UNIVERSITY OF DELHI

CNC-II/093/1(22)/2022-23/223
Dated: 11.10.2022

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1-5 dated 18.08.2022]

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

Add the following:

Syllabi of Semester-I of the following departments under Faculty of Interdisciplinary & Applied Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

DEPARTMENT OF BIOCHEMISTRY
BSc (H) Biochemistry
Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) – : Biomolecules

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biomolecules DSC 1	4	2	0	2	Class XII Science Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry +	NIL

					Physics OR Combination II: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Mathematics	

Learning Objectives

This paper will provide an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties of molecules, biological roles and functions for students. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective and hands-on approach and laboratory techniques.

Learning outcomes

On successful completion of the course students will be:

- Able to comprehend the structure, function and acid-base properties of amino acids.
- Introduced to the structure, properties and roles of carbohydrates, lipids and nucleic acids.
- Aware of the importance of vitamins in biological systems.
- Able to independently identify various biomolecules in the laboratory by qualitative test methods.
- Acquainted with chemical and molecular foundations of life and appreciate the role of buffer in biological systems.

SYLLABUS OF DSC - 1

THEORY

Unit – 1 **(07 Hours)**

Amino acids: Amino acids as bifunctional molecules and their biological significance; Classification of amino acids (Standard, Semi-standard, Non-standard; Proteinogenic, Non-proteinogenic; Essential, Non-essential; Polar, Non-polar). Physical properties (variations in structures, sizes, polarity, charges; resonance hybrid), optical properties (stereoisomerism; chirality; R- and S-; D- and L-; light absorption); and chemical properties (protonation/deprotonation; zwitterions; acid base properties, titration curve, pH and pKa, pI; reactivity of side chains) of amino acids, Amino acids as constituents of proteins, peptide bond. Uncommon amino acids and their functions.

Unit – 2 **(08 Hours)**

Carbohydrates: Introduction, classification and importance of carbohydrates. Monosaccharides - the structure of aldoses and ketoses; Optical properties of sugars: conformations of sugars, mutarotation, anomers, epimers and enantiomers; Chemical properties (Oxidation and reduction of sugars); reducing and non-reducing sugars; Glycosidic linkages (O- and N-type), formation of disaccharides (sucrose, maltose, lactose, trehalose), tri- and oligosaccharides (raffinose, rhamnose, and stachyose) Polysaccharides: homo- and heteropolysaccharides, structural (cellulose and chitin) and storage polysaccharides (starch and glycogen); Role of glycoconjugates with examples - proteoglycans, glycoproteins and glycolipids; Carbohydrates as recognition molecules.

Unit –3 **(07 Hours)**

Lipids: Introduction, importance, and classification of lipids (simple, complex and derived lipid); Structure, properties, and classification of fatty acids (based on chain length and degree of unsaturation); Storage lipids- triacylglycerol and waxes. Structural lipids in membranes– glycerolipids, glycerophospholipids, galactolipids, ether-lipids, sphingolipids, and sterols; Importance of eicosanoids. Role of lipids as storage, signals, hormones, pigments, and in membranes.

Unit – 4 **(05 Hours)**

Nucleic Acids: Structure and properties of bases (purines and pyrimidines). Formation of nucleosides and nucleotides (phosphodiester and glycosidic bond); Nucleic acid structure: Watson-Crick model of DNA double helix, comparison of different forms of DNA (A, B and Z DNA); Structure and functions of major species of RNA (mRNA, tRNA and rRNA). Nucleic acid chemistry - UV absorption, the effect of acid and alkali on DNA; Biologically important nucleotides (source of energy, a component of coenzymes and second messengers)

Unit – 5 **(03 Hours)**

Vitamins: Active forms and major functions of water-soluble and fat-soluble vitamins; Major dietary sources, deficiency diseases, symptoms, and hypervitaminosis.

PRACTICAL

(60 Hours)

1) Laboratory safety and standards (precision, accuracy and sensitivity). Preparation of solutions (w/w, w/v, Molar, Normal)
2) Concept of buffer, buffering capacity and Henderson-Hasselbalch equation. Preparation of acetate buffer/phosphate buffer
3) Titration graph of acetic acid and Glycine.

4) Qualitative analysis of Amino acids (Ninhydrin, Xanthoproteic, Millon's, and lead acetate test)
5) Qualitative test for Carbohydrates: monosaccharides, disaccharides, and polysaccharides (Molisch, Fehling/ Benedict, Barfoed, Seliwanoff's, Osazone and Iodine test)
6) To determine the Iodine Number of oil/fat.
7) Qualitative test for Nucleic acid (Orcinol and DPA).

ESSENTIAL/RECOMMENDED 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. and Stryer L. (2011) 7th Edition. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.
3) 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.

SUGGESTIVE READING:

1) Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations. 7th edition John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
2) Campbell, M.K. and Farrel, S.O. (2017). 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Proteins

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Proteins DSC 2	4	2	0	2	Class XII Science (Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/	NIL

Biochemistry +
Physics OR

Combination II:
Chemistry +
Biology/ Biological Studies/ Biotechnology/ Biochemistry +
Mathematics)

Learning Objectives

The course aims to introduce "proteins" and their importance to modern biochemistry, highlighting their structural features and unique characteristics that help them participate in every physiological process in life, thus also playing an important role in disease manifestation and their interventions.

Learning Outcomes

After completion of the course, a student will

- Understand the diverse functions of proteins in a cell
- Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins
- Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases
- Understand specialized proteins like structural proteins
- Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

SYLLABUS OF DSC - 2

THEORY

Unit – 1 **(2 Hours)**

Introduction to proteins: Introduction to peptides and proteins. Structural and functional diversity. Classification of proteins – simple and conjugated proteins; monomeric and multimeric proteins.

Unit – 2 **(12 Hours)**

Hierarchy of protein structure organization: Organization of protein structure into primary, secondary, tertiary and quaternary structures. Forces stabilizing the protein structure - covalent (disulfide bridges) and non-covalent (electrostatic interactions and salt bridges, hydrophobic, hydrogen bonding, van der Waals). The peptide bond, dihedral angles psi and phi, helices, sheets, turns and loops, Ramachandran map. Motifs and domains. Structural proteins - α-keratin, silk fibroin, collagen. Globular and fibrous proteins, membrane proteins.

Unit – 3 **(05 Hours)**

Protein sequencing and Databases: Sequencing techniques - N-terminal and C-terminal amino acid analysis, Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Solid phase peptide synthesis. Protein databases – sequence and structure based.

Unit – 4 **(05 Hours)**

Protein folding and conformational diseases: Denaturation and renaturation of Ribonuclease A – discovery of protein folding. Introduction to thermodynamics of protein folding. Assisted folding by molecular chaperones, chaperonins and PDI. Diseases associated with protein misfolding – Alzheimer's and Creutzfeldt-Jakob disease.

Unit – 4 **(6 Hours)**

Specialized proteins: Transport protein: myoglobin and haemoglobin - Oxygen binding curves, influence of 2,3-BPG, CO2 and H^+; Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders – Sickle cell anemia.

PRACTICAL

(60 Hours)

1) Scanning of proteins using UV-visible absorbance method
2) Solvent perturbation and denaturation studies of a protein
3) Estimation of proteins using Biuret method.
4) Estimation of proteins using Lowry/Bradford method.
5) Determination of isoelectric point of protein
6) Understanding protein sequence databases and homology modeling of proteins
7) Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB

ESSENTIAL/ RECOMMENDED READINGS

1) Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman and Company. ISBN13: 9781464126116, ISBN10: 1464126119
2) Schulz, G.E., Schirmer, R.H. (1979). Principles of protein structure. Springer, ISBN 978-1-4612- 6137-7
3) Scopes, R.K. (1994) Protein Purification. Principles and Practice (3rd ed). Springer, ISBN 978-1-4737-2333-5

4) Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH:Freeman ISBN-13: 9781319114671
5) Voet. D., Voet. J.G. (2013) Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN : 978-1-11809244-6.

SUGGESTIVE READING:

1) Whitford, D. (2004). Protein Structure and function. Southern Gate, Chichester, West Sussex: John Wiley & Sons, Inc. ISBN-13: 978-047149894 ISBN-10: 0471498947.

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

DISCIPLINE SPECIFIC CORE COURSE- 3 (DSC-3): Biochemical Techniques

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemical Techniques DSC 3	4	2	0	2	Class XII Science (Combination I: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Physics OR Combination II: Chemistry + Biology/ Biological Studies/ Biotechnology/ Biochemistry + Mathematics)	NIL

Learning Objectives

The objective of the course is to introduce various techniques to students that are used in a biochemistry lab. It will provide them an understanding of the principles underlying various techniques. They will develop skills in the form of practical exercises and gain knowledge, which can be applied to pursue research and will be helpful in getting a suitable placement.

Learning Outcomes

On successful completion of this course, the students will

- Acquire knowledge about the principles and applications of spectrophotometric and chromatographic techniques used in a biochemistry lab.
- Learn about the principle and applications of electrophoresis and centrifugation techniques.
- Will be able to identify biochemical techniques for separation and purification of biomolecules.
- Students will obtain hands-on experience to develop their experimental skills expected from any biochemistry student working in a research lab.

SYLLABUS OF DSC – 3

THEORY

Unit – 1 **(07 Hours)**

Spectroscopic Technique: Introduction to electromagnetic radiation. Principle of UV-visible absorption spectrophotometry. Working, instrumentation and applications of spectrophotometer, Lambert's law, Beer's law. Factors affecting UV-vis absorption, bathochromic shift and hypsochromic shift. Fluorescence spectrophotometry: Phenomena of fluorescence, stoke's shift, quantum yield, intrinsic and extrinsic fluors with example, working and applications of fluorimeter.

Unit – 2 **(06 Hours)**

Centrifugation: Principle of centrifugation, basics of sedimentation, svedberg unit, correlation of 'rpm' with 'g' value, factors affecting sedimentation (density, viscosity, size and shape). Types of rotors (fixed angle, vertical and swinging bucket rotors) and relevant applications. Differential centrifugation and density gradient centrifugation - zonal and isopycnic.

Unit – 3 **(09 Hours)**

Chromatography: Introduction to chromatography, Principle and applications of partition chromatography: Paper and thin layer chromatography. Concept of mobile phase, stationary phase, partition coefficient, retention factor, factors affecting separation. Types of partition chromatography: Ascending and descending chromatography. Methods of detecting separated samples.

Principle and applications of ion exchange, molecular sieve and affinity chromatography. Concept of distribution coefficient, types of matrix, mesh size, water regain value, packing of the column, void volume, elution volume, theoretical plates, exclusion limit and resolution. Factors affecting binding, elution and resolution. Methods of detecting eluted samples.

Unit – 4 **(08 Hours)**

Electrophoresis: Principle of electrophoresis. Factors affecting the mobility of molecules: Buffer, electrical field strength and charge. Types of electrophoresis: Polyacrylamide gel (native), SDS PAGE, isoelectric focusing and agarose gel electrophoresis. Continuous and discontinuous buffer systems in electrophoresis. Staining, detection, identification and molecular weight determination of molecules.

PRACTICAL

(60 Hours)

1) Determination of absorption maxima (λmax).
2) Verification of Beer's Law and calculation of molar extinction coefficient.
3) Preparation of cell free extract from a biological sample.
4) Separation and identification of amino acid acids by thin layer chromatography.
5) Separation of molecules by Ion-exchange chromatography.
6) Separation of molecules by gel filtration chromatography.
7) To perform PAGE (native) / SDS-PAGE.

ESSENTIAL/RECOMMENDED READINGS

1) Wilson, K. & Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
2) Boyer, R. F. (2012) Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.
3) Sheehan, D. (2010). Physical biochemistry: Principles and applications (2nd ed.). Chichester: Wiley-Blackwell.
4) 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.

SUGGESTIVE READING:

1) Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168.
2) Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2^{nd} ed.), W.H. Freeman and Company (New York); ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.

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 DEPARTMENT OF BIOCHEMISTRY

Category-IV

GENERIC ELECTIVE
(GE-1: MOLECULES OF LIFE)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Molecules of Life GE 1	4	2	0	2	Class XII Science	NIL

Learning Objectives

The objective of the course is to provide students with an understanding of biomolecules, the basic building blocks that are vital for various life forms. The course emphasizes on studying the importance of water as a biological solvent, different types of molecules of life, focusing on their key properties, biological roles and functions. The course also aims to outline chemical and physical aspects of biomolecules by hands on approach through laboratory experiments.

Learning outcomes

- The course will provide an understanding of how the structures of biomolecules determine their chemical properties and functions.
- Students will develop understanding of biochemistry at atomic level and appreciate the biological importance of molecules of life.
- Students will gain insight into basic structures, classification, and biological importance of amino acids, carbohydrates, lipids and nucleic acid.

SYLLABUS OF GE - 1

THEORY

Unit – 1 **(2 Hours)**

Water and Concept of Buffer: Chemistry of water and biological importance of water, Henderson-Hasselbalch equation, concept of buffer and buffering capacity.

Unit – 2 **(6 Hours)**

Structure and functions of Amino Acids: Introduction and classification of amino acids, peptide bond, zwitterions, L and D form of amino acids, standard and non-standard amino acids and their biological importance.

Unit – 3 **(7 Hours)**

Biochemistry of Carbohydrates: Introduction, and classification of carbohydrates. Monosaccharides, disaccharides, polysaccharides (glycogen, starch, cellulose and chitin). D-and L- isomerism, epimers, and anomers. Carbohydrates as fuel and structural molecules, antigens and cell recognition unit.

Unit – 4 **(7 Hours)**

Lipids in Biological system: Introduction and classification of lipids. Fatty acids (PUFA, MUFA) triacylglycerol, phospholipids, sphingolipids, glycolipids, and cholesterol. Role of lipids as storage fuel, hormones, vitamins, in signaling and in membranes.

Unit – 5 **(8 Hours)**

Structure and Organization of Nucleic acids: Introduction, purine and pyrimidine bases, nucleosides, nucleotides, and nucleic acid. Structure and functions of DNA (B form), organization of DNA into chromatin; RNA structure and functions. Biologically important nucleotides (cAMP and ATP).

PRACTICAL **(60 Hours)**

1) Laboratory safety and preparation of solutions (molar, normal and %).
2) Concept of pH and working of pH meter
3) Preparation of acetate buffer and phosphate buffer.
4) Properties and analysis of amino acids (Ninhydrin, and Xanthoproteic)
5) Test for carbohydrates (Molisch, Fehling/ Benedict, Seliwanoff's)
6) Qualitative analysis of nucleic acids (Orcinol and Diphenyl amine)

ESSENTIAL/ RECOMMENDED 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) 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) Pratt, C.W. and Cornely, K. (2017). Essential Biochemistry (4th ed.) John Wiley& Sons, Inc.ISBN:9781119012375

SUGGESTIVE READING:

1) Berg, J.M., Tymoczko J.L. and Stryer L. (2011). 7th Edition. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-13: 978142927635.

2) Campbell, M.K. and Farrel, S.O. (2017). 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135.

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

GENERIC ELECTIVES (GE-2): TECHNIQUES IN 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
		Lecture	Tutorial	Practical/ Practice		
Techniques in Biochemistry	4	2	0	2	Class XII Science	NIL

GE 2

Learning Objectives

The objective of the course is to introduce different biophysical techniques to students that are used in biological research for separation, purification and identification from mixture of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.

Learning outcomes

- Students will acquire knowledge about the principles and applications of separation and purification techniques like centrifugation and chromatography used in a biochemistry laboratory.
- Students will learn about the principles and applications of electrophoresis and spectroscopic techniques involved in estimation and identification of biomolecules.

- It will also give them an opportunity to get hands-on experience to develop their experimental skills which are required for biological research lab.

SYLLABUS OF GE – 2

Unit - 1 **(8 Hours)**

Separation techniques: Preparation of sample, different methods of cell lysis, salting out, dialysis. Principle and the factors affecting centrifugation Svedberg coefficient, types of rotors, principle and applications of differential and density gradient centrifugation.

Unit – 2 **(8 Hours)**

Purification techniques: Classification of chromatographic techniques, principle and applications: Paper, thin layer, molecular sieve, ion exchange, and affinity chromatography.

Unit - 3 **(7 Hours)**

Electrophoretic techniques: Principle of electrophoresis, various types of electrophoresis: Polyacrylamide gel (native), SDS PAGE and agarose gel, staining procedures for protein and nucleic acids.

Unit - 4 **(7 Hours)**

Spectroscopic techniques: Introduction to electromagnetic spectrum, Principle and working of UV-visible absorption spectrophotometer, single & double beam spectrophotometer, Beer's & Lambert's law, application of UV-visible spectrophotometer in biology.

Practical

(60 Hours)

1) Preparation of cell free extract from E.coli culture.
2) Separation and identification of amino acid acids by thin layer chromatography.
3) Separation of molecules by gel filtration chromatography.
4) Determination of absorption maxima (λmax).
5) Calculate molar extinction coefficient of the given sample.
6) Demonstration of PAGE and Agarose gel electrophoresis.

ESSENTIAL/RECOMMENDED READINGS

1) Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
2) Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.

3) 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.

SUGGESTIVE READING:

1) Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168.

2) Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2nd ed.), W.H. Freeman and Company (New York); ISBN:0-7167- 1315-2 / ISBN:0-7167-1444-2.

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

GENERIC ELECTIVES (GE-3): PUBLIC HEALTH 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
		Lecture	Tutorial	Practical/ Practice		
Public Health Biology GE 3	4	2	0	2	Open to All	NIL

Learning Objectives

The present course attempts to provide an interdisciplinary understanding of public health issues in India with a more detailed understanding of the areas pertaining to biological science and epidemiology. Some overview of the social aspects that impact public health will also be discussed and the statistical analysis of public health data will be taught in the practical. The specific objectives of the course are to provide a basic understanding of the scope of public health issues, particularly related to policies on public health, public health nutrition, infectious biology and sanitation, social and preventive medicine, and the environmental issues that affect public health. The practical exercises aim to provide hands-on training in epidemiology and collection of primary and secondary data relevant to public health issues. It also hopes to generate a discussion platform that would encourage a healthy inter- and multidisciplinary interaction amongst the students to get a holistic view of public health. A mini research project on any relevant topic related to public health will be taken up after completing the theory and practical components of the course. Being interdisciplinary in its nature and scope, the course will be equally engaging and beneficial for students of all subject streams. After completing the course, the students can also apply for some higher-level courses in different areas of public health as the course helps in building a basic understanding on different aspects related to public health.

Learning outcomes

On successful completion of the course

- Students will get a holistic overview of the interdisciplinary nature of Public Health
- They will understand public health issues in India particularly related to Malnutrition, sanitation issues and related burden of infectious disease, and the role of pollution as a public health concern.
- The students will also get an understanding of the public policies applicable and implemented in India.
- They will also be able to appreciate the social aspects that govern many public health issues and implementation of policies
- The students will get hands-on training in epidemiology, preparation of questionnaire and collection of primary and secondary data relevant to public health issues.
- They will also learn to present the relevant data after subjecting it to statistical analysis.

SYLLABUS OF GE – 3

THEORY

Unit – 1 **(04 Hours)**

Understanding public health issues: Conceptual understanding of public health, terminology, public health- multidimensional problem with Delhi as an example (air pollution, stress, sanitation, urbanization and socioeconomic inequalities) Policies on public health- factors affecting making and implementation of these policies.

Unit – 2 **(10 Hours)**

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

Unit – 3 **(06 Hours)**

Infectious biology and sanitation: Defining communicable diseases. Understanding the biology, socioeconomic factors and other environmental conditions that influence the transmission and infection by pathogenic (disease-causing) bacteria, viruses, parasites, and fungi. Precautions, prevention strategies and programs for control; sanitation, Swachh Bharat.

Unit – 4 **(10 Hours)**

Environmental Health & Community Health: Determinants of Environmental Health: factors that affect environmental health; Occupational environment and health concerns; Understanding effect of air, water and soil Pollution on health.

Understanding the definition of community health, Determinants of community health; Define and manage the health problems of the community, Plan, implement and evaluate various health programs of General Health, Reproductive health, Maternal health, Family Welfare and Disease control / eradication.

Lifestyle disease or non-communicable diseases- consequence of imbalanced nutrition, environmental and psychological stresses; Etiology and management of diseases like Obesity, Diabetes mellitus, Cardiovascular disorders, sleep disorders and psychological eating disorders. Preventive health checkups (PHC)- important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis

PRACTICAL

(60 Hours)

1) Assessment of nutritional status using anthropometric indices
2) Assessment of Nutritional status by a survey of clinical and non-invasive biochemical parameters.
3) To determine the potability of water using, pH, BOD, COD and MPN of the water sample from different sources.
4) Collecting secondary data on AQI from different areas and correlate with health indices in that area.
5) Understanding epidemiology: Collection, generation, and analysis of public health data. Application of statistical tools to analyze and present public health data.
6) Case study of a disease (Nutritional, infectious and lifestyle) along with the public health issues associated with that disease.
7) Field visits to nearby health care center to understand health checkups and collect some data on the rate of a particular disease over past few months or years.
8) Data collection from public domain with analysis.

ESSENTIAL/ RECOMMENDED READINGS

1) Aschengrau A, Seage G.R., (2013) Essentials of Epidemiology in Public Health Jones and Bartlett Publishers, Inc; 3rd edition
2) Bamji MS, Rao NP, Reddy V. (2017). Textbook of Human Nutrition. (4th ed). Delhi: Oxford and IBH Publishing Co. (P) Ltd.
3) Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
4) Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition. Academic Press, USA. 2014.

SUGGESTIVE READING:

1) Sullivan. L.M. (2017) Essentials of Biostatistics in Public Health. Jones and Bartlett Publishers, Inc; 3rd edition.
2) Gibney et al. (2004). Public health nutrition. Hoboken, NJ: Blackwell Publishing
3) N. Okafor. (2011) Environmental Microbiology of Aquatic and Waste Systems by Springer, USA.
4) Waste Water Microbiology by D.H. Bergey. 2nd Edition. Medtech, India. 2019.

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

DEPARTMENT OF MICROBIOLOGY

BSc. (H) Microbiology
Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) – Introduction to the Microbial World

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to the Microbial World DSC 1	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	Nil

Learning Objectives

The learning objectives of this course are as follows:

- Introduce students to the world of microorganisms.
- Students will be made familiar with the major milestones that led to the shaping of microbiology as a distinct discipline of science.
- Students will gain insights into the diversity of microorganisms, understand their structural features, and appreciate the role of microorganisms in our day-to-day lives as well as in the sustenance of life on earth.

Learning outcomes

After completing this course, student will be able to understand,

- The developments that led to the emergence of microbiology as a scientific discipline.
- The current systems of classification being used for microorganisms and learn about cell organization in microorganisms.
- Discourse on acellular forms of life such as viruses, viroids and prions.
- The Diversity, distribution, cell structure, reproduction and economic importance of protists.
- The diversity, distribution, structure, life cycles and economic importance of fungi.

- Extensive and impressive impact of microorganisms in our day-to-day life and become aware of the vast scope of microbiology and its allied fields.

SYLLABUS OF DSC - 1

THEORY

Unit – 1 **(09 Hours)**

The Evolution of Microbiology as a Discipline of Science: The discovery of microorganisms, contributions of Anton van Leeuwenhoek, spontaneous generation vs. biogenesis, the germ theory of disease, the golden era of microbiology and major developments in the different fields of Microbiology in the late 20th century. Key contributions of the following scientists: Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Elie Metchnikoff, Ronald Ross, Dmitri Ivanovsky, Martinus Beijerinck, Stanley Prusiner, Paul Ehrlich, Alexander Fleming, Selman Waksman, Sergei N Winogradsky and Anand Mohan Chakraborty

Unit – 2 **(03 Hours)**

Classification Systems: Whittaker's five kingdom classification system and Carl Woese's three domain classification system. Overview of acellular (viruses) and cellular micro-organisms (eubacteria, archaea, protista, fungi). Prokaryotic and Eukaryotic cell structure.

Unit –3 **(15 Hours)**

Brief introduction to viruses: Structure (genetic material, capsid symmetry, envelope), host range, cultivation, bacteriophages (lytic and lysogenic). General characteristics of viroids and prions. Algae: General characteristics including occurrence and thallus organization. Criteria for classification of algae: cell wall composition, pigments, flagellation, food reserves. Cell structure and reproduction of Chlamydomonas and Chlorella. Economic importance of algae. Protozoa: General characteristics of protozoa with a reference to cell structure, modes of locomotion, modes of nutrition, and modes of reproduction. Morphology and importance of Entamoeba histolytica, Tetrahymena and Giardia. Ecological importance of protozoa.

Unit – 4 **(09 Hours)**

Fungi: General characteristics: morphology, cell structure, nutritional requirements, cultivation, preservation and reproduction (asexual and sexual cycles). Structure, life cycle and economic importance of *Saccharomyces*, *Rhizopus, Aspergillus,* and *Agaricus*.

Unit – 5 **(09 Hours)**

The scope of microbiology: an overview. Food and dairy industry: fermented foods, single cell protein. Human health and medicine: human microbiome, probiotics, vaccines, phage therapy.

Microbes in environment: bioremediation, bioleaching, waste management, biogas, bioethanol, carbon sequestration. Microbes in agriculture: biocomposting, biofertilizers, biopesticides. Industrially important microbial products: organic acids, amino acids, antibiotics, enzymes, polysaccharides. Space microbiology: Current developments.

PRACTICAL

Unit –1 **(14 Hours)**

Principles of Good Laboratory Practice (GLP) and Introduction to aseptic techniques: Principles of Good Microbiological Laboratory Practices (GMLP). Concept of biosafety levels (BSLs). Work practices, safety equipment and protective measures to be used in laboratories of the different categories of biosafety levels BSL-1 to BSL-4. Microorganism risk groups: BSL-1 to BSL-4 microorganisms. Methods of disposal of microbial cultures. Sterilization by moist heat, mechanical (filtration), irradiation (UV), chemical (alcohol). Instruments for sterilization: Principle, working and applications of autoclave and hot air oven

Unit –2 **(16 Hours)**

Study of eukaryotic microorganisms: To study the morphological features and reproductive structures of the following using permanent slides/photographs: Fungi: *Rhizopus*, *Aspergillus, Penicillium, Saccharomyces.* Algae: *Chlamydomonas*, *Chlorella, Spirogyra.* Protozoa: *Amoeba, Paramecium, Entamoeba histolytica, Giardia.* To prepare temporary mounts of any two fungi and two algae from those mentioned above

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) Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
4) Algal Biotechnology: Products and Processes. Edited by Bux F. and Chisti Y. 1st edition. Springer, Switzerland. 2016.
5) Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.
6) Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill,USA. 1993.

Practical:

1) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson

Education, USA. 2020.

2) Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology by A. Ray and R. Mukherjee. Taurean Publisher, India. 2019.
3) Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
4) Manual of Microbiology: Tools & Techniques by A.K. Sharma. 1st edition. Ane Books, India. 2007.

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): BASIC

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BASIC BACTERIOLOGY DSC 2	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning objectives of this course are as follows:

- Students to acquire in-depth knowledge of bacterial cell structure and organization, cultivation methods and growth patterns, and reproduction.
- Student gains insights into the vastness of bacterial diversity and its significance.

Learning Outcomes

After completing this course, student will be able to,

- Understand the morphological features and cellular organization of bacteria and archaea, and distinguish between cell wall and cell membrane compositions of gram positive bacteria, gram negative bacteria, and archaea. Will gain insights into the roles of enzymes and antibiotics affecting cell wall structure as well as the formation of spheroplasts, protoplasts, and L forms.
- Isolate pure bacterial cultures and enumerate bacteria using serial dilution and plating techniques. Will learn about various culture media and methods employed to maintain bacterial cultures and preserve bacteria.
- Comprehend the different phases of bacterial growth, and the consequences of binary fission as a means of reproduction. Will learn about various nutritional and physical factors affecting bacterial growth.
- Prepare various types of media; understand the use of membrane filtration to sterilize heat sensitive media components; have hands-on experience of isolating bacteria and fungi from air.
- Streak bacterial cultures on nutrient medium, prepare bacterial slants and stabs, and enumerate bacteria by different plating methods.

SYLLABUS OF DSC - 2

THEORY

Unit – 1 **(15 Hours)**

Structure and organization of the bacterial cell wall and appendages: Shapes, sizes and arrangements of bacterial cells. Cell wall and cell membrane organization: Structure of cell wall in Eubacteria and Archaea, difference between cell wall structure and composition of Gram positive versus Gram-negative bacterial, structure of outer membrane, difference between eubacterial and archaeal cell membranes. Bacteria lacking cell walls, action of antibiotics and enzymes on bacterial cell wall, formation of protoplasts, spheroplasts and L forms. Cell envelope layers outside the cell wall: capsule, slime layer, glycocalyx, S-layers. External appendages: flagella, fimbriae and pili.

Unit – 2 **(09 Hours)**

Cytoplasmic organelles: ribosomes, mesosomes, nucleoid, chromosome and plasmids, intracytoplasmic membranes, inclusions (storage inclusions: PHB, polyphosphate granules, sulfur globules, cyanophycin granules; micro-compartments: Carboxysome; other inclusions: magnetosome, gas vacuole).

Unit – 3 **(09 Hours)**

Bacteriological techniques: Culture media: Chemical types (synthetic and complex), Functional types (supportive and enriched, selective and differential). Cultivation of aerobes and anaerobes, concept of viable but non culturable bacteria (VBNC). Culturing and Preservation methods: Streaking of bacterial culture, spread- plating, serial dilution plating, counting viable cells. Enrichment culture technique. Preservation of bacteria and maintenance of stock cultures. Microbial culture collection centers (ATCC and MTCC).

Unit – 4 **(12 Hours)**

Bacterial growth and reproduction: Different phases of bacterial growth in a batch culture, determination of generation time, analysis of growth rate. Factors affecting bacterial growth: Nutritional and physical factors. Endospore: Structure, formation, stages of sporulation and germination of endospore. Methods of asexual reproduction: budding, fission and fragmentation.

PRACTICAL

Unit– 1 **(14 Hours)**

Introduction to bacterial growth and analysis: Principle, working and applications of instruments used in cultivation and morphological analysis of microorganisms: bacteriological and BOD incubators, light microscope (using simple staining of bacteria). Concept of laminar flow: biological safety cabinets of levels 1 to 4. Preparation of media and capture of aeroflora: Preparation of Synthetic medium (minimal medium) and Complex media (nutrient agar, potato dextrose agar, MacConkey agar). Capture of aero-microflora on nutrient agar and potato dextrose agar plates.

Unit – 2 **(16 Hours)**

Isolation, preservation and quantitation of bacteria: Isolation of pure cultures of bacteria by Quadrant streaking method on nutrient agar plates. Preparation of bacterial culture slants and stabs on nutrient agar. Preservation of bacterial cultures by preparation of glycerol stocks.

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) Microbiology: Principles and Explorations by J.G. Black and L.J. Black. 10th edition. Wiley, USA. 2019.
4) Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
5) Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA. 1997.
6) Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill, USA. 1993.

Practical

1) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
2) Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology by A. Ray and R. Mukherjee. Taurean Publisher, India. 2019.
3) Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
4) Manual of Microbiology: Tools & Techniques by A.K. Sharma. 1st edition. Ane Books, India. 2007.

