (INDSE6C)

CREDIT 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 (INDSE6C)	04	03	-	01	Physics + Mathematics /Applied Mathematics / Biology + Chemistry / Computer Science/Informatics Practices	Elementary Statistics

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand some basic concepts of research and its methodologies
- To select and define appropriate research problem and parameters
- To write a research report and thesis

Learning outcomes

The Learning Outcomes of this course are as follows:

- Acquire the basic knowledge of quality concepts and techniques for quality improvement
- Learn to use various control charts for improving the quality of products
- Describe and compare the different sampling plans and methods
- Understand the concepts of reliability

SYLLABUS OF DSE

Unit -1 **(12 hours)**

Introduction and Design of research : Meaning, Objectives and Importance of Research, Types of research, need and purpose of research, approaches to research, components of the research problem, criteria for selecting the problem, necessity of defining the problem.

Unit – 2 **(10 hours)**

Importance of literature review in defining a problem, Critical literature review – Identifying gap areas from literature review - Development of working hypothesis, various tools for literature survey-Searching journals, metrics of Journals, e book, monograph, patents, Citations, Intellectual Property Rights.

Unit -3 **(12 hours)**

Data Collection and Analysis: Observation and Collection of data - Methods of data collection – Modeling, Mathematical Models for research, Sampling Methods- Data processing and Analysis strategies. Data Analysis with Statistical Packages – Hypothesis-testing, Sampling, Sampling Error, Statistical Methods/Tools - Measures of Central Tendency and Variation, Test of Hypothesis- z test, t test, F test, ANOVA, Chi square, correlation and regression analysis, Error Estimation.

Unit - 4 **(11 hours)**

Writing Research Articles and Thesis: Data Presentation- Types of tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References – Styles and methods, Citation and listing system of documents. Ethical considerations in Research, precautions in preparing report, plagiarism

Practical component: **(30 hours)**

Use latest software package like SPSS/any similar, to conduct experiments based on:

1. Measures of central tendency
2. Normal distribution
3. Chi square test
4. T test
5. Z-test

Essential/recommended readings

1. Ranjit Kumar, Research Methodology, A step by step guide for beginners, SAGE Publications (2015)
2. D. C. Montgomery, Introduction to Statistical Quality Control, 8th edition, John Wiley and sons (2019).
3. Leedy, P. D. and Ormrod, J. E., 2004 Practical Research: Planning and Design, Prentice Hall.
4. C.R Kothari, Research Methodology: Methods and Techniques, New Age International Publishers (2015)

Suggestive readings

1. Prabhat Pandey, Meenu Mishra Pandey, Research Methodology: Tools and Techniques, Bridge Center (2015)
2. S.P Gupta, Statistical Methods, 46th edition, Sultan Chand & Sons (2021)

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 OFFERED BY THE DEPARTMENT

GENERIC ELECTIVE : Standardization and Quality Control (INGE6A)

CREDIT 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		
Standardization and Quality Control (INGE6A)	4	3	-	1	Class XII passed with Mathematics/ Applied Mathematics + Biology/ Computer Science/Informatics Practices	Probability and Statistics

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the basic concepts of Total Quality Management.
- To enable the student on how to apply various Statistical Process Control (SPC) techniques to ensure the quality level of products.
- To understand the significance of Control Charts and Acceptance sampling in modern quality control systems.
- To make students learn the national and international quality assurance standards.

Course Learning Outcome

The Learning Outcomes of this course are as follows:

- Apply the principles and techniques of Total Quality Management in improving quality practices within an industrial or service organization

- Use statistical process control (SPC) techniques such as pareto charts, control charts and cause-effect diagrams recognized throughout industries to ensure the quality level of products
- Understand the role of Acceptance Sampling (AS) in modern quality control systems
- Develop an understanding of national and international quality assurance standards such as ISO 9000 and 14001

SYLLABUS OF GE

Unit-1 **(11 hours)**

Quality Concepts: Meaning of Quality, Dimensions of Quality, Quality Approaches-Deming's Approach, Juran's Approach, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques-Quality Circles, Kaizen, Six Sigma.

Unit-2 **(12 hours)**

Quality Control: Graphical and Tabular representation of data, Measures of Central Tendency, Measures of Dispersion, Random Variables, Chance and assignable causes of variation, Quality Control Tools-Histogram, Pareto Chart, Cause-Effect Diagram, Control Charts. Control Chart for variables (X-bar & R), Control limits, Warning Limits, Process Capability, Sample Size and Sampling Frequency, Sensitizing rules for Control Charts, Control Chart for Attributes (p, np, c).