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

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3)
BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS DSC 3	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Enable the students to develop a clear understanding of the structures and properties of biomolecules: proteins, lipids, carbohydrates and nucleic acids, and lays the foundation for a basic understanding of cellular processes.
- The students will be given an understanding of the principles of thermodynamics and bioenergetics, and will be introduced to the basic concepts of enzymes and enzyme kinetics.
- This course will empower the students with essential knowledge to support learning in subsequent courses offered in the program.

Learning Outcomes

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

- Comprehend the principles of thermodynamics as applied to biological systems and will be able to comment on the rate constants and feasibility of biochemical reactions by calculating free energy changes.
- Understand the structures and properties of various types of carbohydrates and will be able to relate the structures of simple and complex carbohydrates to their wide range of functions. Will gain knowledge of the role of sugars and their derivatives in formation of macromolecules /supramolecular complexes.
- Understand the building block of lipids: fatty acids and their properties. Will acquire a clear understanding of the structures, properties and functions of storage and membrane lipids. Will learn different types of lipid aggregates and their applications.

- Prepare buffers and solutions of different molarity and normality and will be adept in the use of fine weighing balances and pH meter.
- Analyze foodstuff for their microchemical composition, and will be able to detect the presence of carbohydrates and fats in samples by performing qualitative tests. Will become familiar with the use of spectrophotometer.

SYLLABUS OF DSC – 3

THEORY

Unit – 1 **(09 Hours)**
Bioenergetics and thermodynamics: Laws of thermodynamics. Gibbs free energy: exergonic and endergonic reactions. Enthalpy: exothermic and endothermic reactions. Entropy, standard free energy change and actual free energy change, equilibrium constant and spontaneous reactions. Coupled reactions and additive nature of standard free energy change. Energy rich compounds: ATP, BPGA, Acetyl CoA.

Unit – 2 **(15 Hours)**
Carbohydrates: Introduction to mono-, di- and polysaccharides. Monosaccharides: aldoses and ketoses. Stereoisomers: enantiomers, epimers, diastereoisomers, mutarotation and anomers. Fischer and Haworth formulae of sugars. Sugar derivative: O-,N-glycosides. Disaccharides: Structures and properties of maltose, lactose, and sucrose reducing and non- reducing sugars. Polysaccharides: storage polysaccharides (starch and glycogen), structural polysaccharides (cellulose, chitin, peptidoglycan, pectin).

Unit – 3 **(09 Hours)**
Storage Lipids: Introduction to storage and structural lipids. Storage lipids: triacylglycerols, building blocks, fatty acids structure and properties, essential fatty acids, saponification.

Unit – 4 **(12 Hours)**
Structural Lipids: Membrane lipids: phosphoglycerides (building blocks, structure of phosphatidylethanolamine and phosphatidylcholine). Sphingolipids: building blocks, structure of sphingosine, ceramide, general structure and functions of sphingomyelin, cerebroside and ganglioside. Lipid functions. Lipid aggregates: micelles, monolayers, bilayers and liposomes

PRACTICAL

Unit– 1 **(14 Hours)**
Preparation of buffers and solutions: Concepts of molarity versus normality. Preparation of simple stock solutions of different molarities: sodium chloride, potassium permanganate, magnesium chloride solutions. Concept of pH. Role of buffers in biochemical reactions. Buffers

of different pH ranges. Commonly used buffers in biochemical assays. Principle, calibration and use of pH meter. Preparation of two commonly used buffers: phosphate buffer, citrate buffer. Preparation of complex buffered stock solutions. Preparation of working solutions.

Unit– 2 **(16 Hours)**

Qualitative biochemical analyses: The use of pipettes and micropipettes. Cleaning and calibration of micropipettes. Principles and performance of qualitative tests for the detection of reducing and non-reducing sugars: Benedict's Test, Fehling's Test, Molisch Test; and starch: Iodine Test. Detection of lipids using Solubility Test, Osmic acid Test, Acrolein Test, Sudan III Test.

ESSENTIAL/RECOMMENDED READINGS

Theory

1) Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.
2) Biochemistry by J.M. Berg, J.L.Tymoczko, G.J. Gatto, and L. Stryer. 9th edition. W.H. Freeman and Company, UK. 2019.
3) Biochemistry by T.A. Brown and S.N. Mukhopadhyay. 1st edition. Viva Books, India. 2018.
4) Fundamentals of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt. 5th edition. John Wiley and Sons, UK. 2016.

Practical

1) Practical Biochemistry by R.C. Gupta and S. Bhargava. 5th edition. CBS Publishers and Distributors, India. 2018.
2) An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.
3) Introduction to Practical Biochemistry (ebook) by G. Hegyi, J. Kardos, M. Kovacs, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L. Radnai, A. Remenyi and I. Venekei. Eotvos Lorand University. 2013.
4) Modern Experimental Biochemistry by Rodney Boyer. 3rd edition. Pearson, India. 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 Department of Microbiology

GENERIC ELECTIVES (GE-1): INTRODUCTION AND SCOPE OF MICROBIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVE (GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introduction and scope of microbiology GE 1	4	2	0	2	None	NIL

Learning Objectives

The learning objectives of this course are as follows:

- Give students an overview of three major themes: History and scope of Microbiology, microbial diversity (prokaryotes, eukaryotes, and viruses), and the role of microbes in human lives.
- Students will gain insights into how microorganisms affect the everyday lives of humans in both beneficial and harmful ways.
- Students will become familiar with the techniques used in isolation and cultivation of microorganisms, and will learn how to identify microorganisms in the laboratory.

Learning outcomes

Upon completion of this course, students will

- Become familiar with the history of Microbiology, and understand how Microbiology developed as a distinct discipline of science during the golden era of microbiology. Will become familiar with some of the later developments of the 21st century.
- Acquire an understanding about the placement of microorganisms in the tree of life. Will

know about key differences between prokaryotic and eukaryotic organisms. Will also be acquainted with structure of viruses, general characteristics and importance of algae, fungi and protozoa.

- Understand the importance of microbe-human interactions, becoming aware of microorganisms as agents of human diseases. Will become aware of the important role that microorganisms play in food, agriculture, industry, biofuel and in the clean-up of the environment.
- Become aware of good microbiological laboratory and safety practices, and be acquainted with the working of basic microbiological equipment routinely used in the laboratory. Will also be acquainted with the aseptic techniques used for culturing bacteria and fungi.
- Gain hands-on experience in isolation of bacteria and fungi from air and will be acquainted with staining techniques used for observing bacteria, algae and fungi. Will learn the use of compound microscope.
- Get acquainted with different shapes and arrangement of bacteria. Will be able to identify algae, fungi, protozoa using permanent slides/photographs. Will be able to understand the structure of viruses using electron micrographs.

SYLLABUS OF GE - 1

THEORY

Unit – 1 **(08 Hours)**

History of Microbiology: Some key milestones in the field of microbiology: Contributions of Antonie van Leeuwenhoek. Controversy over spontaneous generation. Louis Pasteur and concept of pasteurization. Robert Koch and germ theory of diseases, and concept of pure culture. Edward Jenner and cowpox immunization. Ivanovsky & Beijerinck and the discovery of viruses. Winogradsky and the development of soil microbiology. Golden era of Microbiology.

Unit – 2 **(12 Hours)**

Microbial Diversity: Position of microorganisms in the living world. Whittaker's five kingdom classification. Carl Woese's three domain classification. Detailed characteristics of prokaryotic and eukaryotic organisms with examples of *E. coli* (bacterium) and *Saccharomyces* (yeast). Acellular organisms: structure and genome of Tobacco mosaic virus, polio virus and bacteriophage T4. General characteristics, habitat and economic importance of algae, fungi and protozoa.

Unit – 3 **(10 Hours)**

The impact of microorganisms on humans: Causal organism and transmission of common human diseases: typhoid, tuberculosis, cholera, malaria, gastroenteritis, influenza. Microorganisms and their applications in agriculture: nitrogen fixers and mycorrhiza. Role of microorganisms in the environment: microbial remediation of pollutants. Applications of microorganisms in food and industry: fermented foods and probiotics, biofuel (biogas), antibiotics and enzymes.

PRACTICAL

Unit – 1 **(24 Hours)**

History of Microbiology: Microbiological laboratory practices, and equipment: Good Microbiology laboratory practices and general safety measures while working with microbes. Physical and chemical hazards and immediate first aid. Principle, working and applications of instruments: autoclave, hot air oven, biosafety hood, incubator and light and compound microscope. Demonstration and performance of aseptic technique for culturing of bacteria and fungi.

Unit – 2 **(16 Hours)**

Microbial Diversity: Study of aero microflora by exposing nutrient agar plate at different locations and comparing diversity on the basis of colony morphology. Demonstration of bacterial smear preparation from suitable sample/culture followed by Gram staining and observation under oil immersion objective. Preparation of stained temporary mounts of any one fungus (*Rhizopus*/ *Penicillium*) and any one alga (*Chlamydomonas*/ *Spirogyra*).

Unit– 3 **(20 Hours)**

The impact of microorganisms on humans: Study of shape and arrangement of following bacteria / bacterial structures using permanent slides: bacillus, coccus, spirillum and endospore. Study of vegetative and reproductive structures of following algae using permanent slides: *Chlamydomonas*, *Spirogyra* and *Polysiphonia*/Fucus. Study of vegetative and reproductive structures of following fungi and protozoa using permanent slides: Fungi: *Rhizopus, Penicillium* and *Agaricus*. Protozoa: *Amoeba*, *Paramecium, and Giardia*. Study of structure of the following viruses using electron micrographs: Tobacco mosaic virus, T4 bacteriophage and poliovirus.

ESSENTIAL/ RECOMMENDED READINGS

1) Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley, W.Sattley and Stahl.16th edition. Pearson, USA. 2021.

2) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.

3) Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

4) Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition.

Pearson, USA. 2018.

5) Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
6) Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.
7) Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill,USA. 1993.

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GENERIC ELECTIVES (GE-2): MICROBES IN HEALTH AND HYGIENE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Microbes in health and hygiene GE 2	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce the students to the role of microorganisms in human health.
- Students will be exposed to the importance of microbe-human interactions when learning about the human microbiome. T
- Make the students aware of common diseases caused by microorganisms and will develop an understanding of probiotics and their importance in human health.
- Introduce bacteriophages and their application in treatment/control of bacterial infections.

Learning outcomes

At the end of this course, the students will

- Be acquainted with the importance of the human microbiome including the benefits as well as possible harmful effects. They will have a fair knowledge of various types of microorganisms surviving on/in the human body.
- Have gained knowledge about the spectrum of diseases caused by bacteria, viruses, protozoa and fungi. They will be familiar with the methods of transmission and control of various diseases.
- Have understood the role of probiotics in human health. They will have learnt about the characteristics of probiotic microorganisms and have a fair idea of prebiotics and synbiotics. They will also have an overview of bacteriophages and their role in therapy.
- Acquire expertise in isolation of microorganisms from skin and staining of microorganisms collected from oral cavity, and will be able to check the efficacy of the sanitizer and antimicrobial action of heavy metals.
- Will acquire understanding of various probiotic products available in the market and the organisms included in these products. They will receive hands-on training for evaluation of various probiotic products and microbial strains.
- Gained understanding of bacteriophage typing and will also have hands on training in the isolation of bacteriophages from sewage samples.

SYLLABUS OF GE – 2

Unit - 1 **(08 Hours)**
Role of microbiome in human health: Importance of human microbiome in health. Factors affecting the survival and colonization of microorganisms on various organs including skin, throat and upper respiratory tract, gastrointestinal tract and genitourinary tract. Understanding the human microbiome using animal model systems: *C. elegans*, mice, zebrafish. Strengths and weaknesses of using these systems for human microbiome studies. Technologies for assaying the human microbiome: direct observation methods, molecular profiling techniques, sequencing methods, strengths and weaknesses of the technologies

Unit – 2 **(12 Hours)**
Microorganisms in human diseases: A concise overview of aetiology, symptoms, transmission and control of some common diseases: bacterial (tuberculosis, cholera, typhoid, diphtheria), viral (rabies, hepatitis, zika, COVID , polio, AIDS), protozoan (malaria, kala azar) and fungal diseases (dermatophytoses, candidiasis, aspergillosis).

Unit - 3 **(10 Hours)**
Microbes for maintaining human health: Brief description and distinction between prebiotics, probiotics and synbiotics. Probiotics for maintaining human health: prerequisite characteristics of probiotic strains, common probiotic bacterial strains, modes of action of probiotics, probiotic

supplementation for disease management. Bacteriophage therapy: concept and challenges. A brief account of bacteriophage therapy for various diseases.

Practical

Unit - 1 **(24 Hours)**

Study of human microflora: Isolation of microorganisms from skin by swab method using specific media: nutrient agar, mannitol salt agar, potato dextrose agar. Gram staining of bacterial isolates and lactophenol staining for fungal isolates. Gram staining of dental scrapings/plaques. Checking the efficacy of sanitizer on skin. study of the oligodynamic effect of metals on bacterial cultures. **Student group project**: multiple methods for sampling microbial biomass specimens for oral, skin, gut and respiratory microbiomes.

Unit - 2 **(24 Hours)**

Study of probiotics: Student group project: Conduction of a market survey to identify different probiotic products available in the market. Isolation and basic characterization of bacteria from probiotic products. Bacterial cell surface hydrophobicity (CSH) test to estimate bacterial adherence. Performance of acid and bile resistance test on bacterial strains.

Unit - 3 **(12 Hours)**

Bacteriophage isolation and typing: Principle, process and limitations of bacteriophage typing. Isolation of bacteriophages from sewage sample using double layer technique. Student group project: Phage therapy in India.

ESSENTIAL/RECOMMENDED READINGS

1) Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and
   a. 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) Cappucino, J. and Sherman, N. (2014). Microbiology: A Laboratory Manual. 10th edition. Pearson Education, India.
7) Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A. (2007). Mackie and Mccartney Practical Medical Microbiology. Elsevier 14th edition 1996.
8) Randhawa, V.S., Mehta, G. and Sharma, K.B. (2009). Practicals and Viva in Medical Microbiology. 2nd edition. Elsevier, India.

9) Fuller, R. (2012). Probiotics: The Scientific Basis. Springer Netherlands.
10) Dhanasekaran, D. and Sankarnarayanan, A (2021). Advances in Probiotics, Microorganisms in Food and Health. Academic Press.

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

GENERIC ELECTIVES (GE-3): FOOD FERMENTATION AND PRESERVATION TECHNIQUES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Food fermentation and preservation techniques GE3	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The learning objectives of this course are as follows:

- Develop clear understanding about the microorganisms important in food and various factors affecting their growth.
- The students will gain in depth knowledge about food fermentation, their benefits and the processes involved in production of fermented foods.
- The concept of probiotic, prebiotic and synbiotics will also be discussed. The course also deals with the principle and the techniques involved in processing and preservation of food substances.
- The students will also be trained and be given hands on training in various microbiological techniques involved in food fermentation and food preservation. The course on completion can open many career options.

Learning outcomes

After the completion of this course, the students will have understanding and knowledge of the following

- Microbes important in food, their morphological, cultural, and physiological characteristics, and factors influencing their growth
- Fermented foods and their health benefits. Also, will be acquainted with the microbes and their processes involved in production of fermented foods.
- Causes of food spoilage and be aware of different preservation techniques used to increase the shelf life of food products.
- Acquired hands on experience in isolating and characterizing microbes from food.

- Become familiar with the principle of food fermentation by production of fermented foods in the laboratory.
- Various microbiological and biochemical testing techniques used for assessing the efficacy of various food preservation techniques.

SYLLABUS OF GE - 3

Unit - 1 **(06 Hours)**

Microorganisms in Food Microbiology: Introduction to microorganisms important in foods: morphological, cultural and physiological characteristics of moulds (*Aspergillus, Rhizopus*), yeast (*Saccharomyces)*, and bacteria (*Lactobacillus, Acetobacter),* Factors affecting microbial growth in foods- intrinsic (pH, water activity, mechanical barriers and redox potential) and extrinsic (temperature, gaseous atmosphere).

Unit – 2 **(12 Hours)**

Food Fermentation: History, definition and benefits of fermented foods. Types of food fermentations (acid-, yeast-, solid state-, oriental and indigenous fermented foods). Production and maintenance of microbial cultures involved in food fermentation, starter culture and its problems. Production of dairy (dahi, yoghurt, kefir, cheese) and non-dairy fermented foods (dosa, kanji, sauerkraut, tempeh, soy sauce), beverages (beer, wine) and concept of pre-, pro- and syn- biotics.

Unit – 3 **(12 Hours)**

Principles of food preservation: Definition and causes of food spoilage. Classification of food by ease of spoilage. General principles of food preservation. Preservation by low temperature: freezing & refrigeration. Preservation by high temperature: pasteurisation and canning. Preservation by moisture control: drying and dehydration. Preservation by radiation: Gamma, microwaves and UV rays. Preservation by added food preservatives: salt, sugar, benzoate, nitrite and nitrate, wood smoke, nisin. Preservation by developed preservatives, modified atmosphere packaging.

PRACTICAL

Unit – 1 **(12 Hours)**

Isolation and characterisation of microbes important in food: Isolation and microscopic examination of fungi from a spoiled bread. Isolation of lactic acid bacteria from curd using MRS medium and microscopic characterisation by Gram's staining. Effect of different temperatures/ salt concentration on microbial growth.

Unit – 2 **(24 Hours)**

Food fermentation: Preparation of kefir using kefir grains/ fermented cabbage (sauerkraut). Viability test for yeast using methylene blue. Survey on the availability and usage of various probiotic foods from market

Unit – 3 **(24 Hours)**

Food Preservation: Effect of blanching on food preservation. Incubation test for cans/ tetrapack to determine sterility. Alkaline phosphatase test to check efficiency of pasteurization of milk: principle, performance of the test with various pasteurized milk samples, evaluation of milk quality based on results obtained. Assessment of efficiency of sterilisation of milk: principle and performance of Turbidity Test and evaluation of milk quality based on obtained results

ESSENTIAL/ RECOMMENDED READINGS

1) Food processing and preservation by H. Naik and T. Amin. CRC Press. 2022.
2) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3) Microbiology and Technology of fermented foods by R. Hutkins. 2nd edition. Wiley Blackwell, UK. 2019.
4) Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2017.
5) Handbook of fermented functional foods by F. Edward. 2nd Edition. CRC press, UK. 2016.
6) FSSAI Manual of methods of analysis of foods. Food safety and standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2015.
7) Advances in Fermented Foods and Beverages by W. Holzapfel. 1st edition. Woodhead Publishing, USA. 2014.
8) Handbook of food and beverage fermentation technology by Y. Hui, L. Meunier- Goddik, J. Josephsen, W. Nip and P. Stanfield. 1st edition. CRC Press, UK. 2004.

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

GENERIC ELECTIVES (GE-4): MICROBIAL QUALITY CONTROL AND TESTING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Microbial quality control and testing GE 4	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The learning objectives of this course are as follows:

- Underscore the importance of microbiological quality control in various sectors.
- Students will gain in-depth knowledge about criteria and procedures for safety in quality assurance in water, food and pharmaceutical sector. They will become proficient in various microbiological techniques used for quality testing of samples will be discussed.
- Students will gain hands-on training in basic microbiological techniques used for quality testing.

Learning outcomes

After completing this course, students will

- Gain an understanding of microbiological quality through Good Microbiological laboratory Practices (GMLP), biosafety levels, quality control of microbiological culture media, sterilization and antimicrobial susceptibility test.
- Have learnt methods to assess potability of drinking water, and become aware of Hazard analysis critical control point (HACCP) for food safety, as well as microbial limits in food and pharmaceutical products. Will be familiar with various microbiological standards and certifications by accredited certification bodies.
- Gained insights into various microbiological, biochemical, molecular and immunological testing techniques used for assessing quality of drinking water and food products.
- Will acquire ability to analyze the potability of water by performing various microbiological tests.

- Be capable of performing various biochemical and microbiological tests used to evaluate the quality of milk, packaged foods, pharmaceutical formulation and will gain knowledge about using phenol coefficient test for assessing quality of disinfectants.
- Will acquire understanding of designing HACCP plan for any food product manufacture like milk processing and packaging.

SYLLABUS OF GE - 4

Unit -1 **(06 Hours)**

Safety practices and quality control in microbiology: Principles of Good microbiological laboratory practices (GMLP), Concept of biosafety levels (BSLs), Safety equipment and protective measures used in different categories of biosafety levels laboratories. Examples of microorganisms that are classified as BSL-1 to BSL-4. Quality control of microbiological culture media, sterilization, antimicrobial susceptibility test.

Unit -2 **(10 Hours)**

Quality control and assurance in water, food and pharmaceutical sector: Water potability: criteria and procedures for quality assurance of drinking water, recommended quality control strains for water testing, recommendations of Environmental Protection Agency (EPA) for drinking water quality. Food safety and microbiology: overview of health hazards related to food, Hazard analysis of critical control point (HACCP) for food safety. Role of Codex Alimentarius Commission (CAC) in safety of food and agriculture products. BIS standards, FSSAI standards, ISO certification. Sterility testing of food and pharmaceutical products: importance and objectives, microbial limits.

Unit -3 **(14 Hours)**

Microbial quality control tests: Collection and processing samples for testing. Detection of microorganisms and sample testing by culture and microscopic methods: direct microscopic counts (fluorescence-based), standard plate count method, selective media (Salmonella-Shigella agar, mannitol salt agar, EMB agar, McConkey agar), Bioburden testing, Most Probable Number (MPN), membrane filtration test, phenol coefficient test. Detection of microorganisms and sample testing by molecular methods: nucleic acid probes, PCR-based detection. Biosensors. Detection of microorganisms and sample testing by biochemical and immunological methods: Endotoxin testing by Limulus lysate test, pyrogen testing, rapid detection methods by Clot-on-Boiling Test (COB), Resazurin assay

PRACTICAL

Unit – 1 **(12 Hours)**

Water potability: Testing potability of water samples by standard procedures: Most Probable Number method (MPN) /presumptive test, confirmed test, completed test for faecal contamination: principles of the methods, performance of the tests with various water samples using differential and selective media, evaluation of the water quality based on the results obtained. Testing water potability by using standard kits

Unit – 2 **(24 Hours)**

Food quality control and assurance: Assessment of the microbiological quality of raw versus pasteurized milk by Methylene Blue Dye Reduction Test (MBRT), evaluation and grading of milk quality based on the results obtained. Clot on boiling (COB) test of milk samples: principle, performance of the test with milk samples, and evaluation of milk quality based on results obtained. Sterility testing of canned food, tetra pack drinks and any pharmaceutical formulation (eye drops/ injection ampules) by either using the membrane filtration test or by standard plate count method. Detection of microorganisms in food samples through any one differential and selective medium. Demonstration of phenol coefficient test to evaluate efficacy of disinfectants using standard kits.

Unit – 3 **(24 Hours)**

HACCP: Student research study project: Designing of HACCP plan for milk processing and packaging or any other food product: product description, flowchart of production, assessing hazards and risks associated with different steps of production till consumption, identification of critical control points (CCP) and critical limits, suggestive procedures to monitor CCPs and corrective actions, effective record keeping to document the HACCP plan, and procedures for verification

ESSENTIAL/ RECOMMENDED READINGS

1) Analytical Food Microbiology: A Laboratory Manual by A.E. Yousef, J.G. Waite-Cusic and J.J. Perry. 2nd edition. Wiley Publishers, UK. 2022.
2) Laboratory Manual of Food Microbiology by N. Garg, K.L. Garg and K.G. Mukerji. Dreamtech Press, India. 2021.
3) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
4) Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition.
5) McGrawHill Higher Education, USA. 2019.
6) Food Safety & Quality Control by P. Mathur. Orient Black Swan Pvt. Ltd., India. 2018.
7) Manuals of methods of analysis of foods and water by Food safety and standards authority of India, Ministry of health and family welfare, Government of India, 2016.
8) Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2013.

9) Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices by R.M. Baird and S.P. Denver. 1st edition, CRC Press, U.K. 2000.
10) Microbiological Analysis of Food and Water: Guidelines for Quality Assurance by N.F. Lightfoot and E.A. Maier. Elsevier Science. 1998.
11) Essentials of Food Microbiology by J.H. Garbutt. 2nd edition. Hodder Arnold Publishers. 1997.

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

GENERIC ELECTIVES (GE-5): MICROBES IN ANIMAL HEALTH

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Microbes in animal health GE 5	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The learning objectives of this course are as follows:

- Introduce the students to the importance of microorganisms in animal health.
- Students will learn about the interactions of microbes with various types of livestock and pet animals. Students will be introduced to various bacterial, fungal, viral and protozoan diseases of animals.
- They will be introduced to various types of microorganisms residing in rumen, and learn about various methods for obtaining blood, rumen fluid and milk samples from animals.
- They will be introduced to principles of various diagnostic methods used in lab diagnosis of animal infections. Students will learn about the vaccination schedule followed for cattle and poultry.

Learning outcomes

After the completion of this course, the students will acquire understanding of the following:

- Various types of livestock and pet animals, rumen microflora, and their advantages and disadvantages.
- Spectrum of diseases caused by bacteria and fungi in animals, becoming familiar with the symptoms, transmission mode, treatment, prevention and control of various bacterial and fungal diseases.
- Symptoms, transmission, treatment, prevention and control of various diseases caused by viruses and protozoa.
- Various methods of sampling of blood and rumen fluid. Will have had hands-on training for the detection of mastitis by testing milk samples.
- Principles of serological tests based on agglutination, precipitation, haemagglutination inhibition, ELISA and lateral flow assays for diagnosis of animal diseases/infection.
- Vaccination schedule followed for cattle, buffalo and poultry. They will learn the concept of differentiation between the vaccinated and infected animals.

SYLLABUS OF GE - 5

Unit – 1 **(08 Hours)**

Introduction to livestock and rumen microflora: A brief introduction of various types of livestock and pet animals: cattle, sheep, goat, dogs, cats and poultry. Different types of microbes in rumen along with their functions: archaebacteria (methanogens), bacteria, protozoa, fungi (cellulolytic and proteolytic).

Unit – 2 **(12 Hours)**

Bacterial and fungal diseases of animals: A concise overview of aetiological agent, symptoms, transmission, treatment, prevention and control of the following bacterial and fungal diseases: anthrax, brucellosis, mastitis, Johne's disease, campylobacteriosis, black quarter, haemorrhagic septicemia (HS), aspergillosis and mucormycosis.

Unit - 3 **(10 Hours)**

Viral and protozoan diseases of animals: An overview of aetiological agent, symptoms, transmission, treatment, prevention and control of following viral diseases: foot and mouth disease (FMD), rinderpest/PPR, blue tongue disease, avian influenza, canine distemper, rabies, babesiosis, theileriosis and trypanosomiasis.

PRACTICAL

Unit – 1 **(16 Hours)**

Sampling methods for obtaining blood, rumen fluid and milk: Sampling of blood from cattle, sheep, goat, dog, cat, mice and poultry by virtual lab. Sampling of rumen fluid: syringe, rumenotomy by virtual lab/video. Sampling of milk: California mastitis test

Unit – 2 **(28 Hours)**

Serological tests for diagnosis of infectious agent: Principle and working method of: Agglutination, precipitation, haemagglutination inhibition assay, ELISA, and Lateral flow assay for antigen detection.

Unit – 3 **(16 Hours)**

Vaccination of livestock animals: Concept of differentiation between infected and vaccinated animal (DIVA test) for FMD and brucellosis. **Student group project**: Research study and review of the vaccination schedules for cattle, buffalo and poultry.

ESSENTIAL/ RECOMMENDED READINGS

1) Brock Biology of Microorganisms by M.T. Madigan, K.S. Bender, D.H. Buckley, W.M. Sattley and D.A. Stahl. 16th edition. Pearson Education, USA. 2021.
2) Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020
3) Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4) Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
5) Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition.Universities Press, India. 2017.
6) 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.
7) Veterinary Microbiology by D. Scott McVey, Melissa Kennedy and M.M. Chengappa. 3rd edition. Wiley – Blackwell, USA. 2013.
8) Handbook of Good Dairy Husbandry Practices. National Dairy Development Board (NDDB).
9) Practicals and Viva in Medical Microbiology by V. Randhawa, G. Mehta and K. Sharma. 2nd edition. Elsevier, India. 2009.
10) Mackie and McCartney Practical Medical Microbiology by J. Collee, A. Fraser, B. Marmion and A. Simmons. 14th edition. Elsevier publications. 1996

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

Department of Electronic Sciences

BSc. (Hons.) Electronics

Category-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		
Programming Fundamentals using Python ELDSC-1	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:
This course introduces the student to the fundamental understanding of the Python programming language. The main objective is to help students learn to use the Python programming language to solve problems of interest to them. It introduces the core programming basics including data types, operators, input/output, control structures, iterative and recursive constructs, compound data types, and program design with functions. The course also discusses the fundamental principles of Object-Oriented Programming (OOP), as well as comprehensive data and information processing technique.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Read, write and debug python programs to solve computational problems.

CO2 Select and use a suitable programming construct and data objects like lists, sets, tuples and dictionaries for solving a given problem.

CO3 Be proficient in the handling of strings and functions

CO4 Use Python libraries

CO5 Articulate OOP concepts such as encapsulation, inheritance and polymorphism and use them in applications

SYLLABUS OF DSC-1

UNIT – I Starting with Python (12 Hours)

Introduction to Python: Python Interpreter-IDLE (script and interactive mode), Python shell, using Python as calculator, concept of data types; variables, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical operator, Boolean operator, Assignment operators, Membership operators(in and not in), Identity operators, Bit wise operator, Increment or Decrement operator), comments in the program, understanding error messages.
Creation of a Python Program: Input and Output Statements, Control statements -Branching (if-else, if-elif-else), indentation in python, iteration (using for, while), Conditional Statement, exit function, Difference between break, continue and pass, Nested conditionals

UNIT – II Strings and Lists (12 Hours)
Data objects in Python: Mutable and immutable
Strings- Creating and Storing Strings, Accessing Characters in String by Indexing (positive and negative), String Operations: concatenation, replication (*), membership, comparison, Slicing, string built-in functions, String method
Lists- Creating Lists, Accessing list elements, traversing a list , Aliasing a list, comparing list , list Operations:- concatenation, replication(*), membership, slicing, Indexing, nested list, list built-in functions List methods , del statement.
Sets: Creating sets, Sets built-in functions, Set Methods

UNIT – III Tuples and Dictionaries (12 Hours)
Tuples: Creating Tuples, Tuple operations: slicing, concatenation, replication, membership, comparing and deletion, tuple built-in functions
Dictionaries: Dictionary in python (key : value pairs), creating a dictionary, element accessing and traversing a dictionary, appending values, updating values, removing items from dictionary, membership, dictionary built-in functions, dictionary methods , clear statement
Object Oriented Programming: Introduction to Classes, Objects and Methods, Encapsulation, Inheritance, Polymorphism, Abstraction

UNIT – IV Functions and Modules (12 Hours)
Functions: Built in function (math, statistics), User defined functions: Defining Functions, arguments: positional, default, keyword, variable length arguments, scope of variables, parameter passing (string list, dictionary, tuples, sets), return statement, recursion, importing (using import) user defined function (path).
Modules in python: use of keyword from, namespacing, module aliasing, introduction to python packages (matplotlib, pandas, numpy, scikitlearn, nltk, openCV) and libraries and their applications

Practical component (if any) – Programming Fundamentals using Python Lab (30 Hours)

Learning outcomes
CO1 Develop algorithms and write programs in Python language for arithmetic and logical operations, conditional branching.
CO2 Write programs in Python language using construct and data objects like strings, lists, sets, tuples, dictionaries, Python libraries and use concept of OOP.
CO3 Prepare the technical report on the experiments carried.

1. Write a python menu driven program to calculate area of circle, rectangle, square using if-elif-else.
2. Write a python program to print Fibonacci series up to a certain limit (use 'while').
3. Write a python program to print the Pascal triangle.
4. Write a python program to find HCF (GCD) of two numbers.
5. Write a python program to find LCM of two numbers.
6. Write Python programs to illustrate the various functions of the "Math" module, "Statistics" module in Python.
7. Write a Python program to count number of vowels using sets in given string
8. Write a Python program to Remove all duplicates from a given string in Python
9. Write a Python program to count positive and negative numbers in a list
10. Write a Python program to find sum of elements in list
11. Write a python program to read a list of 'n' integers (positive and negative) and create two new lists one having all positive numbers and the other having all negative numbers from the given list. Print all three lists.
12. Write a python program to create a list of tuples from given list having number and its cube in each tuple
13. Create a Python program to create a dictionary which has record of a student information: Admission number, Roll Number, Name and Marks. Display information on the basis of Admission number
14. Write a python program which contains user defined functions as a 'module' to calculate area, perimeter or surface area , volume for various shapes like square, cube, circle, cylinder. The user defined functions should accept the values for calculation as parameters and calculated values should be returned. Import the module and use appropriate functions.
15. Create a menu driven Python program using user defined functions to implement a calculator to perform :

(a) Basic arithmetic operations

(b) log10(x), sin(x) , cos(x)

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. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. John V Guttag, —Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

5. Timothy A. Budd, —Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2015.

Suggestive readings

1. Kenneth A. Lambert, —Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
2. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
3. Paul Gries, Jennifer Campbell and Jason Montojo, —Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 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 – 2 (DSC-2): Circuit Theory &

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Circuit Theory & Network Analysis ELDSC-2	4	3	0	1	Course Admission Eligibility	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic circuit concepts in a systematic manner suitable for analysis and design.
- To study the steady state analysis of AC Circuits.
- To study and analyse electric circuits using network theorems.
- To study and design passive filters using R, L and C

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Study basic circuit concepts in a systematic manner suitable for analysis and design.
CO2 Determine AC steady state response.
CO3 Analyse the electric circuits using network theorems.
CO4 Determine frequency response of filters

SYLLABUS OF DSC- 2

UNIT – I Introduction to Circuits and DC Analysis (12 Hours)
Basic Circuit Concepts: Voltage and Current Sources, V- I characteristics of ideal voltage and ideal current sources, various types of controlled sources, passive circuit components, V-I characteristics, and ratings of different types of R, L, C elements.
DC Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Super node & Super mesh Analysis, Star-Delta Conversion.

UNIT – II AC Analysis (12 Hours)
Steady State Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Phasor, Complex Impedance, Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Node and Mesh Analysis for AC circuits. Star-Delta Conversion for complex impedances.
Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor.

UNIT – III Network Theorems (12 Hours)
Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. (Independent Sources)
AC circuit analysis using Network Theorems.

UNIT – IV Filters (9 Hours)
Filters and Resonance: Introduction to Passive Filters-High Pass, Low Pass, Band Pass & Band Stop Filters, Frequency response of RC Circuits-High pass and Low pass filters, Frequency response of Series and Parallel RLC Circuits. Resonance in Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth, Band Pass and Band Stop RLC Filters.

Practical component (if any) - Circuit Theory and Network Analysis Lab (Hardware and Circuit Simulation Software) (30 Hours)
Learning outcomes
CO1 Verify the network theorems and operation of typical electrical circuits.
CO2 Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.
CO3 Prepare the technical report on the experiments carried.

1. Familiarization with Multimeter: Resistance, Capacitor and Inductor in series, parallel and series-parallel.
2. Familiarization with Oscilloscope: Measurement of Amplitude, Frequency and phase of a sinusoidal signal
3. Verification of Kirchhoff's Current Law.
4. Verification of Kirchhoff's Voltage Law
5. Verification of Norton's theorem.
6. Verification of Thevenin's Theorem.
7. Verification of Superposition Theorem.

8. Verification of the Maximum Power Transfer Theorem.
9. Design of Low Pass RC Filter and study of its Frequency Response.
10. Design of High Pass RC Filter and study of its Frequency Response.
11. Study of Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

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. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004)
2. M. Nahvi and J. Edminister, Electrical Circuits, Schaum's Outline Series, Tata McGraw Hill.(2005)
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)

Suggestive readings (if any)

1. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Semiconductor Devices

Credit distribution, Eligibility and Pre-requisites of 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 Devices ELDSC-3	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the Physics of semiconductor devices
- To be able to plot and interpret the current voltage characteristics for basic semiconductor devices
- The student should be able to understand the behaviour, characteristics and applications of power devices such as SCR, UJT, DIAC, TRIAC, IGBT

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Describe the behavior of semiconductor materials
CO2 Reproduce the I-V characteristics of diode/BJT/MOSFET devices
CO3 Apply standard device models to explain/calculate critical internal parameters of semiconductor devices
CO4 Explain the behavior and characteristics of power devices such as SCR/UJT etc.

SYLLABUS OF DSC-3

UNIT – I Introduction to Semiconductors and Carrier Transport (12 Hours)
Basic Concepts of Semiconductors: Energy Bands in Solids, Concept of Effective Mass, Direct and Indirect Bandgap Semiconductors, Density of States (Qualitative understanding), Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors and its Temperature Dependence, Derivation of Fermi Level for Intrinsic and Extrinsic Semiconductors and its Dependence on Temperature and Doping Concentration

Carrier Transport Phenomena: Drift velocity, Mobility, Resistivity, Hall Effect , Conductivity, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes (Qualitative concepts), Continuity Equation.

UNIT – II P-N Junction Devices (12 Hours)
P-N Junction Diode: Space Charge at a Junction, Depletion Layer, Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Concept of Linearly Graded Junction
Diode Equation and I-V Characteristics (Qualitative), Zener and Avalanche breakdown Mechanism.
Metal Semiconductor Junctions, Ohmic and Rectifying Contacts, Zener diode, Tunnel diode, Varactor Diode, Optoelectronic Devices: LED, Photodiode, Solar cell, LDR, their Circuit Symbols, Characteristics and Applications

UNIT – III Bipolar Junction Transistors (12 Hours)
Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Energy Band Diagram of Transistor in Thermal Equilibrium, Emitter Efficiency, Base Transport Factor, Current Gain, Relation between alpha and beta, Base-Width Modulation, Early Effect, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations and their Applications.

UNIT – IV FET and Power Devices (9 Hours)
Field Effect Transistors: JFET, Channel Formation, Pinch-Off and Saturation Voltage, Input, Transfer and Output Characteristics.

MOSFET, NMOS, PMOS, Types of MOSFET, Circuit symbols, Working and Characteristic Curves of Depletion mode and Enhancement mode MOSFET (both N channel and P Channel), Complimentary MOS (CMOS) as an Inverter.

Power Devices: Introduction to UJT, SCR, TRIAC, DIAC, IGBT and their Basic Constructional Features (Schematic Diagram), Characteristics and Applications.

Practical component (if any) - Semiconductor Devices Lab (30 Hours)
(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Examine the characteristics of Semiconductor Devices
CO2 Perform experiments for studying the behaviour of semiconductor devices for circuit design applications
CO3 Calculate various device parameters values from their I-V Characteristics
CO4 Interpret the experimental data for better understanding of the device behaviour

1. Study of the I-V Characteristics of Diode – Ordinary and Zener, Solar Cell, Photodiode
2. Study of the I-V Characteristics of the CE, CB and CC configurations of BJT and obtain Input and Output impedances and Gains (Any one configuration to be assigned at the time of Examination)
3. Study of the I-V Characteristics of JFET/MOSFET
4. Study of the I-V Characteristics of the UJT
5. Study of the I-V Characteristics of the SCR
6. Study of the I-V Characteristics of DIAC and TRIAC
7. Study of Hall Effect.

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. S.M Sze Semiconductor Devices: Physics and Technology,2nd Edition, Wiley India Edition
2. Ben G Streetman and S. Banerjee Solid State Electronic Devices, Pearson Education
3. Dennis Le Croissette, Transistors, Pearson Education
4. Jacob Millman and Christos Halkias: Electronic Devices and Circuits, Tata McGraw-Hill Edition

Suggestive readings

1. Nutan Kala Joshi and Swati Nagpal, Basic Electronics with Simulations and Experiments, Khanna Publishers (2021)
2. Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons
3. Kannan Kano, Semiconductor Devices, Pearson Education

BSc. (H) Instrumentation
Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) –: Analog Electronics (INDSC1A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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 Electronics (INDSC1A)	04	03	-	01	Course Admission Eligibility	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart in-depth knowledge of semiconductor devices & circuits focusing on many aspects of design & analysis
- To design various biasing configurations for transistor circuits
- To provide knowledge of amplifiers and their design
- To introduce the concept of feedback for designing oscillators

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the working of the diode circuits
- Analyze analog circuits and their applications using active devices
- Understand the design of feedback circuits and use them in amplifiers and Oscillators
- Explain the operation of various oscillator circuits

SYLLABUS OF DSC-1

UNIT – I **(12 Hours)**

Diode and its application: Introduction to semiconductor materials, intrinsic & extrinsic semiconductors. PN junction diode: Depletion region, Junction capacitance, Construction, and Working, Diode equation, Effect of temperature on reverse saturation current, Ideal diode. Diode applications: clipper circuits, clamping circuits, Half wave rectifier, center-tapped, and bridge full-wave rectifiers, calculation of efficiency and ripple factor. DC power supply: Block diagram of regulated power supply, Zener diode as a voltage regulator.

UNIT – II **(12 Hours)**

Bipolar Junction Transistor (BJT): NPN and PNP transistors, current components in BJT, Transistor amplifying action, Input and Output characteristics of BJT for CE, CB, CC configurations (cut-off, active, and saturation regions), CE configuration as a two- port network: h-parameters, h- parameter equivalent circuit.

UNIT – III **(12 Hours)**

BJT Biasing: Fixed bias, collector to base bias, emitter bias, and voltage divider bias circuits.
CE amplifier and frequency response: dc and ac load line analysis, Hybrid equivalent of CE, the frequency response of CE amplifier.
Introduction to Power Amplifiers: Class A, Class B, Class AB, and Class C

UNIT – IV **(9 Hours)**

Feedback Amplifiers and Oscillators: Concept of feedback, negative and positive feedback, Negative feedback: advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, derivation of gain, input and output impedances for feedback amplifiers. Oscillators: Barkhausen criteria for sustained oscillations, Study of phase shift oscillator, Colpitt's oscillator, and Crystal oscillator.

Practical component- **(30 Hours)**

1. To study I-V characteristics of PN junction and Zener diodes in forward and reverse bias configurations.
2. To study clipping and clamping circuits.
3. To study the Half wave rectifier and full-wave rectifier.
4. To design the power supply with capacitor filter
5. To study input and output I-V characteristics of common base and common emitter transistor configurations.
6. To study Fixed Bias and Voltage divider bias configurations of BJT.
7. To design a Single Stage CE amplifier for a given gain.
8. To study the frequency response of a single stage CE Amplifier
9. To study the Colpitt's Oscillator.
10. To study the Phase Shift Oscillator.
11. To study Class A, Class B and Class AB power amplifier

Essential/recommended readings

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).
2. N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata Mc Graw Hill (2007).
3. J. Millman and C. Halkias, Integrated Electronics, Tata McGraw Hill (2001).
4. David A. Bell, Electronic Devices & Circuits, Oxford University Press, Fifth edition.
5. Mottershed, Electronic Devices, PHI Publication, 1stEdition.
6. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill(2002).

Suggestive readings:

1. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill(2010).
2. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill(2002).

3. J.Cathey, 2000 Solved Problems in Electronics, Schaum"s outline Series, Tata Mc Graw Hill (1991).

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Basic Circuit theory (INDSC1B)

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Circuit theory (INDSC1B)	04	03	-	01	Course Admission Eligibility	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop an understanding of the fundamental laws and elements of electric circuits.
- To learn the energy properties of electric elements and techniques to measure current and voltage.
- To develop the ability to apply circuit analysis to AC and DC circuits.
- To understand signals, waveforms and transient & steady state responses of RLC circuits.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the current-voltage characteristics of basic fundamental elements
- Design and analyze the electronic circuits using various network theorems
- Understand frequency response and behavior of ac circuits
- Understand the concept of two port network and overall response for interconnection of two port networks

SYLLABUS OF DSC- 2

UNIT – I **(12 Hours)**

Basic Circuit Concepts: Voltage and Current Sources including their types, Resistors: types and color coding, Capacitor: types and color coding, Inductor: types and color coding, star-delta conversion & delta-star conversion. Sinusoidal voltage and current: Definition of instantaneous, peak to peak, average and rms value.

UNIT – II **(12 Hours)**

Concepts of Circuit Analysis: Ohms Law, Kirchhoff's Current Law (KCL), Kirchhoff's
Concepts of Circuit Analysis: Ohms Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis.
Network Theorem (DC Circuits): Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. Voltage Law (KVL), Node Analysis, Mesh Analysis.
Network Theorem (DC Circuits): Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.

UNIT – III **(12 Hours)**
DC Transient Analysis: Time Constant, Response of RC, RL and RLC circuit to dc source(s), Response of source free RC, RL and RLC circuit.
AC Circuit Analysis: Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance. Mesh Analysis, Node Analysis and Network Theorems for AC Circuits. Frequency Response of Series and Parallel RLC Circuits, Resonance, Quality (Q) Factor and Bandwidth. Fundamentals of passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

UNIT – IV **(9 Hours)**
Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Complex Power and Power Triangle, Power Factor.
Two Port Networks: Introduction to two port networks, Impedance (Z) Parameters, Admittance (Y) Parameters, hybrid (h) parameters and Transmission (ABCD) Parameters.

Practical component- **(30 Hours)**
1. Verification of Kirchoff's Law.
2. Verification of Norton's Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Reciprocity Theorem.
5. Verification of Superposition Theorem.
6. Verification of the Maximum Power Transfer Theorem.
7. Designing of RC Integrator circuit.
8. Designing of RC differentiator circuit.
9. Designing of a RC Low Pass Filter and study of its Frequency Response.
10. Designing of a RC High Pass Filter and study of its Frequency Response.

Essential/recommended readings
1. S. A. Nasar, Electric Circuits, Schaum"s outline series, Tata McGraw Hill (2004).
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum"s Outline Series, Tata McGraw-Hill (2005).
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004).

Suggestive readings: Nil
1. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill (2005).
2. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2008).

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Testing and Measurement (INDSC1C)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Testing and Measurement (INDSC1C)	04	02	-	02	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To describe the units of measure and the various instruments used in various measurement parameters.
- To teach the various methods in power measurement.
- To make them understand about the error in measurement systems.
- To explain the various components of a testing and calibration system.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concept of measurements and calibration
- Perform error measurement concepts correctly and present final values with the correct units/symbols
- Analyze various standardization techniques in Production Plants
- Familiarize with various testing and calibration procedures in measurement

SYLLABUS OF DSC-3

UNIT – I **(12 Hours)**

Introduction to Measurement System, Significance of Measurement, Methods of measurement, Elements of a generalized measurement system.

Performance characteristics of measurement system: Static Characteristics -Accuracy, Sensitivity, Linearity, Precision, Resolution, Threshold, Range, Hysteresis, Dead Band, Backlash, Drift, Impedance Matching and Loading.

Dynamic Characteristics- Types, Fidelity, Speed of Response, Dynamic Error.

UNIT – II **(12 Hours)**

Measuring Instruments: Introduction to Voltmeters, Ammeters, Ohmmeters, Digital Multimeters, Clamp Meter, Lux meter, Flux Meter, Tester, Function Generator, Bolometer, B-Dot and D-Dot Sensors.

Errors in measurement systems:

Definition of Errors: Systematic Errors, Instrumental Errors, Environmental Errors, Random Errors, Loading Errors, Limiting Errors. Source of Errors in Measuring Instruments.

UNIT – III **(9 Hours)**

Introduction to Testing, Fault, Types of Faults, Methods used for localizing faults, Methods used for ground and short circuit faults, Murray loop test, Varley loop test, location of open circuit faults in cable, types of Probes and Connectors.

UNIT – IV **(12 Hours)**

Standardization and Calibration Modelling: Standardization in Production Plants and manufacturing houses, Reliability studies and inspection, Product Standardization techniques, Calibration: Calibration of measuring instruments, Theory and Principles (absolute and secondary or comparison method), Setup, Modelling.

Various Testing and Calibration Systems: Sensor calibration and testing, Analytical methods in calibrating, Automated test and calibration systems.

Practical component - **(30 Hours)**

1. Testing of Active and Passive Components.
2. Testing of all basic components.
3. Calculation and verification of Resistance.
4. Calculation and verification of Voltage and Current.
5. Testing of Faulty equipment.
6. Fault diagnosis of Lab. Instruments.
7. Measurement of Temperature.
8. Measurement of Pressure.
9. Measurement of Power.
10. Measurement of Energy using Energy meter.
11. Study of Electrical and Mechanical parameters standards used in testing and calibration.
12. Calibration of Instruments.
13. Testing of Electrical Components.
14. Testing of Various Instruments.
15. Murray Loop test
16. Varley loop test
17. B-Dot sensor, D-Dot sensor
18. Study of Lux meter
19. Study of Flux meter
20. Study of Multimeter

Essential/recommended readings

1. Electrical measurement and measuring Instruments by Golding and Widdis.
2. Electrical and Electronic measurements and Instruments By A.K.Sawhney.

Suggestive readings

1. Electrical measurements and Measuring instruments By Rajendra Prasad.

Common Pool of Generic Electives (GE) Courses Offered by Department of Electronic Sciences

Category-IV

GENERIC ELECTIVES (GE-1): Fundamentals of Electronics

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Electronics ELGE-1A	4	3	0	1	None	None

Learning Objectives

The Learning Objectives of this course are as follows:

- The paper equips the learners about basic circuit knowledge to analyze electric circuits using network theorems.
- Understand diode and it's applications in clipping and clamping circuits, Rectifiers and design regulated power supply using Zener diodes.
- To be able to plot the current voltage characteristics of Diode, Transistors and its different biasing conditions
- Usage of semiconductor devices in designing the circuits.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Study basic circuit concepts in a systematic manner suitable for analysis and design and further analyze the electric circuit using network theorems.
CO2 To understand the different types of semiconductor devices and their characteristics
CO3 Illustrate about working of transistors, transistor-based amplifiers and its biasing.
CO4 Explain the concepts of feedback and oscillations and construct feedback amplifiers

SYLLABUS OF GE-1

UNIT – I Basic Resistive Circuit (12 Hours)
Ohm's Law, resistors in series and parallel combinations. DC voltage sources: ideal and non-ideal cases; DC current sources: ideal and non-ideal cases; Introduction to Kirchhoff's current law, Kirchhoff's voltage law, voltage divider circuit, current divider circuit; source

transformations– voltage source to current source and current source to voltage source, basic problems. Resistive circuits: Thevenin's theorem, Norton theorem, Superposition theorem, Maximum power transfer theorem.

UNIT – II PN-junction diode and its applications (12 Hours)

PN junction, Unbiased PN junction, Forward and Reversed biased condition, IV-characteristics of PN junction diode, types of diodes – Zener diode, photo diode, LED.

Diode circuits and power supplies. Half and full wave rectifiers, Bridge rectifier (qualitative comparison), Regulated power supply using Zener diode, Basic Clipper and Clamper circuits using diodes.

UNIT – III Bipolar Junction Transistors (BJT) and Biasing (12 Hours)

NPN Transistor and basic transistor action, Definition of α, β and γ and their interrelations, leakage currents, Modes of operation, Input and output characteristics of CB, CE and CC Configurations. Transistor biasing, thermal runaway, stability and stability factor, Fixed bias without and with R_E, collector to base bias, voltage divider bias and emitter bias ($+V_{CC}$ and $-V_{EE}$ bias), circuit diagrams and their working.

UNIT – IV BJT Applications (12 Hours)

BJT amplifier (CE), dc and ac load line analysis, Operating point, Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances. Positive feedback and Barkhausen criteria for oscillations.

Practical component (if any) - Fundamentals of Electronic Lab (30 Hours)
(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Verify the network theorems and operation of typical electrical circuits.
CO2 Study various stages of a zener diode based regulated power supply.
CO3 Understand various biasing concepts, BJT based amplifiers.

1. Study and operation of digital multi-meter, function generator, regulated power supply, CRO, etc.
2. Verification of KVL and KCL.
3. Verification of Superposition theorem.
4. Verification of Thevenin's, Norton's Theorem
5. Verification of Maximum power transfer theorem.
6. To plot the IV-characteristics of a ordinary and Zener diode and LED
7. Study of Half wave and Full Wave Rectifiers
8. Study of Fixed Bias, Voltage divider bias Feedback configuration for transistors.
9. Study of transistor amplifier 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 seven.

Essential/recommended readings

1. R. L. Boylestad & Louis Nashlesky (2007), Electronic Devices &Circuit Theory, Pearson Education.
2. David A. Bell (2008), Electronic Devices and Circuits, Oxford University Press.
3. B L Theraja and AK Theraja, A Textbook Of Electrical Technology - Vol I.

Suggestive readings

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)

GENERIC ELECTIVES (GE-2): Data Engineering and Analytics

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Data Engineering and Analytics ELGE-1B	4	3	0	1	None	Basic Knowledge of Python Programming Language

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of this course is to introduce students to data analysis and impart them skills to solve data analytics problem. Data Engineering is basically designing and building pipelines that transform and transport data into a highly usable format before it reaches the Data Scientists or other end users. These pipelines must take data from many disparate sources and collect them into a single warehouse that represents the data uniformly as a single source of truth.

Learning outcomes

The Learning Outcomes of this course are as follows:
CO1 Use data analysis tools in the pandas library.
CO2 Develop understanding of basic data analysis techniques.
CO3 Collect, explore, clean, munge and manipulate data.
CO4 Solve real world data analysis problems.
CO5 Build data science applications using Python based toolkits.

SYLLABUS OF GE-2

UNIT – I Mathematical Foundation for Data Engineering (12 Hours)
Linear Algebra: Vectors, Matrices; Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation; Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem ; Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P-hacking, Bayesian Inference

UNIT – II Introduction to Data Engineering and Data Science (12 Hours)
Relationship between Data Engineering and Data Science, Types of Data, Data file formats. Overview of Data Repositories; Data Warehouses, Data Marts, and Data Lakes. Introduction to ETL, ELT, and Data Pipelines. Data Integration Platforms, Traits of Big data, Analysis vs Reporting, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis. Introduction to Cloud Computing in Data Science
Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, stats models

UNIT – III Understanding Pandas and Data Wrangling (12 Hours)
Getting Started with Pandas: Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Cleaning, Preparation and Transformation.
Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting.

UNIT – IV Data Aggregation and Analysis (9 Hours)
Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation
Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.

Practical component (if any) - Data Engineering and Analytics Lab (Python) (30 Hours)
Learning outcomes
CO1 Implement various data analysis tools in the pandas library.
CO2 Implement various basic data analysis techniques, clean and filter and manipulate data.
CO3 Solve real world data analysis problems.

1. Create a Data Frame and perform Matrix-like Operations on a Data Frame
2. Implement basic array statistical methods (sum, mean, std, var, min, max, argmin, argmax, cumsum and cumprod) and perform sorting operation with sort method.
3. Create a data frame with a following structure using pandas

EMP ID	EMP NAME	SALARY	START DATE
1	Satish	50000	01-11-2017
2	Reeya	75000	12-05-2016

3	Jay	100000	22-09-2015
4	Roy	45000	08-01-2017
5	Serah	55000	06-02-2018

4. Load Pima Indians Diabetes dataset (Source: https://archive.ics.uci.edu/ml/datasets/diabetes). Implement the following
   i. Data Cleaning and Filtering methods (Use NA handling methods, fillna function arguments).
   ii. Implement descriptive and summary statistics.
   iii. Plot histogram, bar plot, distplot for features/attributes of the dataset
5. Load Boston Housing Price dataset and perform
   i. Data cleaning and filtering method on the dataset.
   ii. Implement descriptive and summary statistics
   iii. Plot 'distplot' for target variable and 'heatmap' for the correlation in dataset.
6. For above data set, perform grouping the data using index in pivot table, aggregate on specific features with values.
7. For Superstore sales data, perform Time Series Data Analysis.
8. Creating cloud account Amazon/Azure/Google/IBM to store images /files / programs..

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. The Data Engineering Cookbook - Mastering The Plumbing Of Data Science by Andreas Kretz.
2. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python by Peter Bruce, Andrew Bruce, Peter Gedeck, Shroff/O'Reilly. ISBN: 8194435006-978
3. Data Engineering A Complete Guide - 2020 Edition by Gerardus Blokdyk, 5starcooks. ISBN: 1867316718-978
4. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling by Ralph Kimball, Margy Ross, Wiley. ISBN: 978-1118530801

Suggestive readings -

1. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 978-9352134915
2. Data Science from Scratch: First Principles with Python by Joel Grus, Shroff/O'Reilly. ISBN: 9352138326-978

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

GENERIC ELECTIVES (GE-1): Fundamentals of Instrumentation (INGE1A)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical / Practice			
Fundamentals of Instruments (INGE1A)	**04**	**03**	**-**	**01**	**Class XII pass**	**Physics and Mathematics in 10+2**	**Instrumentation**

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about basic concepts of Instrumentation.
- To understand the basic concept of errors and study different types of errors present in measurement systems.
- To study different characteristics of measurement systems.
- To study different types of transducers – resistive, capacitive and inductive
- To study signal conditioning.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basics of concepts of Instrumentation and measurement systems
- Identify and comprehend various sensors used in the real-life applications and paraphrase their importance
- Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, and light
- Be conversant in construction and working of signal conditioning circuits

SYLLABUS OF GE-1

UNIT – I **(12 Hours)**

Basic concepts of Instrumentation: Generalized instrumentation systems block diagram representation, Error in measurement- Gross Errors, Systematic Errors and Random Errors. Statistical analysis of error in measurement-Arithmetic mean, Deviation, standard deviation

UNIT – II **(9 Hours)**

Measurement systems: static characteristics (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), dynamic characteristics (types, fidelity, speed of response, dynamic error)

UNIT – III **(12 Hours)**

Transducers: Classification, Active and Passive. Principle and working of following types: Resistive (Strain Gauge) Capacitive, Inductive (LVDT), Piezoelectric, Light (LDR), Temperature (RTD, Thermocouple, Thermistor)

UNIT – IV **(12 Hours)**
Signal Conditioning: Introduction to Op-Amp, Basic Instrumentation Amplifier, Application of Instrumentation Amplifiers

Practical component- 30 Hours
1. Measurement of strain using strain gauge/load cells.
2. Measuring change in resistance using LDR
3. Measurement of displacement using LVDT.
4. Measurement using capacitive transducer.
5. Measurement of Temperature using Temperature Sensors.
6. Design and study basic circuit of Op-Amp.

Essential/recommended readings
1. Doeblin&Manek, Measurement Systems, McGraw Hill, New York, 1992, 5th edition.
2. Nakra& Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd edition.
3. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition.
4. Rangan, Sarma, and Mani, Instrumentation- Devices and Systems, Tata-McGraw Hill, 2nd edition.
5. H.S Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition.
6. DVS Murthy, Measurement & Instrumentation, PHI, 2nd edition.

Suggestive readings:
1. D. Patranabis, Sensors and Transducers, PHI, 2nd edition.
2. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, DhanpatRai& Co.
3. Mechanical and Industrial Measurements, 3rd Edition, Tenth Edition (1996), R.K. Jain, Khanna Publishers.

GENERIC ELECTIVES (GE-2): Engineering Physics (INGE1B)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Engineering Physics (INGE1B)	04	03	-	01	Class XII pass with Mathematics	Mathematics in 10+2	Instrumentation

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop an intuitive understanding of semiconductor physics
- To provide the students a thorough understanding of the fundamentals of optics
- To introduce fundamental aspects of photonics

Learning outcomes

The Learning Outcomes of this course are as follows:

- Gain in-depth knowledge about basic concepts of semiconductor physics
- Understand the physics behind various phenomena in optics
- Understand the photonics

SYLLABUS OF GE-2

UNIT – I **(12 Hours)**

Semiconductor physics: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, the temperature dependence of carrier concentration, Compensation, and charge neutrality. Conductivity and mobility, Effect of temperature, Doping, and high electric field.

UNIT – II **(12 Hours)**

Interference: Interference of light, Fringe formation, interference in thin films, wedge-shaped film, Newton's rings, Michelson interferometer.

Diffraction - Single, Double & N- Slit, Diffraction grating, grating spectra, Rayleigh's criterion, and resolving power of grating.

UNIT – III **(12 Hours)**

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Fresnel's theory of optical activity, Polarimeters.

Laser: Basic principle, Spontaneous and stimulated emission of radiation, Einstein's Coefficients, Laser applications.

UNIT – IV **(3 Weeks)**

Photonics: Light Emitting Diodes, Construction, materials, and operation, Photodetectors: Photomultiplier tube. Phototransistors and Photodiodes (p-i-n, avalanche).

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Fiber optics: Principles and applications

Practical component-

1. To determine the type (n or p) and mobility of semiconductor material using Hall-effect
2. To determine the refractive index of a prism using a spectrometer

3. To determine the dispersive power of prism using spectrometer and mercury source.
4. To determine the wavelength of sodium light by Newton's Ring.
5. To determine the wavelength of sodium light using Michelson's Interferometer.
6. To determine the resolving power of diffraction grating
7. To determine the specific rotation of cane sugar using a polarimeter.
8. To find the wavelength of He-Ne Laser using a transmission diffraction grating.
9. To determine characteristics of LEDs and Photodetector.
10. To measure the numerical aperture of an optical fibre.

Essential/recommended readings

1. B. G. Streetman and S. Banerjee "Solid-state electronics devices", 5th Edition, PHI.
2. Donald A Neaman, "Semiconductor Physics and Devices Basic Principles" 3rd Ed TMH India.
3. Alok Dutta, "Semiconductor Devices and circuits", Oxford University Press.
4. Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education (2006)
5. AjoyGhatak –Optics, Fourth Edition, McGraw-Hill (2008).