Unit-3 **(11 hours)**

Acceptance Sampling: Advantages and Disadvantages of Sampling, Types of Sampling, Lot formation, Principle of acceptance sampling, OC curve, Producer’s and consumer’s risk, Acceptable Quality Level, Lot Tolerance Percentage Defective, Sampling plans: single, double, Average outgoing Quality, AOQL.

Unit-4 **(11 hours)**

ISO 9001-2000 & 14000 Series of Standards: History and Evolution of ISO 9000 Series, Importance and overview of ISO 9000- 1998 Series standards, structure of ISO 9000-2000 Series standards, clauses of ISO 9000 series standards and their interpretation and implementation, quality system documentation and audit. Environmental management concepts, and requirement of ISO 14001, benefits of environmental management Systems.

Practical component: **(30 hours)**

Use latest statistical software package like SPSS to conduct experiments based on:

1. Descriptive statistics
2. Histogram
3. Pareto Chart
4. Control charts for variables
5. Control charts for attributes
5. OC curve
6. AOQ curve

Essential/recommended readings

1. D. C. Montgomery, Introduction to Statistical Quality Control, John Wiley and sons, 6th edition, 2008.
2. Subburaj Ramasamy, Total Quality management, Tata McGraw Hill, 2 nd Edition, 2012
3. E. L. Grant & R.S. Leavenworth-Statistical Quality Control, 7th Edition, 2000.
4. Kaoru Ishikawa-Guide to Quality Control, Asian Productivity Organization, Series, 1986

Suggestive readings

1. M. S. Mahajan, Statistical Quality Control, 1st Edition, Dhanpat Rai Publishing Co Pvt Ltd (2016).
2. Ranjit Kumar, Research Methodology, A step by step guide for beginners, SAGE Publications (2015)
3. Prabhat Pandey, Meenu Mishra Pandey, Research Methodology: Tools and Techniques, Bridge Center (2015)
4. S.P Gupta, Statistical Methods, 46th edition, Sultan Chand & Sons (2021)

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

GENERAL ELECTIVE COURSE : Wireless Networks (INGE6B)

CREDIT 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		
Wireless Networks (INGE6B)	**04**	**03**	**-**	**01**	**Class XII passed with Mathematics/Applied Mathematics/ + Computer Science/Informatics**	Mathematics in class XII and digital communication

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the concept about Wireless networks, protocol stack and standards
- To understand and analyze the network layer solutions for Wireless networks
- To study about fundamentals of 3G Services, its protocols and applications
- To have in depth knowledge on internetworking of WLAN
- To learn about evolution of 4G and 5G Networks, its architecture and applications

Learning outcomes

The Learning Outcomes of this course are as follows:

- Conversant with the latest 3G/4G networks and its architecture
- Design and implement wireless network environment for any application using latest wireless protocols and standards
- Ability to select the suitable network depending on the availability and requirement
- Implement different type of applications for smartphones and mobile devices with latest network strategies

SYLLABUS OF GE

UNIT – 1 **(12 hours)**

WIRELESS LAN

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE 802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN, BRAN (Broadband Radio Access Networks), HiperLAN2 Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security IEEE 802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX.

UNIT – 2 **(11 hours)**

MOBILE NETWORK LAYER

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6- Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequenced distance vector, Dynamic source routing

UNIT – 3 **(11 hours)**

MOBILE TRANSPORT LAYER

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.

UNIT – 4 **(11 hours)**

4G NETWORKS

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

5G NETWORKS

Introduction – 5G vision – 5G features and challenges - Applications of 5G – 5G Technologies

Practical component: **(30 hours)**

1. Program in NS 3 to connect WIFI TO BUS(CSMA)
2. Program in NS 3 to create WIFI SIMPLE INFRASTRUCTURE MODE
3. Program in NS 3 to create WIFI SIMPLE ADHOC MODE
4. Program in NS 3 to connect WIFI TO WIRED BRIDGING
5. Program in NS 3 to create WIFI TO LTE(4G) CONNECTION
6. Program in NS3 for CREATING A SIMPLE WIFI ADHOC GRID
7. Introduction to GSM Architecture

Essential/recommended readings

1. Wireless Communication and Networks, Second Edition, Williant Stallings.

2. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
3. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Edition, Elsevier 2011.
4. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013

Suggestive readings

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.
2. Vijay Garg, "Wireless Communications and networking", First Edition, Elsevier 2007.

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