Suggestive readings

1. Arthur Beiser -Concepts of Modern Physics, 6th Edition, Mc-Graw Hill.
2. S. O. Kasap, Optoelectronics, and Photonics: Principles and Practices, Pearson Education (2009)
3. Ghatak A.K. and Thyagarajan K., Introduction to fiber optics, Cambridge Univ. Press. (1998)

REGISTRAR

Appendix-60
Resolution No. 38 {38-1 [38-1-5(1)]}

INDEX

DEPARTMENT OF BIOCHEMISTRY

SEMESTER-II

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BSc. (Hons.) Biochemistry
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Learning outcomes

- Students will learn the nature and importance of enzymes in living systems
- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
- Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
- The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

SYLLABUS OF DSC-4

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-201: ENZYMES
Semester – II

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit I: Introduction to enzymes and features of catalysis **(3 weeks)**

General characteristics of enzymes; nature of enzymes - Ribozymes. apoenzyme, holoenzyme, Cofactor and prosthetic group. Classification and nomenclature of enzymes. Types of Enzyme assays - discontinuous, continuous, coupled assays; Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis, factors affecting the rate of enzymatic reactions, activation energy and transition state theory. Catalysis, reaction rates. Catalytic power and specificity of enzymes, Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Metal activated enzymes and metalloenzymes.

Unit II: Enzyme kinetics and inhibition **(5 weeks)**

Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics, mono-substrate reactions. Derivation of Michaelis-Menten equation; other enzyme plots like Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of K_m V_{max} and K_{cat}, specificity constant. Types of bisubstrate reactions (sequential-ordered and random, ping pong reactions), examples.
Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Structural analogs (allopurinol, methotrexate). Mechanism based inhibitors (β-lactam antibiotics).

Unit III: Mechanism of action of enzymes and Regulation of enzyme activity **(5 weeks)**

General features - proximity and orientation, strain and distortion, acid-base and covalent catalysis (chymotrypsin). Coenzymes (TPP, NAD, pyridoxal phosphate) in enzyme catalyzed reactions.

Control of activities of single enzymes and metabolic pathways, feedback inhibition, allosteric modulation (aspartate transcarbamoylase), regulation by covalent modification (glycogen phosphorylase), Zymogen (chymotrypsinogen)**.** Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit IV: Applications of enzymes **(2 weeks)**

Enzymes as reagents (glucose oxidase, cholesterol oxidase); Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); Enzyme linked immunoassay; Enzyme therapy (streptokinase); Enzymes in research. Immobilized enzymes.

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Assay to determine activity and specific activity of an enzyme.
2. Progress curve for an enzyme.
3. Partial purification of an enzyme using Ammonium sulfate fractionation.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of K_m and V_{max} of an enzyme using Lineweaver-Burk plot.

7. Calculation of inhibitory constant (Ki) for an enzyme.
8. Immobilization of enzyme using calcium alginate beads.

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7^{th} ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1-4641-2611-6 / ISBN:10:1-46412611-9.
2. Nicholas, C.P., Lewis, S. (1999). Fundamentals of Enzymology (3^{rd} ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X.
3. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9^{th} ed.). New York, WH: Freeman. ISBN-13: 9781319114671

Suggested reading:

1. Voet, D., Voet. J. G. (2013). Biochemistry (4^{th} ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be introduced to Enzymes. They will also gain insight into features of enzyme catalysis and factors affecting the rate of enzymatic reactions	Teaching will be conducted both through black board mode and power point presentation mode.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
II	Knowledge about the kinetics of enzymatic reactions by understanding different plots and calculating the parameters. They will understand the mechanism of bisubstrate reactions, inhibitions in enzymes.	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. Practical knowledge of enzyme kinetic reactions by determination of Km, Vmax and other values.	Students will be asked to analyze case studies. Written tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Students will gain insight into regulation of activities of single enzymes and metabolic pathways	Teaching will be conducted both through black board mode and power point	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations on

	by feedback inhibition, allosteric modulation, covalent modification, zymogen and isoenzymes	presentation mode. Practical assessment	any topic of interest relating to Enzymes. Internal assessment tests will be conducted.
IV	Students will learn applications of enzymes as reagents, markers in diagnostics, ELISA; Also use of enzymes in therapy, research and industries as immobilized enzymes	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted

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

4. Keyword

Enzymes, Catalysis, Specific activity, Mechanism of action, Isoenzymes.

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

DISCIPLINE SPECIFIC CORE COURSE – 5

Credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

The objective of this course is to provide an understanding of metabolism of carbohydrates and the enzymes involved in various metabolic pathways and regulation of carbohydrate metabolism in cells. The course also aims to outline the importance of such pathways in relation to metabolic defects.

Learning outcomes

Carbohydrates major biomolecules as building blocks in any organism. An understanding of the metabolism of these groups of molecules will help students to know the functioning of an organism as a whole. There are various degradation and synthesis pathways these molecules undergo based on the energy requirement of an organism so as to maintain body homeostasis. Detailed analysis of the pathways will provide an insight into the diseases caused by defects in metabolism highlighting the importance of the same. The metabolism of carbohydrate course will provide to undergraduate students:

- Concept of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
- Detailed knowledge of various pathways involved in carbohydrate metabolism with the enzyme involved and regulation.
- Diseases caused by defects in metabolism with emphasis on the metabolic control and cure of diseases.
- Understanding of various metabolic pathways in animals.

SYLLABUS OF DSC- 2

B.Sc. (HONORS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-202: METABOLISM OF CARBOHYDRATES
SEMESTER – II

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1 - Glycolysis and Gluconeogenesis **(6 weeks)**

Autotrophs, Heterotrophs, Metabolic pathways: catabolism, anabolism, ATP as energy currency, Glycolysis: overview, reactions, Regulation, inhibitors; feeder pathways for glycolysis, Galactosemia, Lactose intolerance. Cori and Cori cycle. Gluconeogenesis. Reciprocal regulation of Glycolysis and Gluconeogenesis.

Unit 2 - Fates of Pyruvate and Pentose phosphate pathway **(2 weeks)**

Fates of pyruvate: Anaerobic ATP production, fermentation. Pentose phosphate pathway: oxidative and non-oxidative arm and its importance. Relationship between glycolysis and pentose phosphate pathway.

Unit 3 - Glycogen metabolism **(3 weeks)**

Glycogen synthesis, glycogen breakdown, regulation of glycogen metabolism, glycogen storage diseases; Von Gierke, Pompe, Cori and McArdle.

Unit 4 - Citric acid cycle **(4 weeks)**

Overview of citric acid cycle, synthesis of acetyl Coenzyme A, Regulation of Pyruvate Dehydrogenase complex, enzymes of citric acid cycle, regulation of citric acid cycle, inhibitors, anaplerotic reactions, amphibolic nature. Diseases associated with metabolic irregularities. Overview of Starve feed cycle.

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Estimation of blood glucose in serum using ortho toluidine method
2. Estimation of blood glucose in serum using GOD-POD method (Glucose oxidase-Peroxidase)
3. Sugar fermentation by microorganisms.
4. Assay of salivary amylase.
5. Estimation of G-6 P by G6PDH
6. Continuous assay of Lactate Dehydrogenase

2.4 Essential readings

1. Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Principles of Biochemistry (2013) 4th ed., Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.
3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

Suggested 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.

3. Teaching Learning Process and Assessment Methods
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	**Course Learning Outcomes**	**Teaching and Learning Activity**	**Assessment Tasks**
I	Students will learn the concepts of metabolism with an emphasis on glycolysis and gluconeogenesis	Traditional chalk and black board method, Audio visual presentation. Classroom discussion	Assignment, unit -test and practical assessment through experiment and case studies.
II	Students will learn about the fates of pyruvate and pentose phosphate pathways.	Traditional chalk and black board method with examples and reactions and experiments	MCQ based assignments, unit test and practical assessment through experiment

III	Students will learn about glycogen synthesis, breakdown and glycogen storage diseases.	Traditional chalk and black board method, Audio visual presentation. Classroom discussion	Internal assessment tests will be conducted, presentations will be assessed along with practical assessment.
IV	The students will learn about overview, enzymes and regulation of citric acid cycle. They will also learn briefly about hormonal regulation of carbohydrate metabolism and diseases associated with metabolic irregularities.	Revision of the previous classes will be conducted. Traditional chalk and black board method, Audio visual presentation	Assessment through midterm examination and internal assessment test.

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

4. Keywords

Metabolism, Carbohydrates, Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenolysis. Glycogenesis, Pentose Phosphate Pathway

DISCIPLINE SPECIFIC CORE COURSE – 6:

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Cell Biology	**04**	**02**	**-**	**02**	**-**	**-**

Learning Objectives

This course will acquaint the students to the subject of Cell Biology and the types of cell divisions seen in the living system. It deals with the details of cell organelles and cell wall. It also explains the molecules which make up the matrix and the proteins which make the framework of the cell as cytoskeleton elements. It also introduces the various tools and techniques of cell biology which are used to study the cell.

Learning outcomes

After the completion of the course, the students will have:

- insights into the basic structure and function of the cell and cellular organelles.
- introduction to the concept of model systems, cell division and cell to cell interaction
- understanding of the structural framework of the cell as cytoskeletal structures
- knowledge of various techniques used in cell biology experiments

SYLLABUS OF DSC-3

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-DSC-203 : BASIC CONCEPTS OF CELL BIOLOGY
SEMESTER - II

2.2 Course Content

Theory

Credits: 2 **Total weeks : 15**

Unit 1: Tools of cell biology **(2 weeks)**

Light microscopy, phase contrast microscopy, Inverted Microscope Histochemical Staining Techniques.

Unit 2: Structure and Function of Cell Organelles **(6 weeks)**

Prokaryotic and eukaryotic cell (Plant and Animal Cell): Structural Features. Nucleus: Nuclear envelope, Nuclear pore complex. Nuclear Import and Export of biomolecules. Rough Endoplasmic Reticulum; Smooth Endoplasmic Reticulum; Golgi Apparatus; Lysosomes; Mitochondria; Chloroplasts and peroxisomes. Cell Division: Mitosis and Meiosis. Types of internalization procedures in the cell: Endocytosis, Pinocytosis and Phagocytosis

Unit 3: Extracellular matrix and Cell Junctions **(3 weeks)**

Cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherens junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata

Unit 4: Cytoskeletal proteins **(4 weeks)**

Introduction to Cytoskeletal Proteins. Structure, assembly and function of Microtubule, Microfilament and Intermediate filament.

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Differentiate prokaryotic and eukaryotic cells and visualization of animal, plant cell, bacteria cells by light microscope

2. Study of Mitosis and Identification of different stages of mitosis in onion root tip.
3. Study of Meiosis and Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Cells as experimental models: Study life cycle of one animal model drosophila/ zebrafish/ nematode.
6. Cytochemical staining of any one biomolecule (Protein/Polysaccharide/RNA)

2.4 Essential readings:

1. The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
2. Cell and Molecular Biology: Concepts and Experimentation (2016) 8th Edition, Gerald Karp Janet Iwasa and Wallace Marshall, John Wiley and Sons, Singapore, ISBN: 978-1-118-88384-6

Suggested readings:

1. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No	Learning Outcomes	Teaching Methods	Assessment Method
1	Students will understand the principle of functioning of various types of microscopy. They will be able to distinguish between various types of Light microscopy. They will understand how cells can be stained and studied under the microscopy	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.
2	Students will understand cell division in somatic and reproductive cell. They will be able to differentiate one cell organelle to another in terms of structure and function. They will understand different modes of internalization into the cell.	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.
3	Students will be able to distinguish between Cell wall of prokaryotes and eukaryotes. The will understand the composition of Cell Matrix, Understand the structure and function of various cell to cell interactions. They will be able to	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos,	Assignments, Quizzes, Research reports.

	differentiate between the different cell junctions.	Modelling	
4	Students will be able to understand the cytoskeletal framework of the cell, the structure and function of three important cytoskeletal proteins, how the organization of these protein change as per the cell division, mobility and transport of organelles, the concept of treadmilling and dynamic instability	They will be taught through explanation through lectures, chalk and board explanation, Powerpoint Presentation, Videos, Modelling	Assignments, Quizzes, Research reports.

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

4. Keywords:

Cell Organelles, Mitosis, Meiosis, Prokaryote, Eukaryote, Cell Wall, Cell Matrix, Cell Junctions, Cytoskeleton Proteins, Treadmilling, Dynamic Stability, Microscopy, Histology

Pool of Generic Electives (GE) Courses

Offered by Department of Biochemistry

Category-IV

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
		Lecture	Tutorial	Practical/ Practice		
Techniques in Biochemistry	04	02		02	-	-

Learning Objectives

The objective of the course is to introduce different biophysical techniques to students that are used in biological research for separation, purification and identification from mixture of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.

Learning outcomes

- Students will acquire knowledge about the principles and applications of separation and purification techniques like centrifugation and chromatography used in a biochemistry laboratory.
- Students will learn about the principles and applications of electrophoresis and spectroscopic techniques involved in estimation and identification of biomolecules.
- It will also give them an opportunity to get hands-on experience to develop their experimental skills which are required for biological research lab.

SYLLABUS OF GE-2

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-2: TECHNIQUES IN BIOCHEMISTRY

2.2 Course Contents

THEORY

Credit: **2** **Total weeks : 15**

Unit I: **Separation techniques** **(4 weeks)**

Preparation of sample, different methods of cell lysis, salting out, dialysis. Principle and the factors affecting centrifugation Svedberg coefficient, types of rotors, principle and applications of differential and density gradient centrifugation.

Unit II: Purification techniques **(4 weeks)**

Classification of chromatographic techniques, principle and applications: Paper, thin layer, molecular sieve, ion exchange, and affinity chromatography.

Unit III: Electrophoretic techniques **(3.5 weeks)**

Principle of electrophoresis, various types of electrophoresis: Polyacrylamide gel (native), SDS PAGE and agarose gel, staining procedures for protein and nucleic acids.

Unit IV: Spectroscopic techniques **(3.5 weeks)**

Introduction to electromagnetic spectrum, Principle and working of UV-visible absorption spectrophotometer, single & double beam spectrophotometer, Beer's & Lambert's law, application of UV-visible spectrophotometer in biology.

2.3 PRACTICALS

Credits: 2 **Total weeks : 15**

1. Preparation of cell free extract from *E.coli* culture.
2. Separation and identification of amino acid acids by thin layer chromatography.
3. Separation of molecules by gel filtration chromatography.
4. Determination of absorption maxima (λ_{max}).
5. Calculate molar extinction coefficient of the given sample.
6. Demonstration of PAGE and Agarose gel electrophoresis.

2.4 Essential Readings

- Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8.
- Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027.
- 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.

Suggested Readings

- Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168.
- Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology, (2nd ed.), W.H. Freeman and Company (New York); ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Students will learn about centrifugation, various types of rotors and different applications of centrifugation.	Demonstration of various centrifuges and their working will be explained. Teaching will be conducted using black board and power-point presentation mode.	Various analytical problems will be assigned to students related to centrifugation to improve their understanding.
2.	Students will learn the principle and applications of various chromatographic techniques like paper, thin layer, gel filtration, ion exchange and affinity chromatography.	Teaching will be conducted using black board and power-point presentation mode. Group discussions and quizzes will be conducted in the class.	Practical exercises will be designed whereby the students get hands-on experience with these chromatography techniques. Internal assessment tests will be conducted.
3.	Students will learn about electrophoresis, its principle and applications in analysing proteins and nucleic acids.	Teaching will be conducted using black board and power-point presentation mode. Oral discussion sessions in the class.	Various analytical problems will be assigned to students related to electrophoretic separation.
4.	Students will learn about the principle and applications of UV-visible spectroscopy.	Teaching using chalk and board. Oral discussion sessions in the class and use of power-point presentations.	Problems will be assigned related to Beer's and Lambert's law to test the understanding of students. Internal assessment tests will be conducted.

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

4. Keywords

Centrifugation, Chromatography, Electrophoresis, Spectrophotometry, Proteins and Nucleic acids.

GENERIC ELECTIVES (GE-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
		Lecture	Tutorial	Practical/ Practice		
Public Health Biology	04	02		02	-	-

Learning Objectives

The present course attempts to provide an interdisciplinary understanding of public health issues in India with a more detailed understanding of the areas pertaining to biological science and epidemiology. Some overview of the social aspects that impact public health will also be discussed and the statistical analysis of public health data will be taught in the practical. The specific objectives of the course are to provide a basic understanding of the scope of public health issues, particularly related to policies on public health, public health nutrition, infectious biology and sanitation, social and preventive medicine, and the environmental issues that affect public health. The practical exercises aim to provide hands-on training in epidemiology and collection of primary and secondary data relevant to public health issues. It also hopes to generate a discussion platform that would encourage a healthy inter- and multidisciplinary interaction amongst the students to get a holistic view of public health. A mini research project on any relevant topic related to public health will be taken up after completing the theory and practical components of the course. Being interdisciplinary in its nature and scope, the course will be equally engaging and beneficial for students of all subject streams. After completing the course, the students can also apply for some higher-level courses in different areas of public health as the course helps in building a basic understanding on different aspects related to public health.

Learning outcomes

- Students will get a holistic overview of the interdisciplinary nature of Public health
- They will understand public health issues in India particularly related to Malnutrition, sanitation issues and related burden of infectious disease, and the role of pollution as a public health concern.
- The students will also get an understanding of the public policies applicable and implemented in India.
- They will also be able to appreciate the social aspects that govern many public health issues and implementation of policies
- The students will get hands-on training in epidemiology, preparation of questionnaire and collection of primary and secondary data relevant to public health issues.
- They will also learn to present the relevant data after subjecting it to statistical analysis.

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-3 : PUBLIC HEALTH BIOLOGY

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1: Understanding public health issues **(2 weeks)**

Conceptual understanding of public health, terminology, public health- multidimensional problem with Delhi as an example (air pollution, stress, sanitation, urbanization and socioeconomic inequalities) Policies on public health- factors affecting making and implementation of these policies.

Unit 2: Public Health Nutrition **(5 weeks)**

Understanding public health nutrition? Basic nutrition concepts, problems of malnutrition and toxicities, Application of nutrition concepts to design programs of public health concern, focussed on improving or maintaining the optimal health of general populations and targeted groups. Programs that will help prevent ill-health due to over or under nutrition. Mid-day meals in schools

Unit 3: Infectious biology and sanitation **(3 weeks)**

Defining communicable diseases. Understanding the biology, socioeconomic factors and other environmental conditions that influence the transmission and infection by pathogenic (disease-causing) bacteria, viruses, parasites, and fungi. Precautions, prevention strategies and programs for control; sanitation, Swachh Bharat.

Unit 4: Environmental Health & Community Health **(5 weeks)**

Determinants of Environmental Health: factors that affect environmental health; Occupational environment and health concerns; Understanding effect of air, water and soil Pollution on health.

Understanding the definition of community health, Determinants of community health; Define and manage the health problems of the community, Plan, implement and evaluate various health programs of General Health, Reproductive health, Maternal health, Family Welfare and Disease control / eradication.

Lifestyle disease or non-communicable diseases- consequence of imbalanced nutrition, environmental and psychological stresses; Etiology and management of diseases like Obesity, Diabetes mellitus, Cardiovascular disorders, sleep disorders and psychological eating disorders. Preventive health checkups (PHC)- important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis

2.3 Practical:

Credits: 2 **Total weeks : 15**

1. Assessment of nutritional status using anthropometric indices
2. Assessment of Nutritional status by a survey of clinical and non-invasive biochemical parameters.
3. To determine the potability of water using, pH, BOD, COD and MPN of the water sample from different sources.
4. Collecting secondary data on AQI from different areas and correlate with health indices in that area.
5. Understanding epidemiology: Collection, generation, and analysis of public health data. Application of statistical tools to analyze and present public health data.
6. Case study of a disease (Nutritional, infectious and lifestyle) along with the public health issues associated with that disease.
7. Field visits to nearby health care center to understand health checkups and collect some data on the rate of a particular disease over past few months or years.
8. Data collection from public domain with analysis.

2.4 Essential reading:

1. Aschengrau A, Seage G.R., (2013) Essentials of Epidemiology in Public Health Jones and Bartlett Publishers, Inc; 3rd edition
2. Bamji MS, Rao NP, Reddy V. (2017). Textbook of Human Nutrition. (4th ed). Delhi: Oxford and IBH Publishing Co. (P) Ltd.
3. Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
4. Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition. Academic Press, USA. 2014.

Suggested readings:

1. Sullivan. L.M. (2017) Essentials of Biostatistics in Public Health. Jones and Bartlett Publishers, Inc; 3rd edition.
2. Gibney et al. (2004). Public health nutrition. Hoboken, NJ: Blackwell Publishing
3. N. Okafor. (2011) Environmental Microbiology of Aquatic and Waste Systems by Springer, USA.
4. Waste Water Microbiology by D.H. Bergey. 2nd Edition. Medtech, India. 2019.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks

I	Students will be introduced to the term public health. They will gain insight into the significance of the multidimensional problem of public health with an example. They will also understand policies on public health.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions will be conducted on Delhi's problems including air pollution, stress, sanitation, urbanization and socioeconomic inequalities.	Students will be taken to field visits to understand public health. Students shall be asked to collect, generate, analyze and present public health data. Also they shall be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
II	Students will be introduced to public health nutrition. They will gain insight into basic nutritional concepts along with problems of malnutrition and toxicities. They will also understand the policies that operate in India that try to ensure adequate nutrition to all like mid-day meals in schools.	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. Students shall design programs of public health concern, focused on improving or maintaining the optimal health of general populations and targeted groups.	Students will be asked to design and analyze various programs to public health nutrition. Open book tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Students shall gain insight of various communicable diseases. Understanding the biology, socioeconomic factors and other environmental conditions that influence the transmission and infection by various pathogens.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions on sanitation measures being implemented and the ongoing Swachh Barath action plan will introduced and analyzed.	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations as well as case study on any communicable disease and pathogenic species. Internal assessment tests will be conducted. Discussions using case studies will be conducted.

IV	Understand the determinants of Environmental Health. Gain knowledge about community health. Understand the etiologies and management of various lifestyle disease or non-communicable diseases.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity. Practical knowledge to assess portability of water using, pH, BOD, COD and MPN of the water sample from different sources shall be imparted. Also secondary data collection like AQI levels will be conducted.	Case studies of lifestyle diseases shall be done. Field visits to nearby health care centers and data collection from public domain with analysis shall be done. Regular oral evaluation will be done. Internal assessment tests will be conducted

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

4. Keywords

Public health, community health, environmental health, public health nutrition, Lifestyle diseases, communicable disease, epidemiology

GENERIC ELECTIVES (GE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Protein and Enzymes	04	02		02	-	-

Learning Objectives

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

Learning outcomes

On successful completion of the course students will be:

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

B.Sc. (HONOURS) BIOCHEMISTRY (NEP FRAMEWORK)
BCH-GE- 4: PROTEINS AND ENZYMES

2.2 Course Contents

THEORY

CREDITS: 2 **TOTAL WEEKS: 15**

UNIT I: Introduction to proteins **(4 weeks)**

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

UNIT II: Three-dimensional structures and protein folding **(3.5 weeks)**

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

UNIT III: Introduction to enzymes and enzyme kinetics **(4 weeks)**

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

UNIT IV: Regulation of enzyme activity and applications of enzymes (3.5 weeks)

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

PRACTICALS

CREDITS: 2 TOTAL WEEKS : 15

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

2.3 Essential Readings

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

Suggested Readings

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

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activities	Assessment Tasks
I	Students will gain knowledge about the building blocks of proteins i.e. amino acids and	Students will be taught using power point presentations, chalk and	Oral questions will be asked in the class. Assignment and tests

	understand about the structural organization of proteins.	board. In class oral discussion sessions will be conducted.	will be given.
II	Students will understand about the characteristics of tertiary and quaternary structures, 3D structure of Hemoglobin and Myoglobin. They will also understand the concept of protein folding (denaturation and renaturation).	They will be taught using power point presentations, chalk and board. The use of E-learning through online Web and Video courses will be included.	Internal assessment will be done on the basis of quiz and class tests.
III	Knowledge about the basic properties and characteristics of enzymes and their action; insights into the factors affecting enzyme activity. Students will learn about the kinetics of enzyme catalyzed reactions and bisubstrate reactions	Historical perspectives; Powerpoint presentations; Teaching using chalk and board method	Oral questions will be asked in the class. Assignments to classify enzymes, determine specific activity and reaction rates
IV	Students will learn how enzymes are regulated and the importance of enzyme regulation in the cellular context. Detailed knowledge of the various applications of enzymes in medicine and research	Teaching using chalk and board method along with powerpoint presentations and video tutorials	Problems will be assigned to test student's analytical ability; Students will discuss methods of regulation in groups

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

4. Keywords

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

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

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	04	02		02	-	-

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

Students will learn about

- The importance of food in our life
- How food is spoiled and learn about some common food borne diseases/ food allergies
- The functions of macro and micronutrients in our body
- The diseases associated with malnutrition/ overnutrition and deficiency diseases

B.Sc. (HONOURS) BIOCHEMISTRY (NEP STRUCTURE)
BCH-GE-5 : NUTRITION AND FOOD SCIENCE

2.2 Course Contents

Theory

Credits: 2 **Total weeks : 15**

Unit 1 –Basics of Food Science and Nutrition **(2.5 weeks)**

Definition of Food, Nutrition, Nutrient, Nutritional status

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

Balanced diet, fad diets

Unit 2– Macronutrients **(5 weeks)**

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

Unit 3 – Micronutrients **(5 weeks)**

Fat soluble vitamins: Sources, physiological importance and deficiency diseases

Water soluble vitamins: Sources, physiological importance and deficiency diseases

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

Unit 4 – Food and Health **(2.5 weeks)**

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

2.3 Practicals
Credits: 2 **Total weeks : 15**

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

2.4 Essential readings:

1. Mahan, L.K., Strings, S. E., Raymond, J. (2012) *Krause's Food and Nutrition Care process.* Elsevier's Publications. ISBN: 978-1-4377-2233-8.
2. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 978019517169
3. Nelson, D.L., Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7^{th} 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* (3^{rd} ed.). Jaypee Brothers Medical

Suggested readings:

1. Practical Biochemistry, Damodaran Geetha K, Jaypee Brothers Medical Publishers Private Limited; 1^{st} edition (1 January 2011), ISBN: 9789350251416, 9789350251416
2. Plummer, D.T. (1998) *An Introduction to Practical Biochemistry* (3^{rd} ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.
3. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

4. Coombs Jr. G.F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
5. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

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

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

4. Keywords:

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

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

UNIVERSITY OF DELHI

CNC-II/093/1(25)/2023-24/79
Dated: 15.06.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 60/ (60-1-4) dated 03.02.2023]

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

Add the following:

Syllabi of Semester-III of the 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

Category-I

BSc. (Hons.) 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		
Metabolism of Lipids	**04**	**02**	**0**	**02**	**Class XII with Science**	**NIL**

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-7

2.2 Course Contents

Theory

Unit 1. Digestion absorption and transport of lipids (04 Hours)

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

Unit 2. Degradation of lipids (10 Hours)

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

Unit 3. Synthesis of lipids (12 Hours)

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

Unit 4. Cholesterol metabolism (4 Hours)

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

2.3 Practical: 60 Hours

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

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN-10: : 1319381499 ISBN-13-978 1319381493
2. Devlin, T.M. (2011). Textbook of Biochemistry with Clinical Correlations (7th ed.). New York, John Wiley & Sons, Inc. ISBN:978-0-470-28173-4.
3. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN:978-1-11809244-6.

Suggested readings:

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

4. Keywords

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

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

DSC-8 : BIOENERGETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

<table>
<tr><th rowspan="2">Course title & Code</th><th rowspan="2">Credits</th><th colspan="3">Credit distribution of the course</th><th rowspan="2">Eligibility criteria</th><th rowspan="2">Pre-requisite of the course (if any)</th></tr>
<tr><th>Lecture</th><th>Tutorial</th><th>Practical/ Practice</th></tr>
<tr><td>Bioenergetics</td><td>04</td><td>02</td><td>00</td><td>02</td><td>Class XII with Science</td><td>NIL</td></tr>
</table>

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-8

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

Unit I: Principles of Thermodynamics (6 Hours)

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

Unit II: Biological Oxidation-reductions (4 Hours)

Redox reactions, reduction potentials, standard reduction potential and its relationship with standard free energy change, Nernst equation. Universal electron carriers-NADH and $FADH_2$.

Unit III: Oxidative phosphorylation (10 Hours)

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

Unit VI: Photophosphorylation (10 Hours)

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

2.3 Practical: - 60 Hours

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

2.4 Essential readings:

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8thed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
2. Berg, J.M., Tymoczko, J.L., Gatto G.J., Stryer L. (2019) *W.H:* Freeman and Company, ISBN:10: 1319114679, ISBN:13:978-1319114671

3. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6^{th}ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

Suggested readings:

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

3. Keywords

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

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

DSC-9: MEMBRANE 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		
Membrane Biology	04	02	00	02	Class XII with Science	NIL

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-9

Theory

Hours – 30 Hours

Unit I: Membrane composition and structure (10 Hours)

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

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

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

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

Unit II: Membrane dynamics (5 Hours)

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

Unit III: Membrane transport (9 Hours)

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

Unit IV: Vesicular transport and membrane fusion (6 Hours)

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

2.3 Practical:

Total Hours : 60 Hours

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

2.4 Essential readings:

1. Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning. ISBN-10: 1305577205, ISBN-13: 978-1305577205

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

3. Keywords:

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

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

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSEs)

DISCIPLINE SPECIFIC ELECTIVE (DSE-1)

credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Environmental Biochemistry	04	02	00	02	Class XII with Science	NIL

Learning Objectives

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

Learning outcomes

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

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

Theory

Credits: 2 **Total Hours- 30**

Unit 1: Introduction to Environment and the Pollutants (9 Hours)

Components of Environment - Atmosphere, Hydrosphere, Lithosphere and Biosphere. Global Warming and Climate change. Ozone depletion. Normal Chemistry of - Air, Water, Soil. Environmental Toxins-Physical Pollutants- Noise, Light and Radiation and Air Pollutants- Carbon Monoxide, Lead, Nitrogen Oxides, Ozone, Particulate Matter, Sulphur Dioxide, Methane Volatile Organic Chemicals (VOC); Water Pollutants - Volatile Organic Chemicals (VOC), Heavy Metals, Insecticides, Herbicides/ Endocrine Disruptors; Soil Pollutants-

Heavy metals, Herbicides/pesticides, Polyaromatic Carbon (PAH), Microplastics; Source, Effect and Impact on Flora, Fauna including Human Beings. Definition of Terminologies: Air Quality Index (AQI) Suspended Particulate matter (SPM), Water Quality Index (WQI), Air Pollution Tolerance Index (APTI), Anticipated Performance Index (API).

Unit 2: Environment and Xenobiotics (7 Hours)

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

Unit 3: Sustainability and its Enhancement (8 Hours)

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

Unit 4: Techniques to Analyse Pollutants (6 Hours)

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

2.3 Practical:

Credits: 2 Total Hours - 60

1. Evaluating APTI and API of Herbs/Shrubs/Trees
2. Evaluating seasonal variations of AQI and SPM
3. Evaluating C/N/P/K content of soil by Spectrophotometry/Titrimetric method
4. Detecting Microbial Contamination of water
5. Composting of waste (Leaf/Kitchen Waste/Cow dung) and Detecting Maturity by pH and Electric conductivity (EC) content changes
6. Studying Enzymatic Activity (amylase/urease) in the soil sample due to microbial activity
7. Student Environment Projects.

2.4 Essential readings:

- Basic Concepts on Environmental Chemistry by Des. W. Conwell (2005) 2nd edition, CRC press, ISBN 9781498770484
- Environmental Chemistry by Stanley E Manahan, 11th Edition, Taylor and Francis,2022, ISBN 9780367560546
- Biodegradation and Bioremediation by Alexander Martin, 2nd Edition, Academic Press, ISBN 978-0-12-049861-8

- Fundamentals of Ecology author Eugene Odum, Cary W. Barrett, 5th edition Cengage learning India. ISBN 9788131500200
- Environment and Ecology author P.D. Sharma, 12th Edition, Rastogi Publication. ISBN 978-93-5078-068-8

3. Keywords

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

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

DISCIPLINE SPECIFIC ELECTIVE (DSE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemical Applications in Forensic Sciences	04	02	00	02	Class XII with Science	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:

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

2.2 Course Contents

Theory

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 – 60 Hours

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 (DSE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Microbiology	04	02	00	02	Class XII with Science	NIL

Learning Objectives

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

Learning outcomes

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

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

2.2 Course Contents

Theory

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: 60 Hours

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

2.4 Essential readings:

1. Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.
2. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) Microbiology (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
3. Pierce, B.A. (2012) Genetics - A Conceptual Approach, (6thed.), 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

4. 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.

Common Pool of Generic Electives (GEs) offered by Department of Biochemistry

GENERIC ELECTIVES (GE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Proteins and Enzymes	**04**	**02**	**00**	**02**	**Class XII with Science**	**NIL**

Learning Objectives

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

Learning outcomes

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

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

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

2.2 Course Contents

THEORY – Total 30 Hours

UNIT I: Introduction to proteins (8 Hours)

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

UNIT II: Three-dimensional structures and protein folding (7 Hours)

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

UNIT III: Introduction to enzymes and enzyme kinetics (8 Hours)

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

UNIT IV: Regulation of enzyme activity and applications of enzymes (7 Hours)

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

PRACTICALS – 60 Hours

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

2.3 Essential Readings

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

Suggested Readings

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

3. Keywords

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

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

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	04	02	00	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

2.2 Course Contents

Theory – 30 Hours

Unit 1 –Basics of Food Science and Nutrition (5 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 – 60 Hours

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 ELECTIVES (GE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Physiology of Sports and Exercise	04	02	00	02	Class XII with Science	Nil

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.

2.2 Course Contents

Theory – 30 Hours

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: 60 Hours

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.

DISCIPLINE SPECIFIC CORE COURSE – 7: BASIC CONCEPTS OF 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-DSC301: BASIC CONCEPTS OF CELL BIOLOGY	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 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.
- To familiarize the students 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 structure of the cell wall and cell membrane, membrane transport mechanisms, cell-matrix and cell-cell interactions, and the importance of the cytoskeleton.
- Student will be able to describe the organization and functioning of various cell organelles and gain insights into the internal organization of the nucleus.
- Student will be able to discuss the mechanisms of protein sorting, intracellular trafficking, and protein export.
- Student will be able to analyse the structure of the plant and animal cell by microscopic observation and the ultrastructure of cell organelles by electron microscopy.

- Student will be able to demonstrate the fractionation of cell components by ultracentrifugation and describe cell sorting by flow cytometry.

SYLLABUS OF DSC-7

UNIT – I (12 hours)
Cell envelope and cell interactions: Structure and composition of bacterial, fungal and plant cell walls. Composition of plasma membrane: phospholipid bilayer, membrane proteins, glycocalyx. Membrane transport mechanisms: passive diffusion, facilitated diffusion (carrier proteins and channel proteins), active transport (Na+-K+ ATPase, ABC transporters). Components of extracellular matrix: polysaccharides, structural proteins, adhesion proteins. Cell-matrix interactions: cell surface receptors, focal adhesions, hemi-desmosomes. Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata

UNIT – II (6 hours)
Cytoskeleton: structural organization of actin filaments, microtubule structure and dynamics, structure of centriole, cilia, flagella. Microtubule motor proteins: kinesins and dyneins.

UNIT – III (12 hours)
Structures and functions of nucleus and other cell organelles: Structure and function of nucleus and its components (nuclear envelope, nuclear lamina, nuclear pore complex). Internal organization of nucleus: heterochromatin, euchromatin, nucleolus. Structure and function of cell organelles: mitochondrion, chloroplast, ribosome, peroxisome, lysosome

UNIT – IV (15 hours)
Protein sorting and membrane trafficking: Structure of endoplasmic reticulum (smooth and rough, ER transmembrane proteins). Targeting and translocation of proteins across the endoplasmic reticulum, protein processing, folding and assembly. Brief overview of the role of endoplasmic reticulum in synthesis of lipids and assembly of phospholipid bilayers. Structure and organization of golgi apparatus. Protein glycosylation, protein sorting, and exocytosis. Signal sequences in transmembrane transport: nuclear localization signal, endoplasmic reticulum signal sequence

Practical component **30 Hours**

UNIT 1: (20 hours)
Cell and cell organelles: Use of light microscopy and electron microscopy in studying cells. Study of the structure and function of a plant cell and an animal cell through microscopy. Analysis of the ultrastructure of cell organelles through electron micrographs: nucleus, plasma membrane, mitochondrion, chloroplast, ribosome, endoplasmic reticulum, golgi bodies, lysosome, centriole

Unit 2: (10 hours)

Cell fractionation and sorting: Principle and working of cell fractionation by density gradient centrifugation using virtual lab. Principle and working of cell sorting by flow cytometry using virtual lab. Analysis of cell cycle stages using flow cytometry.

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. Cell Biology by T.D. Pollard, W.C. Earnshaw, J. Lippincott-Schwartz and G.T. Johnson. 3rd edition. Elsevier, USA. 2016.
6. Becker’s World of the Cell by J. Hardin and G. Bertoni. 9th Edition. Pearson, USA. 2015.
7. Cell and Molecular Biology by E.D.P. De Robertis. 8th edition. Lippincott, Williams and Wilkins, 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.

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

DISCIPLINE SPECIFIC CORE COURSE –8:
MICROBIAL PHYSIOLOGY AND METABOLISM- 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-DSC302: **MICROBIAL PHYSIOLOGY AND METABOLISM- 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 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 discuss the diverse nutritional categories of bacteria/archaea and mechanisms of transport of nutrients across membranes of microbes.
- Student will be able to describe the physiology of bacterial growth, calculation of generation time and specific growth rate, and the effects of physicochemical factors on microbial growth.
- Student will be able to describe the metabolic pathways used by bacteria for energy generation and conservation during growth on glucose and other carbon sources under aerobic and anaerobic conditions.
- Student will be able to discuss energy production processes in microbes.

- Student will be able to analyse growth kinetics of bacteria, and evaluate the impact of external factors on bacterial growth kinetics.

SYLLABUS OF DSC-8

UNIT – I (10 hours)
Nutritional diversity amongst bacteria and mechanisms of nutrients transport: Classification of bacteria based on carbon, electron and energy sources. Nutrient transport across membrane: passive transport (diffusion- simple and facilitated), active transport (primary and secondary with suitable examples, concept of uniport, symport, antiport) and group translocation. Electrogenic and electroneutral transport. Transport of iron in bacteria through concerted action of primary and secondary active transport.

UNIT – II (12 hours)
Microbial growth patterns, kinetics and physiological adaptations: Batch, continuous, diauxic and synchronous growth. Bacterial growth kinetics: growth curve, generation time and specific growth rate. Physiological adaptations by microbes for growth under different environmental conditions: effect of temperature, pH, oxygen concentration, solute and water activity.

UNIT – III (12 hours)
Chemoheterotrophic metabolism under aerobic conditions: Concept of metabolism and energy production. Glucose degradation/catabolism by microbes via: glycolysis, Entner-Doudoroff (ED) pathway, Pentose phosphate pathway (PPP). The pyruvate dehydrogenase reaction, Krebs Cycle, anaplerotic reactions, Glyoxylate cycle. Utilization of fructose, lactose and pentose

UNIT – IV (11 hours)
Electron transport and energy production: Redox potentials of the electron carriers, organization of electron carriers in mitochondria, coupling sites, mechanisms of proton translocation, chemiosmotic hypothesis, oxidative phosphorylation and ATP generation, uncouplers and inhibitors of respiratory chain, comparison of mitochondrial and bacterial electron transport, branched respiratory chain in E. coli under high and low levels of O_2.

Practical component 30 Hours

UNIT 1: (20 hours)
Microbial growth: Study of various methods of measurement of microbial growth. Collection of data and plotting of bacterial growth curve of E. coli using turbidometric method (using optical density as the indirect method of measurement of bacterial growth). Understanding bacterial growth kinetics by calculation of generation time and specific growth rate of bacteria from the graph. Study of radial growth of *Aspergillus niger* using point inoculation method

Unit 2: (10 hours)

Effect of environmental factors on microbial growth: Study of the effect of physicochemical factors like temperature and pH variations on the growth of *E.coli*. Understanding the physiological importance of catalase and oxidase in protecting bacteria from the harmful effects of oxidizing environment: detection and assay of their activity in bacteria.

Essential/recommended readings

Theory:

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman 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.

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

DISCIPLINE SPECIFIC CORE COURSE – 9: ENVIRONMENTAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC303: ENVIRONMENTAL MICROBIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to provide students with in-depth knowledge of diverse microbial populations/ communities present in different habitats in the ecosystem.
- Students will become aware of the inter-microbial, microbe-plant and microbe-animal interactions and their benefits. The students will also learn about the management of solid and liquid waste and different strategies for microbial remediation of environment pollutants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss natural habitats of diverse microbial populations and give an overview of the concept of metagenomics.
- Student will be able to analyse various positive and negative interactions amongst microbes and also between microbes and plants / animals.
- Student will be able to explain the importance of microorganisms in mineral cycling within an ecosystem, and their effects on the environment.
- Student will be able to discuss various methods involved in sewage treatment, how we can make water safe for drinking, and various methods for testing water potability.
- Student will be able to evaluate different waste management strategies using microorganisms.
- Student will be able to describe various methods of microbial remediation for treating pollutants present in our environment. Student will be able to determine the importance of quality control in the food industry and describe various indices being used to measure quality and safety in the food industry.

SYLLABUS OF DSC-9

UNIT – I (11 hours)

Natural habitats and their microbial communities: Concepts of habitat, niche. Autochthonous, allochthonous, zymogenous microorganisms. Colonization and succession. Lithosphere: Soil profile, soil characteristics: physical and chemical, soil microbial community. Hydrosphere: Freshwater habitat: stratification and microbial composition of lake. Marine habitat: stratification and microbial composition of ocean. Atmosphere: atmosphere as microbial habitat, dispersal of microorganisms/spores, bioaerosols, methods of air sampling (filtration and deposition). Extreme habitats with reference to temperature, hydrostatic pressure, salinity and low nutrient levels. Concept of metagenomics, use of metagenomics to profile microbial communities in natural habitats.

UNIT – II (9 hours)

Interactions of microbial populations: Microbe-microbe interactions. Positive interactions: mutualism, protocooperation, commensalism. Negative interactions: antagonism, competition, predation, parasitism. Microbe-plant interactions. Symbiotic association: microbes associated with roots and aerial plant surfaces, leguminous roots-rhizobium symbiosis, Anabaena-Azolla symbiosis, mycorrhizal and actinorhizal associations. Microbe- animal interactions. Microflora in ruminant gut, nematophagous fungi and symbiotic luminescent bacteria.

UNIT – III (9 hours)

Mineral cycling by microbes and their effects on the environment : Importance of biogeochemical cycles. Carbon cycle: microbial degradation of cellulose, lignin and chitin, Nitrogen cycle: nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: solubilisation and immobilization. Sulphur cycle: oxidative and reductive sulphur transformation, metal corrosion, acid mining drainage, nitrate pollution

UNIT – IV (9 hours)

Wastewater treatment and water potability: Sources and composition of liquid waste. Sewage strength: BOD and COD. Primary, secondary (aerobic: trickling filter, activated sludge process; anaerobic: septic tank, anaerobic sludge digestor) and tertiary sewage treatment. Treatment and safety of drinking (potable) water, Methods to detect potability of water samples: standard qualitative procedure - presumptive test/MPN test, confirmed and completed tests for fecal coliforms; membrane filter technique and Presence/Absence tests for coliforms, Indicator microorganisms.

UNIT – V (7 hours)

Disposal of solid waste by microbes and microbial remediation of environment: Sources and types of solid waste. Methods of solid waste disposal: sanitary landfills, composting (static piles, aerated piles and continuous feed reactors). Concepts of xenobiotics, recalcitrant compounds and bioremediation. Biodegradation of pesticides (DDT and Propanil), oil spills, e-waste and plastics.

Practical component **30 Hours**

UNIT 1: (15 hours)

Soil microflora:

Study of the presence of microbial activity in soil by qualitative detection of enzyme activity: dehydrogenase, amylase, urease. Microbial interactions: Isolation and quantitation of bacteria from rhizosphere and root-free soil to determine the rhizosphere effect. Isolation of symbiotic and non-symbiotic nitrogen fixers: *Rhizobium* and *Azotobacter* or *Azospirillum*.

Unit 2: (15 hours)

Mineral cycling and waste management by microbial remediation: Demonstration of phosphate solubilization by plate isolation method. Student group project: Preparation of Winogradsky column mini aquatic ecosystem. Assessment of the microbiological quality of water by standard qualitative procedures. Determination of BOD of wastewater sample by Dissolved Oxygen Electrode method/ Winkler's method. **Student group project**: Sewage surveillance in the fight against COVID19.

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. Microbial bioremediation by P. Rajendran and P. Gunasekaran. 1st edition, MJP Publishers, India. 2019.
3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4. Environmental microbiology by K.V. Ramesh. MJP Publisher. 2019.
5. Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
6. Wastewater Microbiology by D.H. Bergey. Medtech, India. 2014.
7. Environmental Biotechnology by M. Jain. 1st Edition. Alpha Science International Ltd. 2014.
8. Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition.Academic Press, USA. 2014.
9. Microbial ecology by L.L. Barton and D.E. Northrup. 1st Edition. John Wiley & Sons. 2011.
10. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA.2011.
11. Environmental Biotechnology: Basic Concepts and Applications by I.S. Thakur. 2nd Edition. I K International Publishing House Pvt. Ltd. 2011.
12. Advances in Applied Bioremediation edited by A. Singh, R.C. Kuhad and O. P. Ward.Springer-Verlag, Germany. 2009.
13. Microbial Ecology: Fundamentals and Applications by R.M. Atlas, R. Bartha. 4th edition.Benjamin Cummings, USA. 2000.
14. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.

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. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja. 5th edition. New Age International Publishers, India. 2017.
4. Manual of Environmental Microbiology by C. J., Hurst, R. L., Crawford, J. L., Garland and D. A. Lipson. American Society for Microbiology Press. USA. 2007.
5. Microbial Ecology: Fundamentals and Applications by R.M. Atlas and R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.
6. Methods in Applied Soil Microbiology and Biochemistry by K. Alef and P. Nannipieri. Ist edition. Academic Press, USA. 1995.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 1: EUKARYOTIC MICROBES: BIOLOGY AND BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE1: EUKARYOTIC MICROBES: BIOLOGY AND BIOTECHNOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of the course is to make students familiar with eukaryotic microorganisms namely algae, protozoa and fungi. They will become aware of their characteristics and applications in various fields such as industry, food, environment and medical science.
- They will understand how eukaryotic microbes can be used to develop eco-friendly and sustainable solutions to problems we are encountering in various fields.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the characteristics of major algal types, the applications of micro and macro algae in different fields, and algae mass cultivation methods.
- Student will be able to describe different types of protozoa and their salient features, the significance of protozoa in medical, environmental and other fields.
- Student will be able to explain the characteristics of different types of fungi, their benefits and harmful effects, the biology and commercial importance of mushrooms.
- Student will be able to demonstrate the isolation and identification of green algae from pond water, the extraction and analysis of chlorophyll pigment. They will be able to discuss the thallus organization of different types of algae and the taxonomic position of Euglena.
- Student will be able to identify different types of protozoa and explain their major characteristics, the life cycles of some protozoa which cause diseases transmitted through insects or by contaminated food and water.

- Student will be able to describe different types of fungi and will be able to identify them based on their macroscopic and microscopic characteristics. They will be able to demonstrate fungal techniques, the difference between edible and poisonous mushrooms, steps of mushroom cultivation through visit to mushroom cultivation centre.

Theory component

Unit 1: (10 hours)

Algae structure, ecology and significance: General characteristics and brief account of habitat and thallus organization of major algal types: Chlorophyta, Bacillariophyta, Dinoflagellates, Xanthophyta, Phaeophyta and Rhodophyta. Applications of algae in wastewater treatment, biofuel and bioenergy products, pharmaceutical industries and food and feed sectors with reference to *Chlorella, Euglena, Dunaliella, Porphyra, Gracilaria,* diatoms*, Sargassum* and *Laminaria.* Mass cultivation of algae in open and closed photobioreactors.

Unit 2: (10 hours)

Protozoa structure, ecology and significance: An overview of habitat, cell structure, locomotion, and nutrition of different protozoa: *Entamoeba, Plasmodium, Giardia, Tetrahymena, Trypanosoma and Leishmania*. Disease causing protozoa: list of diseases, causative agent, mode of transmission, preventive measures currently in use (if any). Significance of protozoa in food web and water purification. Marine protozoa as source of filtering agents, chalk, abrasive and building material. Role of protozoa in symbiosis therapy and drug discovery. Role of *Tetrahymena* as model organism.

Unit 3: (10 hours)

Fungal structure, ecology and significance: An overview of habitat, thallus structure, nutrition and positive and negative importance (ecological, industrial, and medical) of different fungi: *Neocallimastix, Saccharomyces, Penicillium, Neurospora, Agaricus* and *Armillaria.* Detailed account of biology and commercial importance of Mushrooms: History, classification and distribution, life cycle, cultivation, nutrient and medicinal values; Edible and poisonous mushrooms.

Practical component **60 Hours**

Unit 1: (24 hours)

Isolation, identification and pigment analysis of algae: Study of the following algae by temporary mounts/permanent slides/photographs (at least one alga to be studied by making temporary mounts): *Chlorella, Porphyra, Gracilaria,* diatoms*, Sargassum, Dunaliella, Caulerpa, Ulva.* Comparison of the vegetative thallus organization. Isolation of green algae from pond water and their identification by making temporary mounts. Recording of macroscopic and microscopic characterteristics of isolated algae. Extraction of pigment (chlorophyll) from algae and its analysis using chromatography or spectrophotometry. Study of the structure of *Euglena* cell highlighting its algal and protozoa characteristics discussion of its 'taxonomic enigma' status.

Unit 2: (16 hours)

Identification of protozoa and their importance: Study of different protozoa (*Entamoeba, Plasmodium, Giardia, Tetrahymena, Trypanosoma and Leishmania*) with the help of permanent slides / photographs. Comparison of their structure and important characteristics. Study of the different stages of disease cycles of arthropod-borne protozoal diseases (*Plasmodium, Trypanosoma* and *Leishmania*) with the help of pictorial aids. **Student research study project**: Transmission, symptoms, prevention and cure of these diseases. Study of food and water-borne diseases caused by protozoa (*Entamoeba* and *Giardia*) in reference to life cycle, transmission, symptoms, prevention and cure. Comparison of the disease cycles of *Entamoeba* and *Giardia*.

Unit 3: (20 hours)

Identification of fungi and their importance: Study of fungi by temporary mounts/ permanent slides/photographs (at least one fungus to be studied by making temporary mounts): *Neocallimastix, Saccharomyces, Penicillium, Neurospora, Agaricus* and *Armillaria.* Observation of macroscopic and microscopic identifying characteristics. Preparation of spore suspension of fungus (*Aspergillus niger*) and counting of spores / ml using hemocytometer. Study of edible and poisonous mushrooms with the help of samples/photographs. Visit to mushroom cultivation center to learn various steps involved in mushroom cultivation.

Suggested Reading (Theory & Practical):

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
2. A Textbook on Mushroom Cultivation: Theory and Practice by A. Aggarwal, Y. P. Sharma, and E.Jangra.1st edition. Newrays Publishing House, India. 2021.
3. Prescott's Microbiology by J.M.Willey, K.Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.
4. Paniker's Textbook of Medical Parasitology by C.K. J. Paniker and S. Ghosh.8th edition. Jaypee Brothers Medical Publishers, India. 2018.
5. Laboratory Manual for Algae and Fungi by B.K.Chetri.1st edition.Lulu.com publisher.2018.
6. Textbook of Algae by O.P.Sharma. Tata McGraw Hill Publishing Co. Ltd, India. 2017.

7. Algae Biotechnology: Products and Processes by F.Bux, and Y. Chisti (Eds.) 1st edition. Springer International Publishing, USA. 2016.

8. Algae: Anatomy, Biochemistry, and Biotechnology by L. Barsanti and P.Gualtieri. 2nd edition.CRC Press, Taylor and Francis group,USA. 2014.

9. Introductory Mycology by C.J. Alexopoulos, C.W. Mims and M. Blackwell. 4th edition. John Wiley and Sons, New York. 2012 (reprint).

10. Manual of Soil Fungi by J.C. Gilman. 1st edition. Biotech Books, India. 2012 (Reprint).

11. Introduction to Fungi by J. Webster and R.W.S. Weber. 3rd edition. Cambridge University Press. USA. 2007.

12. The Fungi by G.Sumbali. 2nd edition. Narosa Publishing India House, India. 2005.

13. Protozoa by R.L. Kotpal. 12th edition. Rastogi Publication, India. 2006.

14. Manual of Phycology by G.M.Smith.1st edition. Scientific Publishers Journals, India.1994

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2:
Applications of Statistics in 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-DSE2: Applications of Statistics in Biology	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable the students to understand the basic concepts of statistics and how statistics helps in analysing biological data by using simple examples. Students will learn to handle biological data using statistical tools and to draw appropriate conclusions from the analysis.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the collection and analysis of data through descriptive statistics, measures of skewness and kurtosis, Discrete and Continuous Random variable; with emphasis on examples from biological sciences.
- Student will be able to describe correlation and regression, various Discrete and Continuous Distributions namely Binomial, Poisson, Exponential and Normal distribution.
- Student will be able to explain different statistical methods, principles of statistical analysis of biological data, sampling parameters.
- Student will be able to describe large sample test based on normal distribution, and small sample test based on t-test and F test

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

Data collection and handling: Collection, Classification, Tabulation and Graphical representation of Data. Measure of central tendency and dispersion. Correlation and Regression analysis: Relation between two variables, curve fitting, two regression lines, Karl Pearson's coefficient of correlation.

Unit 2: (10 hours)

Probability, variables and types of distribution: Probability theory and concept of Random Variable (discrete and continuous), Standard distributions: Exponential distribution, Binomial distribution, Poisson distribution, Normal distributions.

Unit 3: (10 hours)

p-value and sample tests: Sampling Distributions, Testing of Hypothesis, Level of Significance and Degree of Freedom; Interpretation and significance of p-value. Large Sample Test based on Normal Distribution, small sample test based on t-test and F test.

Practicals: 60 hours

Unit 1: (20 hours)

Handling of data, dispersion, Karl Pearson coefficient, and regression analysis using Excel: Handling of data using measures of central tendency; handling of data using measures of dispersion; finding Karl Pearson correlation coefficient and interpretation of result; Spearman rank correlation with and without ties; how to obtain regression lines.

Unit 2: (20 hours)

Distributions (Practical Using Excel): Fitting of binomial distributions for n and p = q = ½ given; fitting of Poisson distributions for given value of lambda; application problems based on binomial distribution; application problems based on Poisson distribution; problems based on area property of normal distribution; finding the ordinate for a given area for normal distribution; application based problems using normal distribution

Unit 3: (20 hours)

Sample tests and their applications (Practical Using Excel): Problems based on Large Sample Tests and interpretation of result; estimators of population mean when Population is large; Tests of hypotheses for the parameters of a normal distribution-Single Mean; Tests of hypotheses for the parameters of a normal distribution -Difference of Means; application of t-test- single mean, difference of means and Paired t-test; application of F- test and interpretation of result on given data set.

Suggested reading (Theory & Practical):

1. Introduction to the Theory of Statistics by A.M. Mood, F.A. Graybill and D. C. Boes. 3rd edition (Reprint). Tata McGraw-Hill, India. 2017.
2. An Introduction to Medical Statistics by M. Bland. 4th edition. Oxford University Press USA, 2015.
3. An Introduction to Biostatistics by N. Gurumani. 2nd edition. MJP publishers, India. 2014.
4. An introduction to Biostatistics and Research Methods by PSS Sunder Rao and J. Richard. 5th edition. PHI learning, India. 2012.
5. Fundamentals of Statistics (Vol. I & II) by A. M. Goon, M. K. Gupta and B. Dasgupta. 8th edition. The World Press, India. 2008.
6. Mathematical Statistics with Applications by I. Miller and M. Miller. 7th edition, Pearson Education, Asia. 2006.
7. Biostatistics: A Foundation for Analysis in the Health Sciences by Daniel, Wayne W. John Wiley, UK. 2005.
8. Fundamentals of Biostatistics by Irfan A Khan. Ukaaz Publications, India. 1994.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 3: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES	4	2	0	2	Class XII pass with Biology/ Biotechnology / Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is for students to develop an understanding of the concept and implementation of microbial quality control in the food and pharmaceutical industries.
- Students will gain insights into how the final products obtained for human and animal consumption are consistent, certified as safe for human consumption, and compliant with microbial standards.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the parameters and techniques of Good Laboratory and Microbiological practices, sources of contamination, microbial monitoring of the environment and the concept of clean areas in the industry.
- Student will be able to explain the techniques of collecting and processing food, water and pharmaceutical samples for bioburden testing, various microscopic, culturing, biochemical, molecular and immunological testing techniques used for assessing the presence of microbes/pathogens as well as the toxic microbial products.
- Student will be able to describe Total Quality Management (TQM) system and Standard Operating Procedures (SOP) for fulfilling the requirements of Quality

Control (QC) are created, various microbiological standards and certifications by accrediting bodies for food and pharmaceutical industries.

- Student will be able to demonstrate the techniques for checking milk quality by performing rapid and standard laboratory tests, method of testing of microbiological quality of water samples (Most Probable Number).
- Student will be able to describe how the food sample is processed for the detection of microorganisms, various differential and selective media to detect and identify different microorganisms present in a food sample.
- Student will be able to demonstrate sterility testing of various food and pharmaceutical products under different conditions.
- Student will be able to develop HACCP flow charts for different products, the application of various standards in quality regulation in food and pharma products with the help of case studies.

Contents:

Theory: 30 hours

Unit 1. (8 hours)

Microbiological safe practices for food and pharmaceutical industry: Laboratory practices for safety and quality (GLP and GMLP). Concept of Biosafety cabinets. Biosafety
levels (BSL-I to BSL-IV): designs, specifications and uses. Concept of Clean Area and its classification. Microbial monitoring of controlled environments (bioburden). Sources of contamination in food and pharmaceutical industries. Steps to avoid contamination. Food Safety, Sanitation Standard Operating Procedure (SSOP) and Personal Hygiene**.**

Unit 2: (14 hours)

Monitoring and analysis of microbiological quality of food and pharmaceutical samples: Types of products in food and pharmaceutical industries. Bioburden testing for food, beverages and medical devices. Collection and processing of samples for microbiological monitoring. Detection of microorganisms by microscopic method (fluorescence-based Direct Microscopic Count). Detection of microorganisms by cultural methods: enrichment technique, standard plate count, the concept of differential and selective media for detection of pathogens (XLD agar, Salmonella-Shigella agar, Mannitol salt agar, EMB agar, McConkey agar). Microbiological examination of non-sterile pharmaceutical products, concept of microbial limits, sterility testing (its objectives and significance). Molecular, biochemical and immunological methods for detection of microorganisms and their products (Nucleic acid probes, PCR, biosensors, Limulus lysate test, pyrogen testing). Significance of rapid detection methods (Clot on

Boiling Test, dye reduction test by Resazurin) in food industry.

Unit 3: (8 hours)

Microbial quality standards and management: Introduction and importance of quality standards. Concepts and approaches of Total Quality Management (TQM), Quality Management System, ISO 9001:2000, Quality Assurance and Quality Control. Development of Standard Operating Procedures. Hazard analysis of critical control point (HACCP): principles, applications and limitations. Concept of Codex Alimentarius and Codex Standards. Role of accredited certification bodies (BIS, Agmark, FSSAI, ISO) in maintaining product quality.

Practicals: **60 hours**

Unit 1: (20 hours)

Testing of quality of milk and water samples: Checking the effectiveness of pasteurization of milk: Alkaline phosphatase test. Detection of microbiological quality of milk sample through Triphenyltetrazolium chloride (TTC) test, Clot on boil (COB) test and dye reduction test (Resazurin). Determination of microbiological quality of water sample by MPN method.

Unit 2: (30 hours)

Microbiological quality of food and pharmaceutical products: Sample processing for detection of microorganisms in food (one solid: Bread/idli batter/cheese/ biscuits/ pizza base/salad/cake etc. and one liquid:juice/ butter milk/ energy drink etc. sample/s.) Detection and Identification of microorganisms present in processed food samples through different types of media (XLD agar/Salmonella-Shigella agar, Mannitol salt agar, EMB agar, McConkey agar). Sterility testing of food (canned food/tetrapak drink) and pharmaceutical products (eye drops/injection ampoule) for aerobic microbes using cultural methods. Demonstration to test the presence of anaerobic microbes by virtual lab/video .Principle and concept of Limulus lysate (LAL) test for detecting the presence of endotoxin in consumable products by virtual lab/video.

Unit 3: (10 hours)

Quality regulation of food and pharmaceutical products: Study of HACCP of milk/dairy product with the help of flow chart. **Student group project**: applications of various standards (BIS, Agmark, FSSAI, ISO) in quality regulation in food and pharma products: case studies involving at least one food and one pharma product.

Suggested Reading (Theory & Practical):

1. Analytical Food Microbiology: A Laboratory Manual by A.E. Yousef, J.G. Waite-Cusic and J.J. Perry. 2nd edition. Wiley Publishers, UK. 2022.
2. Essentials of Pharmaceutical Microbiology by A. Kar, 2nd edition. New Age International. India. 2020.
3. Food Safety and Quality Control by P. Mathur. 1st edition. The Orient Blackswan, India. 2018.
4. Pharmaceutical Biotechnology: Fundamentals and Applications by J.A.D. Crommelin, R. D. Sindelar, and B. Meibohm.(Eds.) 4th edition. Springer, Germany. 2016.
5. Manuals of methods of analysis of foods and water by Food Safety and Standards Authority of India, Ministry of health and family welfare, Government of India, 2016.
   https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/WATER.pdf
   https://old.fssai.gov.in/Portals/0/Pdf/Manual_Fruits_Veg_25_05_2016.pdf
6. Pharmaceutical Microbiology: Essentials for quality assurance and quality control by T. Sandle. 1st edition. Woodhead Publishing. UK. 2015.
7. Fundamentals of Food Microbiology by Bibek Ray and A. Bhunia. 5th edition. CRC Press UK. 2013.
8. Pharmaceutical Biotechnology: Concepts and Applications by G. Walsh. 1st edition. John Wiley & Sons Ltd. USA. 2011.
9. Modern Food Microbiology by J.M. Jay, M.J. Loessner and D.A. Golden. 7th edition. CBS Publishers and Distributors, India. 2006.
10. Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices. R.M Baird, N.A Hodges, and S.P Denyer (Eds) 2nd edition. Taylor and Francis Inc., USA. 2005.
11. Hugo and Russell's Pharmaceutical Microbiology by S.P. Denyer, N.A. Hodges and S.P. Gorman. 7th edition. Blackwell Science. 2004.
12. Microbiological Analysis of Food and Water: Guidelines for Quality Assurance by N.F. Lightfoot and E.A. Maier. 1st edition. Elsevier Science. 1998.
13. Quality control in the Pharmaceutical Industry by M.S. Cooper (Ed). Vol.2. Academic Press,USA.1974.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 4: BIOTECHNIQUES AND INSTRUMENTATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 4: BIOTECHNIQUES AND INSTRUMENTATION	4	2	0	2	Class XII pass with Biology/ Biotechnology / Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to develop a strong understanding of the principles and applications of some basic and advanced techniques frequently used in sciences dealing with biological systems. This will allow the students to relate the concepts of the various areas being taught to them with the working and applicability of the instruments and techniques involved.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Will have learnt about the main components, working principles, and applications of different types of microscopes. The student will also be familiarized with the preparation of samples and staining for microscopy.
- Will have gained knowledge of basic concepts, applications, merits and limitations of various bio separation techniques like chromatography, electrophoresis and centrifugation.
- Will be acquainted with the principles and applications of some analytical techniques like X-ray diffraction and UV-visible spectrophotometry. Will have been introduced to the concepts of advanced techniques like circular dichroism, NMR spectroscopy and mass spectrometry.
- Will be able to use the microscope to determine the size of microbial cells applying the technique of micrometry. Will also be able to separate biomolecules using planar (paper chromatography/ TLC) and column chromatography.

- Will have gained hands-on experience of separation of mixtures using gel electrophoresis techniques (PAGE/Agarose) and laboratory centrifuges. Will have gained knowledge of working of density gradient centrifugation with the help of virtual lab / videos.
- Will be able to determine the λmax for an unknown sample and be able to calculate its extinction coefficient using a spectrophotometer. Will get familiar with the technique of autoradiography and NMR spectroscopy with the help of virtual lab / videos.

Theory: **30 hours**

Unit 1: (10 hours)

Principles and applications of microscopy: Concept of resolving power and magnification. Principles, working, and applications of : Bright-field and dark-field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy (scanning electron microscopy, transmission electron microscopy, and cryo- electron microscopy).

Unit 2: (12 hours)

Principles and applications of separation techniques: Partition chromatography: thin layer chromatography. Column chromatography: gel filtration, ion-exchange, affinity and HPLC. Differential and density gradient centrifugation, ultracentrifugation. Agarose gel electrophoresis. Polyacrylamide gel electrophoresis.

Unit 3: (8 hours)

Principles and applications of other analytical techniques: UV-Visual spectrophotometry (Beer and Lambert Law), X-ray diffraction, circular dichroism, nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry.

Practicals: **60 hours**

Unit 1: (24 hours)

Micrometry and chromatography: Principle of micrometry. Determination of the sizes of different microbial cells by micrometry. Separation of complex mixtures of biomolecules by paper chromatography/ Thin Layer Chromatography. Group project: Packing and running column chromatography. Determination of molecular weight of a protein using gel filtration chromatography.

Unit 2: (20 hours)

Electrophoresis and centrifugation: Separation of DNA by agarose gel electrophoresis. Separation of proteins by SDS-PAGE. Separation of components of a given mixture using a laboratory scale centrifuge using various rotors. Understanding density gradient centrifugation with the help of virtual lab.

Unit 3: (16 hours)

Imaging and advanced analytical techniques: Using spectrophotometer to determine λmax for an unknown sample and calculation of extinction coefficient. Principle and working of autoradiography. Demonstration of autoradiography using virtual lab / video. Understanding NMR spectroscopy with the help of virtual lab / video.

Suggested Reading (Theory & Practical):

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology edited by A. Hofmann and S. Clokie. 8th edition. Cambridge University Press, UK. 2018.
2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.
3. The Cell: A Molecular Approach by G.M. Cooper. 8th edition. Sinauer Associates, UK. 2018.
4. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 7th edition. W.H. Freeman and Company, UK. 2017.
5. Biophysical Chemistry by D. Klostermeier and M.G. Rudolph. 1st edition. CRC press, UK. 2017.
6. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and S.R. Crouch. 7th edition. Cengage Learning, USA. 2017.
7. Techniques and Methods in Biology. K. L. Ghatak. PHI Learning Private Limited, India. 2011.
8. Lab Manual in Biochemistry, Immunology and Biotechnology by A. Nigam and A. Ayyagari. Tata McGraw Hill, India. 2007.
9. Physical Biochemistry- Application to Biochemistry and Molecular Biology by D. Freifelder. 2nd edition. W.H. Freemen and Company, USA. 1982.
10. Systems Biology: A textbook by E. Klipp et al. 2nd edition. Wiley-VCH. 2016

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 5: PLANT-PATHOGEN INTERACTIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 5: PLANT-PATHOGEN INTERACTIONS	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to provide the students with an overview of the interactions of pathogenic microbes with their host plants, and how these interactions lead to plant disease. The students will become aware of the biochemical basis of plant- pathogen interactions, the production of virulence factors by pathogens, and thei defence mechanisms induced in plants in response to infection.
- They will learn about the genetic basis of disease resistance. They will be able to identify plant pathogens from the symptoms and microscopic study of infected plant specimens.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the important terms related to plant diseases, the scientific contributions of prominent plant pathologists, how microbes attack plants using enzymes, toxins, growth regulators etc., thereby affecting their physiological processes.
- Student will be able to explain describe how plants defend themselves upon attack by pathogens with help of Case studies of some important plant diseases.
- Student will be able to describe the genetics of plant disease and resistance, and developing disease-resistant transgenic plants.

- Student will be able to identify plant pathogens by observing symptoms of diseased plants, cutting sections/ preparing whole mounts of diseased plant material, and observing microscopically.
- Student will be able to explain the etiology, symptoms and control measures of specific bacterial, phytoplasma, virus and viroid diseases with the help of photographs of diseased plants, common disease symptoms observed in locally grown plants during a field visit.
- Student will be able to explain the concept of Koch's postulates using pathogen-infected plant material.

Contents:

Theory: 30 hours

Unit 1: (5 hours)

Introduction to plant pathology: Concepts and history: Concept of disease and pathogenesis. Causal organisms and symptoms associated with common plant diseases: rust, smut, blight, chlorosis, necrosis, gall, mosaic and wilt. Contributions of the following plant pathologists: E. J. Butler, Anton DeBary, Alexis Millardet, E. Smith, T. O. Diener, E. C. Stakman, J. E. Vanderplank, B. B. Mundkur, J. F. Dastur.

Unit 2: (19 hours)

Physiochemical basis of host-pathogen interactions: Virulence factors of pathogens - Enzymes: pectinases, cellulases. Toxins: host-specific (HV, T-toxin) and non-specific (tabtoxin, tentoxin). Growth regulators: auxin, gibberellin. Virulence factors in viruses: replicase, coat protein, silencing suppressors. Host physiological processes affected by pathogens - photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction. Defense mechanisms in plants - Inducible structural defenses (histological: cork layer, abscission layer, tyloses,gums), inducible biochemical defenses (hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis-related (PR) proteins). Study of some important diseases (etiology, epidemiology, symptoms and control measures): bacterial (crown gall), fungal (black stem rust of wheat), viral (Tobacco mosaic virus, Banana bunchy top).

Unit 3: (6 hours)

Genetics of plant disease resistance: Gene for gene hypothesis: concept of resistance (R) gene and avirulence (avr) gene, the gene for gene hypothesis. Types of plant resistance: true resistance– horizontal and vertical, apparent resistance-disease escape, disease tolerance. Genetic engineering for disease resistance in plants: with plant-derived genes and pathogen-derived genes.

Practicals: **Duration: 60 hours**

Unit 1: (24 hours)

Identification of plant pathogens examining infections microscopically: Principle and working method of lactophenol cotton blue staining. Preparation of whole mount of plant material, followed by staining with lactophenol cotton blue and microscopic observation for identification of the pathogen. Cutting fine transverse sections of infected plant material, staining with lactophenol cotton blue and observing the slide microscopically for identification of the pathogen. Any four from: *Albugo/ Puccinia/ Ustilago/ Phytophthora/ Fusarium/ Peronospora.*

Unit 2: (24 hours)

Study of plant diseases: Study of the etiology, symptoms and control measures of the following diseases. Bacterial: angular leaf spot of cotton, citrus canker. Phytoplasma: aster yellow, citrus stubborn. Viral: rice tungro disease, papaya ring spot, leaf curl of tomato. Viroid: potato spindle tuber, coconut cadang cadang disease. Field visit to a local park/college garden, to study common plant disease symptoms in plants. Recording observations in files with photographs of the diseased plants. **Study research study project**: History, etiology, symptoms, control measures, and economic impact if any, of any four rare plant diseases.

Unit 3: (12 hours)

Demonstration of Koch's postulates using a fruit/ vegetable infected with a plant pathogen: Observation of symptoms, isolation of pathogen by inoculation on potato dextrose agar plates, microscopic identification of the pathogen. Reinoculating it on a healthy fruit/vegetable to observe for similar symptoms, followed by reisolating it and observing microscopically in order to prove Koch's postulates.

Suggested Reading (Theory & Practical):

1. Fundamental of Plant Pathology Practical Manual by S. Singh, A. Kumar, A.K. Mishra. 1st edition. Deepika Book Agency, India. 2021.
2. Practical lab manual for Microbiology and Plant pathology by Huma Naaz, Hadi Husain Khan, Chandan Kumar Singh. 1st edition. AkiNik Publications, India. 2018.
3. Plant Diseases by R.S. Singh. 10th edition. MedTech, India. 2017.
4. Introduction to Principles of Plant Pathology by R.S. Singh. 5th edition. MedTech, India.2017.

5. Plant Pathology by R.S. Mehrotra and A. Aggarwal. 3rd edition. Tata McGraw-Hill Education, India. 2017.

6. Diseases of Crop Plants in India by G. Rangaswami and A. Mahadevan. 4th edition. Prentice Hall, India. 2005.

7. Plant Pathology by G. N. Agrios. 5th edition. Elsevier Academic Press, USA. 2005.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 6: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 6: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of the course is to introduce students to the fundamental aspects of biosafety and Intellectual Property Rights (IPR) to enable them to understand concerns related to safety from biological hazards and to gain an overview of the biosafety regulatory framework.
- They will be introduced to the importance of protecting intellectual property and become familiar with all aspects of the IPR Acts. Through case studies in law and scientific research students will understand the applications of the legal concepts in the space of scientists, scientific discoveries and innovations.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe how national and international biosafety regulations are formulated and implemented at the level of research institutes and laboratories locally, so as to safeguard the handlers as well as the environment from potential pathogens.
- Student will be able to describe the role of an IBSC in the biosafety regulatory framework and how to file an application seeking approval of a research proposal involving an LMO.

- Student will be able to explain the guidelines and precautions that need to be followed during the handling of radioisotopes, the concepts of Intellectual Property Rights, how they are protected through patents.
- Student will be able to demonstrate how to file a patent application. Student will be able to explain some International Agreements, Treaties and Acts governing protection of IPR.
- Student will be able to discuss the basic concepts of protection of IP through Copyright, Trademarks, Geographical indications, Industrial designs, Traditional Knowledge and New Plant Varieties along with specific biotechnological cases.

Contents:

Theory: **30 hours**

Unit 1: (12 hours)

Biosafety: Biosafety levels and risk groups. Role of Institutional Biosafety Committees (IBSC). GMOs/LMOs: Concerns and Challenges. GRAS microorganisms. Risk Analysis, and Assessment for Environmental release of GMOs, Cartagena Protocol. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions to be taken.

Unit 2: (12 hours)

Intellectual Property Rights and its types: Introduction and need for intellectual property rights (IPR). Patents: Types of inventions protected by a patent. Prior art search, patent applications and its types, patenting process. Patent infringement, Rights and Duties of patent owner. Patent Publications. Trade secrets and know-how agreements. Budapest Treaty on international recognition of the deposit of microorganisms. Patenting life: legal protection of biotechnological inventions-World Intellectual Property Rights Organization (WIPO) TRIPS, compulsory licensing, Patent Co-operation Treaty (PCT)

Unit 3: (6 hours)

Copyrights, Trademarks, Geographical indications, Industrial designs and New Plant Varieties and Traditional knowledge: Concepts, need, coverage and duration. Commercializing Biotechnology Invention. Case studies of Biotechnology.

Practicals: **60 hours**

Unit 1: (24 hours)

Biosafety levels and guidelines: Study of the layout and design of BSL-1, BSL-2, BSL-3 and BSL-4 laboratories and precautions to be followed according to the level of containment. Filing applications for approval from the Institutional Biosafety Committee (IBSC). **Student group project**: the emergence of biotechnology as the most important tool used to combat the Covid19 pandemic, biosafety protocols in handling Sars-CoV2.

Unit 2: (16 hours)

Genetically Modified Organism: Designing a suitable strategy to protect a genetically modified organism. Case study of the release of GMO Bt Cotton. Status of Bt brinjal and GM mustard in India.

Unit 3: (20 hours)

Patent applications and related case studies: The procedure for filing a patent application. Case study of patenting of basmati rice (GI). Case study of turmeric/ neem (traditional knowledge). **Student group project**: Preparation of patent application

Suggested Reading (Theory & Practical):

1. Intellectual Property Rights in India by P. Saidaiah and K. Ravinder Reddy. International Books and Periodical Supply Service, India. 2020.
2. The Blessing and Curse of Biotechnology: A Primer on Biosafety and Biosecurity, article by R. Langer and S. Sharma. https://carnegieendowment.org/2020/11/20/blessing-and-curse-of-biotechnology- primer-on-biosafety-and-biosecurity-p. 2020.
3. Intellectual Property Rights at a Glance by P. Singh and R.Singh. Daya Publishing House, New Delhi. 2018.
4. Biological Safety: Principles and Practices by D.P. Wooley and K.B. Byers. 5th edition. ASM Press, USA. 2017.
5. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers by B. Ramakrishna and H.S. Anil Kumar. 1st edition. Notion Press, India. 2017.
6. Biotechnology and Intellectual Property Rights: Legal and Social Implications by K. K Singh. Springer, India. 2015.

7. IPR, Biosafety and Bioethics by D. Goel and S. Parashar. 1st edition. Pearson Education, India. 2013.

8. Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications by. B.L.Wadehra. Universal Law Publishing, India. 2004

9. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology edited by T. M Murrayand M.J. Mehlman. John Wiley and Sons, UK. 2000.

10. http://shodhganga.inflibnet.ac.in/bitstream/10603/205165/7/chapter%20iii.pdf

11. https://dbtindia.gov.in/regulations-guidelines/regulations/biosafety-programme

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 7: APPLICATIONS OF MICROBES IN BIOREMEDIATION AND PETROLEUM INDUSTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 7: APPLICATIONS OF MICROBES IN BIOREMEDIATION AND PETROLEUM INDUSTRY	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to provide students with a comprehensive understanding of the process of bioremediation, its strategies, and the role played by microorganism in dealing with environmental pollutants of concern.
- This course highlights the applications of microbes in Microbial Enhanced Oil Recovery (MEOR), clean-up of oil spills, and the detoxification of heavy-metal contaminated environment. Students will acquire hands-on training in the above-mentioned areas.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the concepts of microbial bioremediation, its strategies and its applications, the microbiology of oil fields,Microbial Enhanced Oil Recovery (MEOR) and role of microbes in cleaning up of oil-spills.
- Student will be able to describe the use of biosensors in detection of heavy metals, explain heavy metal tolerance in microorganisms and the application of microbes in the detoxification of such contaminated sites.
- Student will be able to demonstrate the practical skills to isolate hydrocarbon-degrading microorganisms and assess their degradation potential.
- Student will be able to demonstrate how to detect and screen biosurfactant-producing microorganisms in the laboratory.

- Student will be able to demonstrate the isolation of heavy metal tolerant microorganisms, and discuss with case-studies on Microbial Enhanced Oil Recovery.

Contents:

Theory: **30 hours**

Unit 1: (12 hours)

Microbes and Bioremediation: Concept of bioremediation. Abiotic and biotic factors affecting bioremediation by microorganisms. *In-situ* bioremediation strategies: Biosparging, Bioventing, Bioslurping, Biostimulation, Bioaugmentation, and Bioattenuation. *Ex-situ* bioremediation techniques: Bioreactor, Biopiling, Landfarming, composting and Biofilters. Use of genetic engineered microorganisms (GEMs). Advantages, disadvantages and applications of bioremediation.

Unit 2: (12 hours)

Bioremediation of oil spills and microbial enhanced oil recovery: Microbiology of oil fields: introduction to oil fields, formation of oil reservoirs, oil production, indigenous microbial communities in oil fields. Hazards of petroleum hydrocarbon contamination. Microbial degradation of petroleum hydrocarbons (aliphatic, alicyclic, aromatic). Abiotic and biotic factors affecting the degradation of petroleum hydrocarbons. Strategies used to clean up oil spills using microorganisms. Applications of microbial consortia and oil-eating superbugs in bioremediation. Enhanced oil recovery (EOR) versus Microbial Enhanced Oil Recovery (MEOR) Microorganisms and microbial products used in MEOR (biomass, bio- surfactants, biopolymers, solvents, acids, and gases). Technologies used in *ex-situ and in - situ* MEOR applications.

Unit 3: (6 hours)

Heavy metal remediation by microbes: Sources and hazards of heavy metal pollution (As, Cu, Pb, Cd, Hg). Metal-microbes interaction and heavy metal tolerance by microorganisms. Applications of microbes in biosorption and detoxification of environment contaminated with heavy metal(s). Use of biosensors in detection of heavy metal contamination.

Practicals: **60 hours**

Unit 1: (20 hours)

Isolation and detection of hydrocarbon-degrading microorganisms: Sample collection from an oil - contamination site, enrichment, isolation on a suitable minimal medium containing petroleum hydrocarbon, identification of isolates by suitable staining and microscopic observation. Detection of hydrocarbon degradation by the isolates using the redox dye Dichlorophenol-indophenol (DCPIP)**.**

Unit 2: (20 hours)

Detection and screening of bio-surfactant producing microorganisms: Detection of biosurfactant production by hydrocarbon-degrading microorganisms using oil spread method. Screening and selection of the biosurfactant-producing microbes by the following hydrophobicity tests: (1) Drop-collapse method using positive control (Tween-80) and negative control (distilled water) (2) Toluene test (spectrophotometric measurement) and (3) by hydrophobic interaction column chromatography (using Octyl-Sepharose resin).

Unit 3: (20 hours)

Isolation of heavy metal-tolerant microorganisms and case-studies: Sample collection from potential heavy metal-contamination sites (soil/sewage/water bodies/mines), isolation on minimal medium with increasing concentrations of the heavy metal, identification of isolate by suitable staining and microscopic observation. Screening of the isolates for their metal tolerance in broth cultures containing heavy metals. Case studies on *ex-situ* and *in-situ* Microbial Enhanced Oil Recovery by discussions and with the help of visual aids.

Suggested Reading (Theory & Practical):

1. Brock Biology of Microorganisms by M. T. Madigan, K.S. Bender, D.H. Buckley, W.M. Sattele and D. A. Stahl 16th edition. Pearson, USA. 2021.
2. Microbiology: A Lab Manual by J. G. Cappuccino and C. T. Welson. 12th edition. Pearson. 2020.
3. Waste Water Microbiology by D. H. Bergey. 2nd edition. MedTech, India. 2019.
4. Practical Environmental Bioremediation: The Field Guide by R. B. King, J. K. Sheldon and G.M. Long. 2nd edition. CRC Press, USA. 2019.
5. Prescott’s Microbiology by J.M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education. USA. 2019
6. Soil Microbiology by N. S. Subba Rao. 5th edition. MedTech, India. 2017
7. Environmental Microbiology by I. L. Pepper, C. P. Gerba and T.J. Gentry. (Ed). 3rd edition. Academic Press, USA. 2014.
8. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA. 2011.
9. Advances in Applied Bioremediation by A. Singh, R. C. Kuhad and O. P. Ward. Springer- Verlag,

Germany. 2009.

10. Environmental Microbiology: A Laboratory Manual by I. L. Pepper and C. P. Gerba 2nd edition. Elsevier Academic Press, USA. 2004.
11. Microbial Ecology: Fundamentals and Applications by R. M. Atlas and R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 8: SCIENTIFIC WRITING AND COMMUNICATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 8: SCIENTIFIC WRITING AND COMMUNICATION	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to familiarize the students with the basic principles of science writing and communication. Students will become aware of databases and tools for effective writing and will be empowered to take up careers as research analysts, technical writers, editors of journals and books etc. They will gain insights into the process of scientific publication. They will learn to effectively communicate science to the masses.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to demonstrate how to carry out a literature search, and explain various types of scientific writings, structure of scientific manuscript and study design.
- Student will be able to describe various types of journals, the concept of impact factors, steps in publication, and software to detect plagiarism.
- Student will be able to discuss the process of writing grant, and how to communicate effectively on scientific issues
- Student will be able to describe the process of writing research/review articles, the process of presenting scientific data through poster or oral presentation.

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

Scientific literature and study design: Understanding research writing. Conducting literature search, scientific literature databases and gap analysis. Types of contemporary science writing (original research article, review, systematic review, meta-analysis, commentary, and opinion). Structure/outline of a research article. Survey study, questionnaire design, using common statistical tools/software for data analysis and presentation in research articles.

Unit 2: (13 hours)

Publication process: Identifying relevant journals through online tools. Impact factor, H-index, citations, Science Citation Index. Steps of the publication process: preparation of manuscript, textual and graphical abstracts, use of multimedia in scientific writing, editing and proofreading, referencing styles, authorship, ethical requirements in science publication, plagiarism detection tools (URKUND/Turnitin), peer review process, predatory publishers andjournals, open access publication.

Unit 3: (7 hours)

Generating funding for research and elements of communication: Introduction to national (DBT, SERB) and international funding agencies (NIH, Welcome Trust). Basics of grant- writing, and structuring a research proposal for extramural funding.

Practicals: **60 hours**

Unit 1: (15 hours)

Communicating scientific issues to the public: Drafting popular articles (newspaper/ magazines). Multimedia tools for effective writing and communication (creating stories using photos, illustrations, audio, video, animation). Publishing blogs.

Unit 2: (30 hours)

Writing original research / review articles: Drafting abstracts. Hands-on training in the preparation of manuscript text: methods, results, discussion, and conclusion. Presenting data in tables and figures: use of Microsoft Excel. Hands-on training in the use of Mendeley to insert references / citations in an article. Writing a review article based on 10 research papers in 1000 words.

Unit 3: (15 hours)

Presentation of scientific data in conferences/seminars: Designing posters. Training in oral presentations: use of Microsoft Powerpoint. Presenting the research and main findings of recent scientific articles through Journal Club**.**

Suggested Reading (Theory & Practical):

1. Research Methodology and Scientific Writing by C.G. Thomas. 2nd edition. Springer. 2021.
2. Scientific writing and communication by A. Hoffman. 4th edition. Oxford University Press. 2019.
3. Effective writing and publishing scientific papers - Part I: how to get started by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(4):397.
4. Effective writing and publishing scientific papers - Part II: title and abstract by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(6):585.
5. Effective writing and publishing scientific papers - Part III: introduction by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(7):702.
6. Effective writing and publishing scientific papers - Part IV: methods by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(8):817.
7. Effective writing and publishing scientific papers - Part V: results by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(9):945.
8. Effective writing and publishing scientific papers - Part VI: discussion by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(10):1064.
9. Effective writing and publishing scientific papers - Part VII: tables and figures by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(11):1197.
10. Effective writing and publishing scientific papers - Part VIII: references by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(11):1198.
11. Effective writing and publishing scientific papers - Part IX: authorship by D. Kotz and J.W. Cals. 2013. J Clin Epidemiol. 66(12):1319.
12. Effective writing and publishing scientific papers - Part X: choice of journal by D. Kotz and J.W. Cals. 2014. J Clin Epidemiol. 67(1):3.
13. Effective writing and publishing scientific papers - Part XI: submitting a paper by D. Kotz and J.W. Cals. 2014. J Clin Epidemiol. 67(2):123.
14. Effective writing and publishing scientific papers - Part XII: responding to reviewers by D. Kotz and J.W. Cals. 2014. J Clin Epidemiol. 67(3):243.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 9: AGRICULTURAL 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-DSE 9: AGRICULTURAL MICROBIOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to enable students to develop a clear understanding of the importance of microbes in agriculture to enable them to find eco-friendly solutions to agricultural problems.
- Students will get an overview of soil characteristics and the role of microbes and plant-microbe interactions in soil fertility. Students will study about the production and application of different types of commercial biofertilizers, become familiar with microbial biocontrol agents, and gain knowledge of composting, and organic farming. They will gain insights into recent trends in agriculture including agrowaste management and transgenics

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain types of soil and its characteristics, important microorganisms involved in mineralization of essential nutrients present in the soil and their significance in agriculture, plant-microbe interactions including symbiotic and asymbiotic associations, the commercial production of biofertilizers and method of composting.

- Student will be able to describe eco-friendly ways to control agricultural pests and pathogens, the mode of action, mass production and field applications of various biocontrol agents.
- Student will be able to discuss the recent trends in agricultural microbiology with reference to agrowaste management, organic farming and transgenic plants.
- Student will be able to demonstrate the isolation and screening of various microbes important in soil fertility (PGPR, VAM), the isolation of microorganisms from commercially available biofertilizers.
- Student will be able to explain the different stages of nodule development in leguminous plant roots and will observe nodule-forming bacteria under the microscope, the antagonistic potential of Trichoderma spp. as biological control agent against other fungi.
- Student will be able to describe composting as one of the ways of agrowaste management, the role of thermophiles in composting and the different enzymes involved in biodegradation, steps of mass production of blue green algae and application of microbes in organic farming/biogas production.

Theory: **30 hours**

Unit 1: (14 hours)

Soil fertility and Biofertilizers: Physical and chemical characteristics of different types of soil. Macro and micronutrients in soil. Role of NPK and biogeochemical cycles in soil fertility. Scope of microbes as biofertilizers and their advantages over chemical fertilizers. Isolation, characteristics, mass production and field applications of biofertilizers- Symbiotic: *Rhizobium, Frankia, Acetobacter diazotrophicus*, *Anabaena,* Mycorrhizal associations with special emphasis on VAM/AM fungi. Asymbiotic**:** Nitrogen-fixing bacteria (*Azospirillum, Azotobacter*), Plant growth promoting rhizobacteria (PGPR). Composting: types, methods, applications.

Unit 2: (8 hours)

Biocontrol agents and Biopesticides: Importance, potential and types of biocontrol agents. Microbes used as biopesticides, their mode of action, and advantages over chemical pesticides. Mass production and field applications of *Bacillus thuringiensis*, *Baculoviruses, Beauveria bassiana*, *Metarhizium anisopliae* and *Trichoderma spp*.

Unit 3: (8 hours)

Recent trends in Agriculture Microbiology: Agrowaste management and its significance: Biofuel, Bioenergy, Animal Feed. Organic farming: types, methods and advantages. Development of transgenic plants: *Agrobacterium*-mediated plant transformations with specific example of Bt cotton.

Practicals: **60 hours**

Unit 1: (28 hours)

Isolation of microbes important in soil fertility: Isolation and screening of plant growth promoting rhizobacteria (PGPR) from soil. Isolation of microbes from commercially available biofertilizers using solid media. Isolation of VAM spores from the soil sample using "Wet-sieving and decanting technique" for spores extraction and observing them under microscope. Study of VAM colonization using temporary slides/photographs.

Unit 2: (16 hours)

Study of microbe interactions in soil: Demonstration of stages of nodule formation in leguminous plant with the help of photographs. Slide preparation of crushed nodule to observe nodule forming bacteria. Study of antagonistic activity of *Trichoderma* sp. against different fungi (any 2) using dual culture plate technique. Test of antagonistic efficacy on potato dextrose agar: simultaneous inoculation of antagonist and test fungus at two extreme positions and recording of zone of inhibition after 5 days of incubation.

Unit 3: (16 hours)

Agrowaste management: Hands-on training in composting using a variety of plant/food waste. Isolation of thermophiles from compost and qualitative assay of any two enzymes (amylase/cellulase/xylanase) using compost sample. Visit to mass production facility of blue green algae/biogas plant/organic farm.

Suggested Reading (Theory & Practical):

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. E. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.

2. Biopesticides and Bioagents: Novel tools for pest management by M. A. Anwer. Ist edition. Apple Academic Press, USA. 2021.

3. Bioprocess Technology by P. T. Kalaichelvan and I. A. Pandi. 1st edition. MJP Publishers, India. 2021 (reprint).

4. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.

5. Soil Microbiology by N.S. Subba Rao. 5th edition. Oxford & Ibh Publishing, USA. 2020.

6. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.

7. Biofertilizers in Agriculture and Forestry by N.S. Subba Rao. 4th edition. Medtech. India. 2019.

8. Advances in soil microbiology: recent trends and future prospects by T.K. Adhya, B. Lal, B. Mohapatra, D. Paul and S. Das. Volume 2. Springer, Singapore. 2018.

9. Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja. 5th Edition. New Age International Publishers, India. 2017.

10. Development of Bioinsecticides by F. Saleem A.R. Shakooori. Lap Lambert Academic Publishing, European Union. 2012.

11. Advanced Environmental Biotechnology by S.K. Aggarwal. 1st edition. APH publication, India. 2005.

12. Biotechnology of Biofertilizers edited by S. Kannaiyan. 1st edition. Springer, Netherlands. 2002.

13. Bioinoculants for Sustainable Agriculture and Forestry by S.M. Reddy. 1st edition Scientific Publishers, India. 2002.

14. Microbial Ecology: Fundamentals and Applications by R.M. Atlas and R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 10: PRINCIPLES OF GENETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 10: PRINCIPLES OF GENETICS	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is for students to gain knowledge of the major concepts of genetics. Students will build a foundation for understanding the basic principles of inheritance and heredity starting from classical genetics, and will gain insights into chromosomal behaviour, rearrangements and their consequences.
- Students will also learn about complex multifactorial quantitative genetics and population genetics in relation to survival and evolution. Through this course the students will develop a better understanding of life processes, survival and maintenance.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the laws of inheritance, linkage, crossing over and its application to gene mapping.
- Student will be able to describe the mechanisms for extranuclear inheritance, complex traits and population genetics principles, model organisms of genetic research.
- Student will be able to explain pedigree analysis, aberrations in chromosomal structure and number.
- Student will be able to demonstrate the techniques of karyotyping and chromosome banding, the giant chromosomes.

Theory: **30 hours**

Unit 1: (12 hours)

Introduction to basics of Genetics: History: A brief account of early genetic experiments: Mendel's work. Studying variation: phenotype and genotype. Single gene inheritance pattern: concept of alleles, allelic interactions, autosomal and X-linked inheritance. Concept of segregation, penetrance, expressivity. Test for allelism: complementation. Two- gene inheritance pattern: independent assortment versus linkage. Molecular basis of phenotypic variation and inheritance patterns. Introduction to genetic maps: three point test crosses.

Unit 2: (9 hours)

Extra-nuclear inheritance and epigenetics: Introduction and rules of extra-nuclear inheritance. Organelle heredity: chloroplast mutations in *Chlamydomonas* and *Mirabilis jalapa.* Maternal effect: shell coiling in *Limnaea peregra.* Infectious heredity: Kappa particles in *Paramecium.*

Unit 3: (9 hours)

Quantitative and Population Genetics: Polygenic inheritance, Johannsen pure-line theory, multiple factor hypothesis. Types of quantitative traits, heritability and its measurements. Genetic structure of populations, gene pool, genotype frequencies, allele frequencies. Hardy–Weinberg Law: Assumptions and Predictions.

Practicals: **60 hours**

Unit 1: (30 hours)

A review of model organisms for genetic analysis: **Student group research study**: Organisms for genetic research: *Escherichia coli, Saccharomyces cerevisiae, Neurospora crassa, Drosophila melanogaster, Caenorhabditis elegans, Arabidopsis thaliana, Tetrahymena thermophila*. Case studies highlighting one major biological finding from studies with each of these organisms. Understanding genetic analysis through problem solving: statistical analysis of given genetic data by Chi-Square Analysis.

Unit 2: (20 hours)

Studying inheritance in humans: Pedigree analysis: chromosomes and aberrations through karyotyping and chromosome banding techniques.

Unit 3: (10 hours)

Study of Giant Chromosomes: Polytene and Lampbrush chromosomes. Preparation of temporary mounts of salivary glands of *Chironomus* / *Drosophila* larvae, and their visualization by bright field microscopy. Study of lampbrush chromosomes through permanent mounts.

Suggested Reading (Theory & Practical):

1. Introduction to genetic analysis by A. Griffiths, J. Doebley, C. Peichel and D. Wassarman. 12th edition. Macmillan Learning. 2020.

2. Laboratory Manual for Principles of Genetics by W. Mhiret. Lap Lambert Academic Publishing. 2020.

3. Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 12th edition. Pearson Education, USA. 2019.

4. Genetics: A Conceptual Approach By B. Pierce. 7th edition. W.H. Freeman and Co. 2019.

5. Genetics: Analysis of Genes and Genomes by D. Hartl and B. Cochrane. 9th edition. Jones and Bartlett Learning, USA. 2017.

6. Introducing Epigenetics : A graphic guide by C. Ennis. Icon Books Ltd, India. 2017.

7. iGenetics- A Molecular Approach by P.J. Russell. 3rd edition. Pearson Education India. 2016.

8. Principles of Genetics by D. Snustad and M. Simmons. 7th edition. Wiley and Sons, UK. 2015.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 11: MICROBIAL BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 11: MICROBIAL BIOTECHNOLOGY	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to give students an overview of the beneficial role of microbial biotechnology in the welfare of humankind. They will learn about harnessing the power of microorganisms to manufacture medicinal, industrial, and agricultural products.
- Students will be acquainted with the large-scale culturing of microorganisms to produce various metabolites at a commercial scale. Students will gain hands-on experience in screening samples for enzyme and pigment producers and dye degrading microorganisms. They will learn to immobilise enzymes and cells and use enzyme-based biosensors for analytical purposes.
- The students will get conversant with applications of bioremediation and the protection of intellectual property rights.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the emerging biotechnology industries at the national and international level, use of microbe-based technologies and innovations for the benefit of mankind.
- Student will be able to explain the potential use of high-yielding microorganisms to commercially produce human therapeutics and industrial products, biosensors and steroid biotransformation.

- Student will be able to describe how microorganisms are utilized for the industrial production of biofertilizers and biopesticides, their potential use in environmental pollution management.
- Student will be able to demonstrate immobilization of biocatalysts (whole cells/enzymes) and explain how this technology can find applications in large-scale enzymatic reactions, bioremediation and designing of biosensor-based kits.
- Student will be able to explain the screening of environmental samples to isolate organisms with desired properties (enzyme production, pigment production, dye degradation).
- Student will be able to describe the research work involving GMOs and approvals required thereof and will appreciate the importance of protecting Intellectual Property Rights.

Theory: **30 hours**

Unit 1: (4 hours)

Microbial Biotechnology as an emerging Industry: Global Biotechnology industries and their products. Biotechnology trends in India with particular reference to our country's premier biotechnology institutes and industries and their products : Biocon, Serum Institute of India, Bharat Biotech and Hindustan Antibiotics Ltd. Innovations and Startups based on Microbial Biotechnology. Biotechnology in mass production of valuable products using microorganisms and advantages of using microorganisms (Laboratory, pilot and industrial- scale bioreactors).

Unit 2: (14 hours)

Microbial Biotechnology in the development of human therapeutics and industrial products: Prokaryotes and eukaryotes as expression hosts for heterologous proteins. Microbial production of therapeutic recombinant products: hormones (insulin, human growth hormone), thrombolytic agents (streptokinase and tPA) and vaccines (Hepatitis B and Covid-19 vaccines). Industrial bulk products: Production of microbial polysaccharides (xanthan gum and agar-agar), bioplastics (PHB), food-grade pigments/colorants (phycocyanin and Beta-carotene/lycopene), high fructose corn syrup. Development and functioning of enzyme- based biosensors (GOD and cholesterol oxidase). Microbial transformation of steroids**.**

Unit 3: (12 hours)

Role of Microbial Biotechnology in agriculture and environment management: Biofertilizers: liquid and carrier-based biofertilizers. Mass production of *Rhizobium, Acetobacter diazotrophicus, Azotobacter sp*. Commercial production of Biocontrol agents (*Bacillus thuringiensis* & *Trichoderma harzianum*). Development of transgenic crops with particular emphasis on insect resistance, viral resistance and nutritional quality enhancement (Bt-brinjal, Roundup-ready crops and golden rice). RNAi and its application in crop improvement. Edible vaccines, synthetic meat and Single Cell Protein (*Spirulina* & *Fusarium graminearum*), biodiesel production (algal biofuel).

Microbial bioremediation of oil spills using genetically modified organisms (GMOs) and microbial consortia. Microorganisms in the removal of heavy metals from aqueous effluents and copper bioleaching.

Practicals: **60 hours**

Unit 1: (18 hours)

Immobilization of enzymes, cells and biosensors: Immobilization of yeast cells (*Saccharomyces cerevisiae*) by entrapment using calcium alginate beads/agarose/agar and determination of the invertase activity of the immobilized cells by carrying out an invertase assay. Immobilization of an enzyme (amylase/urease/invertase) using calcium alginate/ agarose/ agar and study of its long term storage stability using enzyme assays. Use of an enzyme-based biosensor (glucose oxidase/glucose-1-dehydrogenase based devices to monitor glucose uptake/consumption during a fermentation; cholesterol oxidase/beta- hydroxybutyrate dehydrogenase-based kits to monitor changes in levels of the substrate over a period of time).

Unit 2: (30 hours)

Screening for enzymes and pigment-producer / dye-degrading microorganisms, and expression of a cloned gene: Primary screening of soil samples to isolate microorganisms that produce hydrolytic enzymes (any one): amylase, protease, lipase, CM cellulase, xylanase. Isolation of pigment-producing microorganisms from the environment and laboratory-scale production of any pigment using the shake-flask technique OR Screening for dye-degrading (methylene blue/ methyl orange/ Rhodamine B, etc.) microorganisms from the environment using plate assays and study of the absorption spectra of any dye. Transformation and expression studies of a given plasmid (expressing Green Fluorescent Protein) in the BL21 strain of *E coli,* analysis of protein expression using SDS-PAGE.

Unit 3: (12 hours)

An orientation to the biosafety regulatory framework for Genetically Modified Organisms (GMOs) in India: An introduction to different methods of protecting Intellectual Property in India (Patents, Copyrights, Trademarks, Geographical Indications, Industrial Design and New Plant Varieties). Filing applications for approval of research proposals by the concerned regulatory bodies. Filing of a patent application to the regulator for the protection of a GMO. **Student group research project:** Case study of any microbial consortium available in India for environmental bioremediation.

Suggested Reading (Theory & Practical):

1. Industrial Microbiology by A.H. Patel. 2nd edition. Laxmi publication Pvt Ltd/Trinity Press. 2022.

2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition.

Pearson Education, USA. 2020.

3. Industrial Microbiology by L.E. Casida. 2nd edition. New Age International Publisher. 2019.

4. Intellectual Property Rights in India. Pidigam Saidaiah and K. Ravinder Reddy. International Books and Periodical Supply Service. 2020.

5. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.

6. Crueger's Biotechnology: A Textbook of Industrial Microbiology by W. Crueger, A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.

7. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rd edition. Elsevier Science Ltd, Netherlands. 2016.

8. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by A.E. Brown and H. Smith. 15th edition. Mc-Graw Hill Education, USA. 2022.

9. Manual of Industrial Microbiology and Biotechnology by R.H. Baltz, A.L.Domain, and J.E. Davies. 3rd edition. American Society for Microbiology. 2010.

10. Molecular Biotechnology by B.R. Glick, J.J. Pasternak and C.L. Patten. 4th edition, ASM Press, USA. 2009.

11. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer and H. Nikaido. 2nd edition. W.H. Freeman and Company, UK. 2007.

12. Manual of Industrial Microbiology and Biotechnology by A.L. Demain, J.E. Davies and R.M. Atlas. 2nd edition. ASM Press, USA. 1999.

13. The DBT portal: https://dbtindia.gov.in/regulations-uidelines/regulations/biosafety- programme

14. Intellectual Property Rights: Chapter III on the INFLIBNET portal: http://shodhganga.inflibnet.ac.in/bitstream/10603/205165/7/chapter%20iii.pdf

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 12:
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		
MICROB-DSE 12: RESEARCH METHODOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of the course is to give the students a broad understanding about research approaches and tools, and importantly, an ability to deploy them in their degree programme.
- This will impart skills for critical reading of research literature, various research methods, including theory of scientific research and qualitative and quantitative methods and for developing a research proposal. The course will outline all the fundamentals of carrying out research in an ethical manner.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the basics of research and hypothesis formulation, the different approaches of doing research, acquiring data, and performing data analysis.
- Student will be able to describe the process of scientific writing and presenting of research data.
- Student will be able to demonstrate the process of effective literature search and writing a review.
- Student will be able to analyse datasets and present them through tables, charts and graphs.
- Student will be able to describe the process of writing proposals for research grants.

Contents:

Theory **30 hours**

Unit 1: (8 hours)

Foundation of research and research ethics: What is research, benefits of research. Selection of research topic. Effective literature search. Problem identification and hypothesis building. Qualities of a good hypothesis, hypothesis testing, null hypothesis and alternative hypothesis, logic and importance. Ethics in research: indices for scientific rigor, honesty and integrity, respect for intellectual property, responsible publication of data.

Unit 2: (14 hours)

Approaches to research and research methods: Basic and applied research, descriptive and analytical research, quantitative and qualitative research, experimental and non-experimental research. Good laboratory practices (GLP): Standard Operating Procedures, Biosafety, Radiation safety. Experimental Design. Concept of Experiment Controls. Concept of independent and dependent variables. Recording experimental protocol and data in lab notebooks, preparation for experiments. Field experiments: sampling, types of sampling studies, characteristics of a good sample, sampling frame, sample size, sampling error, scales of measurement, double blind studies. Data analysis and representation: Use of Excel for tables and charts, Common statistical tests (hypothesis of association, student t test) and introducing popular statistical packages.

Unit 3: (8 hours)

Research Communication: Knowledge dissemination. Effective presentation in scientific conferences (Poster/oral). Structure of research paper. Structure of a thesis/dissertation. Software for scientific paper formatting (LaTeX/MS Office). Software for management of references (Mendeley/Endnote). Software for image processing. Choosing a journal for publication. Impact factor of journals. Ethical issues related to publishing, plagiarism, software for detection of plagiarism.

Practicals: **60 hours**

Unit 1: (20 hours)

Literature Search and Review: General Search Engines, Bibliographic Databases, Digital Libraries, Types of publications, literature search on a given topic and writing a review.

Unit 2: (20 hours)

Analysis and presentation of given dataset: Training in the use of Microsoft Excel for data presentations in tables, graphs and charts. Training in the use of Microsoft Powerpoint for presenting scientific findings at meetings/conferences. Writing an Abstract for paper/conference based on given data.

Unit 3: (20 hours)

Planning and writing a research proposal: General considerations, finding a research problem. Major Funding agencies in India. Mandate of the call for proposals. How to write a proposal. **Student group project**: writing a research proposal on a given topic

Suggested Reading (Theory & Practical):

1. Research Methodology for Natural Sciences by S. Banerjee. I.I.Sc. Press, India. 2022.
2. Research Methodology and Scientific Writing by C.G. Thomas. 2nd edition. Ane Books, India. 2019.
3. Scientific writing and communication by A. Hoffman. 4th edition. Oxford University Press. 2019.
4. Research Methodology: Methods and Techniques by C.R. Kothari. 4th edition. New Age International Publishers, India. 2019.
5. Testing treatments: Better research for better healthcare by I. Evans, H. Thornton, I. Chalmers and P. Glasziou. 2nd edition. Pinter & Martin Ltd, UK. 2013.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 13:
Applications of Informatics in 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-DSE 13: Applications of Informatics in Biology	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to enable the students to develop a clear understanding of the various concepts and applications of bioinformatics, a field which encompasses diverse applied disciplines such as molecular biology, genomics, proteomics, transcriptomics and systems biology. Students will also learn applications of artificial intelligence in bioinformatics.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the goals of bioinformatics and its applications, diverse types of biological databases, concept and significance of sequence alignment, phylogeny, types of phylogenetic trees.
- Student will be able to describe the diversity of viral, prokaryotic, eukaryotic genomes and their organization, proteomics along with the details of structure of proteins, protein structure prediction, and energy minimizations.
- Student will be able to explain the significance of artificial intelligence and machine learning in various biological applications, computer-aided drug discovery, epitope prediction and its significance in vaccine development and allergen prediction.
- Student will be able to demonstrate how to work with biological databases, similarity searches, sequence alignments and phylogenetic analysis.

- Student will be able to demonstrate working with databases and analysis, gene prediction and other features, and primer designing.
- Student will be able to demonstrate how to identifying secondary structural features of proteins, prediction of protein structure models from amino acid sequences, molecular docking and epitope prediction.

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

Fundamentals of bioinformatics, sequence alignment and phylogeny: Aims and scope of bioinformatics. Concepts of genome, transcriptome, proteome, systems biology, metabolome, interactome and neural network. Biological databases and types. Sequence similarity and Sequence alignment (Local and Global Sequence alignment), pairwise and multiple sequence alignment. Phylogeny, rooted and unrooted trees.

Unit 2: (10 hours)

Genomics and Proteomics: Features of the viral, prokaryotic (*E. coli*) and eukaryotic (human) genomes. Gene Ontology, Hierarchy, and features of protein structure, Structural classes, motifs, folds and domains. Homology modelling of tertiary structure of protein, Molecular dynamic simulations and energy minimizations, Evaluation by Ramachandran plot.

Unit 3: (10 hours)

Artificial Intelligence in bioinformatics: Role of AI and machine learning in biology (proteomics, structural biology, disease management, drug discovery and genomics). Computer-aided drug discovery and design. Bioinformatics in epitope mapping for vaccine design and allergen prediction.

Practicals: **60 hours**

Unit 1: (24 hours)

Biological Databases, similarity search, sequence alignments and phylogenetic analysis: Study of bioinformatics databases, File formats: FASTA, GenBank. Sequence submission tools: NCBI, PDB. Sequence retrieval and similarity search using BLAST, Multiple sequence (DNA/Protein) alignment using CLUSTAL omega. Phylogenetic analysis using MEGA.

Unit 2: (16 hours)

Identification and analysis of genome features: Picking out a given gene from genomes using

GENSCAN or other software (promoter region identification, repeats in the genome, ORF prediction, Gene finding tools), Genome browsing using Ensemble/Genome Data Viewer (NCBI) for features of E. coli and Human Genome (Search a genomic assembly to display a region annotated with a particular gene), Design and analysis of PCR primers using PRIMER BLAST or any other tool.

Unit 3: (20 hours)

Protein structure prediction and evaluation, molecular docking, epitope prediction: Primary structure analysis. Secondary structure prediction using psi-pred. Molecular visualization using JMOL/PyMOL, protein structure model evaluation, virtual screening of drugs using AUTODOC-VINA/ any other software, Demonstration of IEDB (https://www.iedb.org) server for the prediction of HLA class I and II binding epitopes.

Suggested Reading (Theory & Practical):

1. Bioinformatics: Tools and Techniques edited by L. Baker. 1st edition. Callisto. 2018.
2. Applied Bioinformatics: An Introduction by P. Selzer, R. Marhöfer and O. Koch. 2nd edition. Springer, USA. 2018.
3. Bioinformatics Techniques for Drug Discovery: Applications for Complex Diseases by A. Kaushik, A. Kumar, S. Bharadwaj and R. Chaudhary. 1st edition. Springer International, UK. 2018.
4. Foundations of Computing by P. Sinha and P.K. Sinha. 6th edition. BPB Publications, India. 2017.
5. Basic Applied Bioinformatics by C. Mukhopadhyay, R. Choudhary and M.A. Iquebal. 1st edition. Wiley-Blackwell, USA. 2017.
6. Bioinformatics: Principles and Applications by Z. Ghosh and V. Mallick. 1st edition. Oxford University Press, India. 2015.
7. Introduction to Bioinformatics by M.Lesk. 4th edition. Oxford Publication, UK. 2014.
8. Bioinformatics: methods and applications, genomic, proteomics and drug discovery by S. Rastogi, N. Mendiratta and P. Rastogi. 4th edition. Prentice Hall India Publication. 2007.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 14: ADVANCES IN 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-DSE 14: ADVANCES IN MICROBIOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to educate students about the latest developments in the field of microbiology and apprise them of the cutting-edge technologies being used for research and development.
- They will learn the uses of omics approaches, meta-omics, systems biology, and synthetic biology. They will become familiar with the development and applications of CRISPR-Cas technology and will gain insights into the versatile field of microbial nanotechnology.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss the host-microbe arms race, newer methods to combat challenges of antimicrobial resistance and biofilms, the use of meta-omics approaches in research, latest cutting-edge technology of CRISPR-Cas and its applications.
- Student will be able to explain the Systems and Synthetic Biology and their applications; the principles, techniques, and applications of the versatile field of nanobiotechnology.
- Student will be able to demonstrate soil metagenomics and PCR-based taxonomy analysis, and describe major metagenomics projects worldwide through case studies.
- Student will be able to demonstrate synthesis and testing of silver nanoparticles with antimicrobial properties from plant, fungal/bacterial

extracts; and explain about the analytical research tools to characterize the nanoparticles.

- Student will be able to describe Poliovirus synthesis, mRNA vaccine synthesis and Genome synthesis of mycoplasma through case studies.

Contents:

Theory: 30 hours

Unit 1: (10 hours)

Host- microbe interactions and use of microbes in healthcare: Host-Microbe arms race, genome- pathogenicity islands, Type Three Secretion System (T3SS), Quorum Sensing, and Biofilm formation in bacteria. Viral zoonosis and pandemics. Gene for Gene hypothesis, hypersensitive response, plant resistance genes, and signal transduction mechanism. Addressing the challenges of Anti-Microbial Resistance (AMR) and biofilms by phages, and of cancer through oncolytic viruses.

Unit 2: (10 hours)

Modern molecular techniques in Microbiology: Meta-Omics technology (Metagenomics, Metatranscriptomics, Metaproteomics, and Metabolomics): Principles, techniques deployed, and applications. CRISPR-Cas technology- History, mechanism, applications (in Health, Agriculture and other Industries) and limitations of this technology.

Unit 3: (10 hours)

Systems biology, Synthetic biology, and Nanobiotechnological Approaches in Microbiology: Systems biology approach for holistic perspectives and better outcomes. Types of Biological Networks. Cell signaling and interaction networks. Synthetic biology: principles and applications. Concept, methodology, and applications of Microbial Nanotechnology in health, agriculture, and food industry. Applications of Viral and Viral-like Nanoparticles.

Practicals: 60 hours

Unit 1: (20 hours)

Metagenomic technique to study soil microorganisms: Hands-on training in extraction of DNA from soil, and PCR amplification of metagenomic DNA using universal16S ribosomal gene primers. **Student group project:** Research and review on major metagenomic projects (Sargasso Sea Project, Viral Metagenomics and Human Microbiome Project)

Unit 2: (25 hours)

Synthesis and analysis of silver nanoparticles from plants extracts and microbes (fungi/bacteria). Hands-on training in synthesis of silver nanoparticles by any one method. Testing of antimicrobial properties of synthesized silver nanoparticles. Characterization of nanoparticles by UV-vis Spectroscopy, X-ray Diffraction (XRD), Scanning and Transmission Electron Microscopy (SEM and TEM) through virtual labs / videos. Visit to Sophisticated Instrumentation Facility of a research institution.

Unit 3: (15 hours)

Student research study project: Poliovirus Synthesis: a case study to understand how the poliovirus was synthesized in the laboratory. mRNA-Vaccine Synthesis: a case study of the steps involved in synthesis of mRNA vaccine and testing its efficacy. **Student group project**: Covid19 mRNA vaccines in the market in India and overseas. Genome synthesis of mycoplasma: a case study to develop a synthetic genome of mycoplasma.

Suggested Reading (Theory & Practical):

1. Brock Biology of Microorganisms by M.T. Madigan, and J.M. Martinko. 16th edition. Pearson., USA. 2021.
2. Microbiomes: Current Knowledge and unanswered Questions by E. Rosenberg. Springer Nature, Switzerland. 2021.
3. An Introduction to Systems Biology: Design, Principles of Biological Circuits by Uri Alon, 2nd edition. CRC Press. 2020.
4. Antimicrobial Resistance: Global Challenges and Future Interventions edited by Sabu Thomas. Springer. 2020.
5. Biological Synthesis of Nanoparticles and Their Applications, by L. Karthik, A. Vishnu Kirthi, S. Ranjan, V. M. Srinivasan. CRC Press, Taylor and Francis, USA. 2020
6. Genomic Engineering via CRISPR-Cas 9 system edited by Vijay Singh and Pawan K. Dhar. Academic Press. 2020
7. Microbial Nanotechnology edited by M. Rai and Golinsky P. CRC Press. 2020
8. Bacterial Pathogenesis: A Molecular Approach by B.A. Wilson, A.A. Salyers, D. D. Whitt, and M.E. Winkler. 4th edition. ASM Press, USA. 2019.
9. Implications of Quorum Sensing and Biofilm formation in Medicine, Agriculture and Food Industry by P. V. Bramhachari. Springer. 2019.
10. Nanotechnology in Food: Concepts, Applications, and Perspective by H.J. Malmiri. Springer. 2019.
11. Quorum Sensing: Molecular Mechanism and Biotechnological Applications by G. Tommonaro. Academic Press, USA. 2019.
12. Agricultural Nanobiotechnology: Modern Agriculture for a Sustainable Future by F. Lopez-Valdez and F. Fernandez-Luqueno. Springer. 2018.

13. Implications of Quorum Sensing System in Biofilm Formation and Virulence by Bramhachari. Springer. 2018.
14. Nanobiotechnology: Human Health and the Environment by A. Dhawan, S. Singh, A. Kumar, and R. Shanker (editors). CRC Press, USA. 2018.
15. Synthetic Biology: Omics Tools and their Applications by Shailza Singh. Springer. 2018
16. Viral Metagenomics: Methods and Protocol by V. Pantaleo and M. Chiumenti. Springer Protocols. Humana Press. 2018.
17. Virus Derived Nanoparticles for Advanced Technologies-Methods and Protocols by C. Wege and G. Lomonsoff. Humana Press, Springer, USA. 2018.
18. Microbial Biofilms: Omics Biology, Antimicrobials and Clinical Implications by C. J. Seneviratne. CRC Press. 2017.
19. Precision Medicine, CRISPR, and Genome Engineering: Moving from Association to Biology and Therapeutics by S. H. Tsang. Springer. 2017.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 15:
MICROBIOME IN HEALTH AND DISEASE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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-DSE 15: MICROBIOME IN HEALTH AND DISEASE	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to introduce the human microbiome to students and give them an understanding of its dynamics and function in maintaining homeostasis.
- Students will gain an understanding of the diversity of microbial communities present in various organs in humans. They will gain insights into our current understanding of the impact of microbiome alterations on host health and disease. Students will become aware of techniques used to analyze large omics data sets in investigating microbial communities colonizing humans.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain about human microbiome and methods to study microbiomes, the link between human microbiome and diseases
- Student will be able to describe microbiome-based therapeutic approaches and their challenges, human microbiome project and various databases and software for microbiome analysis
- Student will be able to discuss the basic workflow in a typical microbiome study and analyze microbiome data

- Student will be able to describe current knowledge on the role of microbiome in various diseases

Contents:

Theory **30 hours**

Unit 1: (14 hours)

The human microbiome: Understanding microbiome, importance of microbiome research, development of the microbiome. Vertical and horizontal transfer of human microbiomes, source of the organisms in the human microbiome. Diversity in oral, gut, respiratory and skin microbiome. Microbiome-Gut-Brain Axis. Methods to study the human microbiome: DNA-based analysis of microbial communities, 16S rDNA gene amplicon sequencing and whole metagenome shotgun sequencing methods. Data pre-processing and quality control. Microbiome data analysis: clustering and OTU picking, taxonomic analysis, alpha and beta-diversity. Comparing microbial communities: phylogenetic trees, UniFrac, principal coordinate analysis, Venn diagrams, heat maps. Functional and comparative analysis: metatranscriptome, metabolome, metaproteome.

Unit 2: (10 hours)

Microbiome and its relation to health and disease: Dysbiosis, correlation of dysbiosis with disturbance in microenvironment. Dysbiosis in progression of non-communicable diseases such as cancer, Inflammatory Bowel Disease (IBD), obesity, diabetes, Alzheimer's, and incommunicable diseases such as COVID-19, tuberculosis and typhoid. Nutritional modulation of the gut microbiome. Prakriti and gut bacteria: perspective of traditional ayurveda. Microbiome and host immune system interaction. Effect of antibiotics on microbiota, oral dysbiosis and oral diseases, skin microbiome alterations and cutaneous allergic diseases.

Unit 3: (6 hours)

Microbiome-based therapeutic approaches: Maintaining and restoring a healthy microbiome. Additive, subtractive, and modulatory microbiome-based therapies. Health benefits of prebiotics and probiotics. Fecal transplant and its applications. Challenges in the field of microbiome therapeutics. Microbiome-based diagnostics.

Practicals **60 hours**

Unit 1: (20 hours)

Tools and techniques to study microbiome: Human Microbiome project. Hands-on exposure to various databases (NCBI, HOMD) and opensource software related to microbiome analysis (microbiome analyst, QIIME 2.1, galaxy).

Unit 2: (20 hours)

Research strategy and experimental design in a typical microbiome study: Sample collection, DNA extraction, library preparation and DNA sequencing through virtual lab. Data analysis. Comparison of alpha and beta diversity in given data sets. Interpretations of given heat maps.

Unit 3: (20 hours)

Student group research study projects: Current knowledge on the role of microbiome in respiratory health, the impact of the human microbiome on auto-immune diseases, the interplay of bacteria and eukaryotic microbes in the human gut: presentation of the findings and submission of research study report.

Suggested reading (Theory & Practical):

1. Recent Advances in Understanding the Structure and Function of the Human Microbiome by W. Mousa, F. Chehadeh, and S. Husband. *Frontiers In Microbiology*, *13*. doi: 10.3389/fmicb.2022.825338. 2022.

2. *Microbiome-Gut-Brain Axis* by R. Sayyed and M. Khan. Springer, Singapore. 2022.

3. Targeting the Gut Microbiota for Remediating Obesity and Related Metabolic Disorders by B. Wang et al. J Nutr. 151:1703-1716. http://doi: 10.1093/jn/nxab103. 2021.

4. The human microbiome and COVID-19: A systematic review by S. Yamamota. *PloS One* 16;6. doi:10.1371/journal.pone.0253293. 2021.

5. Metagenomics: Techniques, Applications, Challenges and Opportunities by R.S. Chopra, C. Chopra and N.R. Sharma. Springer. 2020.

6. Gut-Brain Axis: Role of Gut Microbiota on Neurological Disorders and How Probiotics/Prebiotics Beneficially Modulate Microbial and Immune Pathways to Improve Brain Functions by K. Uganya and B.S. Koo. *International journal of molecular sciences*, *21*(20), 7551. 2020.

7. The Influence of the Gut Microbiome on Obesity in Adults and the Role of Probiotics, Prebiotics, and Synbiotics for Weight Loss by A. Aoun, F. Darwish and N. Hamod. Prev Nutr Food Sci., 25(2):113-123. doi: 10.3746/pnf.2020.25.2.113. 2020.
8. The gut microbiome in tuberculosis susceptibility and treatment response: guilty or not guilty? by Eribo, O. A., du Plessis, N., Ozturk, M., Guler, R., Walzl, G. and Chegou, N.N. *Cellular and molecular life sciences : CMLS*, *77*(8), 1497–1509. https://doi.org/10.1007/s00018-019-03370-4. 2020.

9. The influence of the microbiome on respiratory health by T.P. Wypych, L. Wickramasinghe and B. Marsland. *Nature Immunology*, *20* (10), 1279–1290. https://doi.org/10.1038/s41590-019-0451-9. 2019.

10. The microbiome, cancer, and cancer therapy by Helmink *et al*. *Nat Med* 25, 377–388. https://doi.org/10.1038/s41591-019-0377-7. 2019.

11. *Metagenomics* by M. Nagarajan. London: Academic Press. 2018.

12. The human skin microbiome by A.L. Byrd, Y. Belkaid, and J.A. Segre. *Nature reviews in Microbiology*, *16*(3), 143–155. https://doi.org/10.1038/nrmicro.2017.157. 2018.

13. Insights into the human oral microbiome by D. Verma, P.K. Garg and A.K. Dubey. *Archives of microbiology*, *200* (4), 525–540. https://doi.org/10.1007/s00203-018-1505-3. 2018.

14. Human Gut Microbiome: Function Matters by A. Heintz-Buschart and P. Wilmes. *Trends in microbiology*, *26*(7), 563–574. https://doi.org/10.1016/j.tim.2017.11.002. 2018.

15. *Functional Metagenomics: Tools and Applications* by T. Charles, M. Liles, A. Sessitsch, Springer. 2017.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 16:
MICROBIAL DIAGNOSIS AND PUBLIC HEALTH MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 16: MICROBIAL DIAGNOSIS AND PUBLIC HEALTH MANAGEMENT	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to introduce the students to diagnostic microbiology and public health management. Students will be exposed to various methods of sampling of specimens for laboratory diagnosis.
- Student will be introduced to various automated systems and methods of pathogen identification and microbial typing. Students will develop an understanding of basic concepts of epidemiology. They will be introduced to the role of environment in human health and key aspects of disaster management.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the methods of collection and transport of clinical specimens, the automated systems for pathogen identification and various methods of microbial typing.
- Student will be able to describe epidemiology, types of epidemics and pandemics, the epidemiology of infectious diseases, the reservoirs of infectious agents and modes of transmission of various diseases.

- Student will be able to explain the concept of one health, various types of zoonoses, overview of air and water pollution and its impact on human health, the key aspects of disaster management.
- Student will be able to describe the significance of various parameters determining health, the methods of blood sampling used for various animals, and demonstrate rapid diagnostic techniques.
- Student will be able to analyze epidemiological data to calculate mortality and morbidity rates, explain about epidemics through case studies.
- Student will be able to describe various disease control regulatory agencies (National and International), genome and disease surveillance.

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

General principles of diagnosis and microbial typing methods: Challenges of diagnosis. General principles of specimen collection. Choice of clinical samples and methods of collection. Transportation of clinical samples. Evaluation of a diagnostic test based on specificity, sensitivity, positive predictive value, negative predictive value. Automated systems of pathogen identification: a brief outline of BACTEC, MALDI-TOF, VITEK, and their advantages and disadvantages. Microbial typing: phage typing, bacteriocin typing, serotyping, antibiogram typing, plasmid profile analysis.

Unit 2: (12 hours)

Basic concepts of epidemiology: Definitions: health, epidemiology, prevalence, birth rate, morbidity, mortality, sero-prevalence, genome surveillance, R^o value, quarantine, endemic, epidemics and types (common source, propagated/progressive, mixed), pandemic, travel notice, public health guidelines. Uses of epidemiology. Infectious disease epidemiology. Modes of transmission of disease and its dynamics, human reservoirs, animal reservoirs, carriers. Investigation of an epidemic. Role of immunization in public health. Clinical trials: randomized control trials (multiple treatment arms, factorial design, cluster design), nonrandomized trials.

Unit 3: (8 hours)

Environment and Health: The concept of one health. Definition, history and socio-economic impact of zoonotic diseases. Classification of zoonoses with examples (based on transmission cycle: orthozoonoses, cyclozoonoses, metazoonoses, saprozoonoses;

based on reservoir hosts: anthrapozoonoses, zooanthroponoses, amphixenoses). Air pollution and its effects. Water pollution and its effect. Disaster management: key aspects.

Practicals: 60 hours

Unit 1: (30 hours)

Health indicators, blood sampling methods and diagnostic methods: Student individual project: preparation of a short report on indicators of health. Guidelines and collection sites for sampling of blood from humans, cattle, sheep and goat. **Student group study project:** preparation of a flow chart for detection of microbial pathogens for two diseases prevalent in India. Principles and working of rapid antibody detection test using COVID-19 as example. Principles and working of antigen and antibody detection kits for HIV. Principle and working of slide agglutination test for typhoid. Principles and working of quantitative real time PCR test for COVID-19 through virtual lab.

Unit 2: (15 hours)

Epidemiological Data Analysis: Student group research study: Case studies of a common source epidemic (Cholera outbreak, London, 1854) and progressive epidemic (SARS 2002, MERS 2012, and COVID-19). **Student group research project**: Measurement of disease: determination of morbidity and mortality rates/ratios. Generation of epidemiological protocols and reports.

Unit 3: (15 hours)

Case Studies through student group research projects: INSACOG: role in SARS- CoV-2 genome surveillance, Role of WHO and National Centre for Disease Control in disease management, AMR stewardship and National Action Plan, CDC –EOC levels (www.cdc.gov).

Suggested Reading (Theory & Practical):

1. Park's Textbook of Preventive and Social Medicine by K. Park. 26th edition. Banarsidas Bhanot Publishers, India. 2021.

2. Brock Biology of Microorganisms by M.T. Madigan, K.S. Bender, D.H. Buckley, W.M.Sattley and D.A. Stahl. 16th edition. Pearson Education, USA. 2021.

3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition.

Pearson Education, USA. 2020.

4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
5. National Centre for Disease Control: Anti-Microbial Resistance and COVID National Action plan: https://ncdc.gov.in/index1.php?lang=1&level=2&sublinkid=389&lid=347
6. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
7. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition.Universities Press, India. 2017.
8. Veterinary Microbiology by D. Scott McVey, Melissa Kennedy and M.M. Chengappa. 3rd edition. Wiley – Blackwell, USA. 2013.
9. An Introduction to Public Health and Epidemiology by S. Carr, N. Unwin and T. Pless-Mulloli. 2nd edition. Open University Press, UK. 2007.
10. Handbook of Good Dairy Husbandry Practices. National Dairy Development Board (NDDB). https://www.nddb.coop/sites/default/files/handbook_of_good_dairy_husbandry_practices_low.pdf
11. Mackie and McCartney Practical Medical Microbiology by J. Collee, A. Fraser, B. Marmion and A. Simmons. 14th edition. Elsevier. 1996.

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

DISCIPLINE SPECIFIC CORE COURSE – 7: Engineering Mathematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Engineering Mathematics ELDSC-7	4	3	00	1	Course Admission Eligibility	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide the students with the skill and knowledge to perform calculations for solutions to the problems related to various topics that they would be taught during the course of this programme.
- To prepare the students with the mathematical tools they would require while studying and analysing problems in electronics networks, electronic and optical communications, semiconductor devices such as transistors, diodes, transient circuits in power devices, and problem solving in Electromagnetic theory, waveguides, and antennas.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use mathematical tools to solve/model the problems related to Electronics
- Solve linear differential equations using a variety of techniques, power series method and special functions
- Understand to solve N coupled equations using matrices, concept of Eigen values and Eigen vectors
- Familiarize with the concept of sequences and series, convergence and divergence
- Appreciate the complex variables and perform operations with complex numbers

SYLLABUS OF ELDSC-7 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Ordinary Differential Equations(ODE): Introduction to First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations.

Series Solutions of ODE: Power Series method, Legendre Polynomials, Bessel's equations and Frobenius method.

Special functions: Beta and gamma functions, error functions

UNIT – II (11 Hours)

Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Solution of a system of Linear equations by LU decomposition, Gauss Jordan and Gauss-Seidel Method. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices. Real and Complex Matrices.

Matrix Eigen Value Problems: Linear transformation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors.

UNIT – III (11 Hours)

Sequences and Series: Sequences and its kind, Limits of a sequence, Convergent, Divergent and oscillatory sequences.

Convergence of Infinite series, Tests of Convergence: Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series Test.

UNIT – IV (11 Hours)

Complex Variables Analysis: Complex Variables, Complex functions, Continuity, Differentiability, Analyticity, Cauchy-Riemann (C-R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Functions, Trigonometric Functions, Hyperbolic Functions.

Complex Integration: Line integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula. Taylor series-exponential, logarithmic and trigonometric functions.

Practical component (if any) – Engineering Mathematics
(Scilab/MATLAB/ any other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform operations with various forms of complex numbers to solve equations
- Use mathematics as a tool for solving/modeling systems in electronics
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Solution of First Order Differential Equations
2. To test convergence of a given series.
3. To test divergence of a given series.
4. Solution of linear system of equations using Gauss Elimination method.
5. Solution of linear system of equations using Gauss – Seidel method.
6. Solution of linear system of equations using L-U decomposition method.
7. Plots of the exponential, logarithmic and trigonometric functions and comparison with the plots of their Taylor series expansion till first 10 terms

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. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2010), 10th Edition
2. Murray Spiegel, Seymour Lipschutz, John Schiller, Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill (2009), 2nd Edition
3. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
4. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill (2006)

Suggestive readings

1. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007).

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

DISCIPLINE SPECIFIC CORE COURSE – 8: Analog Electronics-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		
Analog Electronics-II ELDSC-8	4	3	0	1	Course Admission Eligibility	Basic knowledge of BJT based circuits

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop understanding of Analog Devices starting with ideal Op Amp model and assessing the practical device limitations and learning importance of the Data Sheets.
- Design linear applications but also design of non-linear application without feedback (voltage comparators), with positive feedback (Schmitt Trigger), and the negative feedback but using non- linear elements such as diodes and switches (sample and hold circuits)
- Study of Oscillators and other Signal Generators
- Study Multivibrators and its applications using IC 555 Timer

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basic building blocks of an op-amp and its parameters for various applications design.
- Elucidate and design the linear and non-linear applications of an op-amp.
- Understanding and Designing of various Signal Generators
- Understand the working of multivibrators using IC 555 timer

SYLLABUS OF ELDSC-8 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Basic Operational Amplifier: Concept of differential amplifiers (Dual Input Balanced and Unbalanced Output), Block Diagram of an Operational Amplifier, Characteristics of an Ideal Op-Amp.

Open and Closed Loop Configurations: Inverting, Non-Inverting and Differential Amplifier

Op-Amp Parameters (IC741): Differential Input Resistance, Output Resistance, Input Capacitance, Input Voltage Range, Large Signal Voltage Gain, Offset Voltage Adjustment Range, Input Offset Voltage, Input Offset Current, Input Bias Current, Common Mode Rejection Ratio, Supply Voltage Rejection Ratio, Bandwidth, Gain Bandwidth Product, Slew Rate.

UNIT – II (11 Hours)

Frequency Response of an Op-Amp.: High Frequency Op-Amp Equivalent Circuit, Open Loop Voltage Gain as a function of Frequency, Closed Loop Frequency Response, Effect of Slew Rate in Applications.

Linear Applications of an Op-Amp: Summing, Scaling and Averaging Amplifiers, Subtractor, Integrator, Differentiator, Current to voltage converter.

UNIT – III (11 Hours)

Active Filters: First Order Low Pass and High Pass Butterworth Filter, Concept of Higher Order Butterworth Filters, Band Pass Filter, Band Reject Filter, All Pass Filter.

Non-Linear Applications of an Op-Amp: Basic Comparator, Level Detectors, Schmitt Trigger, Characteristics of Comparator, Voltage Limiters, Sample and Hold circuit.

UNIT – IV (11 Hours)

Signal Generators: Phase Shift Oscillator, Wien Bridge Oscillator, Square Wave Generator, Triangle Wave Generator, Saw Tooth Wave Generator

IC 555 Timer: Block Diagram, Astable and Monostable Multivibrator Circuit, Applications of Monostable and Astable Multivibrator.

Practical component (if any) – Analog Electronics- II
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the non-ideal behaviour by parameter measurement of Op-amp.
- Design application oriented circuits using Op-amp ICs.
- Generate square wave using different modes of 555 timer IC.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an Op-Amp.
3. Designing of an Integrator using op-amp for a given specification.
4. Designing of a Differentiator using op-amp for a given specification.
5. Designing of analog adder/subtractor circuit.
6. Designing of a First Order Low-pass / High Pass Filter using op-amp and study its frequency response.
7. Designing of a RC Phase Shift Oscillator using Op-Amp.
8. Study of IC 555 as an astable multivibrator.

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. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits , Pearson Education
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education
3. Nutan Kala Joshi and Swati Nagpal, Basic Electronics, Khanna Publishers

Suggestive readings

1. D.Roy Choudhary and Shail B. Jain, Linear Integrated Circuits, New Age International Publishers
2. A.P.Malvino, Electronic Principals, Tata McGraw-Hill

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

DISCIPLINE SPECIFIC CORE COURSE – 9: Signals and 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		
Signals and Systems ELDSC-9	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand mathematical description and representation of continuous and discrete time signals and systems.
- Develop input-output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
- Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in *s*- domain.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Represent various types of continuous-time and discrete-time signals and their convolution.
- Understand concept of convolution, LTI systems and classify them based on their properties and determine the response of LTI system.
- Determine Fourier series of periodic signals.
- Analyze various systems using Fourier and Laplace transformations.

SYLLABUS OF ELDSC-9 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Signals and Systems: Continuous and discrete time signals, time domain operations (shifting, scaling, reflection, *etc.*) with precedence rules. Exponential and sinusoidal signals, impulse and unit step functions, continuous-time and discrete-time systems and their basic properties.

UNIT – II (11 Hours)

Linear Time -Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative. LTI systems with and without memory, invariability, causality, stability, unit step response. Differential and Difference equation formulation. Block diagram representation of first order systems.

UNIT – III (12 Hours)

Fourier series Representation of Periodic Signals: Fourier series representation of periodic continuous and discrete signals. Convergence of the Fourier series (Dirichlet conditions).

Fourier Transform: Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and multiplication Properties, Properties of Fourier transform and basic Fourier transform Pairs.

UNIT – IV (11 Hours)

Laplace Transforms: Unilateral Laplace transform, inverse Laplace transform, properties of the Laplace transform, Laplace transform pairs, Laplace transform for signals. Solutions of first and second order differential equations with initial conditions.

Practical component (if any) – Signals and Systems
(Scilab/MATLAB/ OCTAVE/Other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Generate/plot various signals, there transformation and compute convolution
- Generate/plot Fourier series of periodic signals.
- Compute Fourier transform
- Learn the use of simulation tools and design skills.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Plotting/generation of signals: continuous time
2. Plotting/generation of signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of signals
5. Fourier series representation of continuous time signals.
6. Fourier series representation of discrete time signals.
7. Computation of Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.

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. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
2. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007).

Suggestive readings

1. S. Haykin and B. V. Veen, Signals and Systems, John Wiley & Sons (2004).

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		
Artificial Intelligence and Machine Learning ELDSE-1A	4	3	-0	1	Course Admission Eligibility	Basic knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:
Artificial Intelligence and Machine Learning has emerged as one of the most rapidly growing technology sector 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. Advancement in the field of AI and ML has also led to complete revolution in the other technology areas including Robotics, embedded systems and Internet of Things. AI and ML is considered to be one of the major contributor to the paradigm shift in technology which has taken place over the past few decades, which is very similar in scale to past events such as the industrial revolution, the computer age, and the smart phone revolution.
This course will give an opportunity to gain expertise in one of the most fascinating areas of science and technology through a well-structured classroom program that covers almost all the topics related to designing machines which can replicate human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence and Machine Learning.

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 ir structured environment
- To study different supervised and unsupervised learning algorithms.
- To understand the application development process using ML
.

SYLLABUS OF ELDSE-1A 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, Knowledge based Agents and Knowledge Representation Techniques. Types of Environment, PEAS representation of Intelligent Agents, Problem Solving Agents, AI Problem Formulation, State space representation

UNIT – II (11 Hours)

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, A* search algorithm, Game Search Algorithms: Minimax Search Algorithm and Alpha-Beta Pruning.

Simple AI problems (such as Water Jug Problem, Maze Problem, 8-Tile Puzzle problem, Traveling Salesman Problem).

UNIT – III (11 Hours)

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.

Markov Decision Process Model: MDP formulation, Elements of MDP Model, concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world

UNIT – IV (12 Hours)

Machine Learning: Types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Supervised Learning Vs. Unsupervised Learning **Supervised Learning Techniques:** Regression Analysis, Linear Regression, Classification Algorithm, Logistic Regression, K-NN Algorithm, Classification Vs. Regression, Linear Regression Vs. Logistic Regression, Decision Tree Classification Algorithm, Random Forest Algorithm, Clustering in Machine Learning, Hierarchical Clustering in Machine Learning, K-Means Clustering Algorithm

Practical component (if any) – Artificial Intelligence and Machine Learning *(Python software)*

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement various search algorithms
- Implement Bayesian network
- Demonstrate classification and clustering
- Make a small project

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to solve the given search tree using Breadth First Search
2. Write a program to solve the given search tree using Depth First Search and Depth Limited Search
3. Write a program to solve the given search tree using Uniform Cost Search
4. Write a program to solve the given search tree using Greedy Best First Search
5. Write a program to solve the given game search tree using Minimax Search
6. Program for construction and inference of a Bayesian network
7. Write a Program to perform Regression on given data sets
8. Write a Program to demonstrate Classification
9. Write a Program to demonstrate Clustering
10. Mini Project work

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. Saroj Kaushik, —Artificial Intelligence , Cengage Learning India, 2011
5. 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. Machine Learning by Tom. M. Mitchell, Tata McGraw Hill
3. Introduction to Machine Learning by Nils. J. Nillson

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		
Algorithm Design and Analysis ELDSE-1B	4	3	0	1	Course Admission Eligibility	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the understanding of usage of basic data structures like stack, queue, linked list, trees
- To introduce the students to design and analyse algorithms
- To highlight the differences between various problem-solving techniques for an efficient algorithm design
- To provide an understanding of algorithm design through a survey of the common algorithm design paradigms of Iterative techniques, Divide and Conquer, Dynamic Programming, Greedy Optimization
- To develop proficiency in Problem Solving and Programming
- To provide an understanding of time and space complexities of algorithms designed to solve computational problems
- To familiarize with various Searching and Sorting techniques

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement data structures like Stacks, Queues. Linked List, trees
- Use an appropriate algorithm using the algorithm design techniques, namely,
- Iterative, Divide and Conquer, Greedy, Dynamic Programming for a series of
- computational problems
- Apply various Searching and Sorting techniques
- Solve computational problems with an understanding of time and space complexities of algorithms

SYLLABUS OF ELDSE-1B **Total Hours- Theory: 45 Hours, Practicals: 30 Hours**

UNIT – I (11 Hours)

Data Structures: Stacks, array implementation of stack, operation on stacks, application of stacks-conversion of infix expression to prefix and postfix, evaluation of expression; Queues, array implementation of queues, operation on queues, Linked List and its implementation of stack and queue.

UNIT – II (11 Hours)
Trees: Introduction to trees, Binary search tree, preorder, postorder and inorder traversal (recursive)
Searching Techniques: Linear and Binary Search, Hashing techniques

UNIT – III (12 Hours)
Algorithm Design Techniques: Iterative techniques-Insertion Sort, Divide and Conquer-Merge Sort, Dynamic Programming-Weighted Interval Scheduling, 0-1 Knapsack Problem

UNIT – IV (11 Hours)
Greedy Algorithm- Interval Scheduling, Fractional Knapsack problem, Dijkstra's shortest path problem. Comparison between Dynamic programming and Greedy algorithm
Sorting Techniques: Quick Sort, Heap sort, Sorting in Linear Time - Bucket Sort, Radix Sort and Count Sort, Time and Space complexity

Practical component (if any) – Algorithm Design and Analysis
(Python/MATLAB software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement Data Structures
- Develop algorithms and write programs in Python language
- Write programs based on Algorithm design techniques
- Implement various Sorting techniques
- Prepare a Technical Report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to create a stack and perform Pop, Push, traverse operations on the stack using Linear Linked List
2. Program to create a linear queue using Linked List and implement insertion, deletion and display of the queue elements
3. Program to create a Binary Tree to perform traversals (Preorder, Postorder, Inorder) using the concept of recursion.
4. Program to solve the Interval Scheduling problem
5. Program to solve the Weighted Interval Scheduling problem
6. Program to solve the 0-1 Knapsack problem
7. Program to implement Insertion Sort
8. Program to implement Merge Sort
9. Program to implement Heap Sort
10. Program to implement Quick Sort

11. Program to implement Bucket Sort
12. Program to implement Radix Sort
13. Program to implement Binary Search

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. M.T.Goodrich, R.Tamassia, M.H.Goldwasser, Data Structures & Algorithms, Wiley
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Prentice Hall India. Third edition (2015).
3. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education India, First Edition (2013).
4. S. Lipschutz, Data Structures with C, Schaum's Outlines Series, Tata McGraw Hill
5. A.M.Tenenbaum, Y.Langsam, M.J. Augenstein, Data Structures using C, Pearson/PHI

Suggestive readings

1. Sarabasse and A.V. Gleder, Computer Algorithm-Introduction to Design and Analysis, Pearson Education, Third Edition (1999).

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		
Mathematics Foundation for Computing ELDSE-1C	4	3	0	1	Course Admission Eligibility	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:

- The aims is to introduce to students of electronics new mathematics such as Boolean algebra, relations, and graph theory which though look abstract concepts can be used effectively to design and analyze electronic circuits.
- To apply mathematical techniques for real world and engineering problems and expose students to some front-line techniques used in industry and academics.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Formulate recurrence relations to solve problems involving an unknown sequence. Student should see the significance in light of the Forbenius method they learn.
- Use Boolean algebra to design and analyze digital switching circuitry, such as found in personal computers, pocket calculators, CD players, cellular telephones, and a host of other electronic products.
- Appreciate circuit analysis in terms of topology.

SYLLABUS OF ELDSE-1C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Elementary Combinatorics: Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formula.

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

UNIT – II (10 Hours)

Recurrence Relations: Recurrence Relations, generating functions, iteration and induction, Linear Recurrence Relations with constant coefficients and their solution, Substitution Method, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

UNIT – III (11 Hours)

Boolean Algebras and Switching Circuits: Axioms of Boolean Algebra, De Morgan's law, Simplification of Boolean Expressions, Representation theorem, Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial,3, 4 and 5 variable Karnaugh diagrams, Quine-McCluskey method, Switching circuits and applications of switching circuits.

UNIT – IV (12 Hours)

Graph Theory: Introduction to Graph Theory with emphasis on DC circuit analysis, Representing circuital network as a graph, identification of branches, nodes, Tree branch/ twig. Formulation of incidence matrix. Usage of incidence matrix to solve for node voltage in two loop DC circuits with voltage and/ or current sources.

Practical component (if any) – Mathematics Foundation for Computing
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement python programs to calculate permutation and combinations.
- Write python programs based on Boolean Algebra and Minimize Karnaugh diagrams
- Should be able to do node analysis using incidence matrix/ Graph Theory.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Write a program that generates all the permutations of a given set of digits (with or without repetitions).
2. Write a program to generate Fibonacci Series using recursion.
3. Write a program to implement binary search using recursion.
4. Write a Program to accept the truth values of variables x and y, and print the truth table of the following logical operations:
   a. Conjunction
   b. Disjunction
   c. NAND
   d. NOR
   e. Exclusive OR
   f. Exclusive NOR
   g. Negation

5. Determine node voltages of given two loop circuits using given incidence matrix.

Essential/recommended readings

1. V. Krishnamurthy, Combinatorics, Theory and Application, Affiliated East-West Press 1985.
2. C.L. Liu & Mahopatra, Elements of Discrete mathematics, 2nd Sub Edition 1985, Tata McGraw Hill
3. G. Langholz, A. Kandel and J. Mott, Foundations of Digital Logic Design, World Scientific, Singapore, 1998.
4. Kenneth H. Rosen. Discrete Mathematics and Its Application. McGraw-Hill Education, Pennsylvania, U.S.A, 2011.
5. M.O. Albertson and J.P. Hutchinson, Discrete Mathematics with Algorithms, John Wiley and Sons (USA, 1988).

Suggestive readings

1. T.H. Coremen, C.E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice Hall India (3rd edition 2009)

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		
Electronic Circuits and Interfacing ELGE-3A	4	3	0	1	-	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the basics of operational amplifier and it's linear and nonlinear applications.
- To familiarize IC 555 Timer and its application
- Understand the working of multivibrators
- To understand working of various types of transducers.
- To introduce concept of embedded systems using Arduino.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with design of the linear and non-linear applications of an op-amp.
- Understand the working of multivibrators
- Understand working of various types of transducers.
- Understand working of Arduino

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

UNIT – I (12 Hours)

Basic Operational amplifiers: Block diagram, symbol, op- amp parameters (IC 741).

Op -Amp Circuits: Closed loop Inverting, Non-inverting, Summing and difference amplifier, Integrator, differentiator, Instrumentation Amplifier, Audio Amplifier (LM386) Voltage to current converter.

Comparators: Basic comparator, Schmitt Trigger.

UNIT – II (11 Hours)

Signal Conditioning Circuits: Active filters: First order Butterworth low pass and high pass filter, Wide Band -Pass filter, Wide Band-Reject filter, All-Pass filter (Designing with Circuit diagrams and formulas only for all filter)

Signal Generators: Phase shift oscillator, Wein Bridge oscillator (Designing with Circuit diagrams and formulas)

Multivibrators (IC 555): Block diagram, Astable and Monostable circuit. Applications of Astable and Monostable multivibrators.

UNIT – III (11 Hours)

Transducers (Basic Working): Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge),Capacitive (diaphragm), Hall effect sensors, Microphone, Touch Switch, Piezoelectric sensors, light (photoconductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), Pressure sensor.

UNIT – IV (11 Hours)

A-D and D-A Conversion: D-A conversion: 4-bit binary weighted resistor type, circuit and working. Circuit of R-2R ladder- Basic concept. A-D conversion characteristics (Number of channels, resolution), successive approximation ADC. (Mention the relevant ICs for all).

Data Acquisition using Arduino: Arduino: Birth, Open-Source community, Functional Block Diagram, Functions of each Pin, Applications of Arduino, IDE, Basic Interfacing and I/O Concept, Interfacing LED, Switch,7seg LED.

Practical component (if any) – Electronic Circuits and Interfacing
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Design application-oriented circuits using Op-amp.
- Design application-oriented circuits using timer IC
- Familiarization with different specifications of arduino boards.
- Interfacing of various sensors with arduino.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Study of inverting and non-inverting amplifier.
2. Study of analog adder/ subtractor circuit.
3. Study of basic integrator circuit/ basic differentiator circuit.
4. Design of first order LPF / first order HPF.
5. Study of basic astable multivibrator / monostable multivibrator.
6. 555 Timer-Rain alarm /Motor control by PWM /LED flasher circuit.

7. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement Strain using half and full bridge.)/ To determine the Characteristics of LVDT.
8. To determine the Characteristics of Thermistors and RTD.
9. Test the different Arduino Boards, Open-Source and Arduino Shields and install Arduino IDE and its development tool.
10. Develop a program to Blink LED for 1second when switch is pressed.

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. Measurement Systems, 4/e, Doeblin McGraw Hill, New York, 1992.
2. Electrical Measurements & Electronic Measurements by A.K. Sawhney
3. Electronic Instrumentation by H.S Kalsi, McGraw Hill
4. R. A. Gayakwad, Op-Amps and Linear IC‗s, Pearson Education (2003)
5. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.
6. Beginning Arduino Programming, Brian Evans, Technology in Action

Suggestive readings

1. Instrumentation- Devices and Systems by Rangan, Sarma, and Mani, Tata-McGraw Hill
2. Instrumentation measurements and analysis by Nakra & Choudhary
3. Measurement & Instrumentation- DVS Murthy
4. Timer, Op Amp, and Optoelectronic Circuits & Projects, Forrest M Mims, Master Publishing Inc.
5. Exploring Arduino, Jeremy Blum, Wiley
6. Beginning Arduino, Michael McRobetrs, Technology in Action
7. Practical Arduino Engineering, Harold Timmis, Technology in Action
8. Practical Arduino: Cool Projects for open-source hardware, Jonathan Oxer, Hugh Blemings, Technology in Action

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		
Modelling and Simulation ELGE-3B	4	3	0	1	12th Pass	Basic Knowledge of Python language

Learning Objectives

The Learning Objectives of this course are as follows:
It covers modeling and simulation principles as applied to engineering and social sciences. It discusses the techniques for modeling a simple to slightly complex system and perform statistical analysis. It covers about the steps involved in developing models for static, continuous and discrete systems. It also offers the introduction to number of latest models and simulation tools being used in industry with a set of examples. Examples may include modeling and analysis of manufacturing systems, computer-communication networks, operating system and various utilities and logistic systems.

Learning outcomes

The Learning Outcomes of this course are as follows:
- Enable to perform simulations for developing models in order to solve problems in static and dynamic systems.
- Evaluate simulation models and do the analysis of a number of systems existing in real life.
- Synthesize queuing theory, random numbers generators and their application to modeling and simulation.

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

UNIT – I (12 Hours)
Introduction to Modeling and Simulation: Introduction and historical development in Modeling and Simulation. System, Model and Simulation. Real system vs. Model of the system. Analytical solution vs. Simulation. Static vs. Dynamic Simulation Models. Continuous time vs. Discrete time modeling system. Hybrid systems, Feedback systems, Iterative systems Modeling. Random numbers in Simulation, random variables with discrete and continuous probability distribution. Deterministic and Stochastic Modeling System. Mathematical Modeling & Mathematical Tools.

UNIT – II (11 Hours)

Modeling Techniques and Design Steps: Discrete Event Simulation Models. System Models and Events. State variables, Entities and Attributes. Steps of Model Designs, Verification, validation and calibration of the Model.
Single server Queuing system, Database server as Queuing System.
Monte Carlo Method for static System.
Discrete and continuous Markov Models.

UNIT – III (11 Hours)
Simulation Techniques and Specifications: Advantages and disadvantages, Limitations, Steps in Simulation Study.
Differential Equation System Specification DESS, Discrete Event System Specification DEVS, Discrete Time System Specification DTSS.
Random numbers in Simulation. Random numbers generation and testing, Random variables with Discrete and continuous probability distribution. Simulation with Mathematical Models, Stochastic Models

UNIT – IV (11 Hours)
Modeling and Simulation Tools with Applications: System development, Project planning, System definition, Model formulation, input data collection and analysis, Model translation, verification and validation, experimentation and Analysis.
Different Applications domain of Modeling and Simulation.
Case Studies: Simulation of DEVS in a Bank, School, Hospital, or any such system. Modeling and analysis of a manufacturing systems, grocery store, computer-communication network or CPU scheduling.

Importance of different Modeling and Simulation softwares and their selection.
Brief overview and usefulness of Modeling and Simulation softwares- Scilab, SPICE, VHDL, Freemat, IMODELER, platform JModelica.org, Statistical Analysis Software SAS, MS- Excel.

Practical component (if any) – Modelling and Simulation
(Python or any Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Program for implementation, testing of random numbers
- Simulation of gaming dice
- Different Models implementation- GPSS, DEVS
- Implementation of DESS, Monte Carlo Method, Markov Chain
- Simulation of real time problems

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Implement different methods of random number generation
2. Simulating games of dice that generate discrete random variate, using random number generation

3. GPSS models - queue, storage, facility, multi-server queue, decision making problems
4. Perform an experiment on Testing of random numbers.
5. Write a simulator for any DEVS model that has scalar real values for its inputs, states and outputs.
6. Define a DEVS counter that counts the number of non-zero input events received since initialization and outputs this number when queried by a zero valued input.
7. Formulate a causal simulator for multi-component DESS.
8. Implementing an application of Monte Carlo methods.
9. Implement an application of Markov's chain.
10. Simulation of single queue server system.
11. Study of an implemented goal programming system and on decision making tools.
12. Study of a Game theory problem and solution.

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. Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman, 3ed, Theory of Modeling and Simulation, Academic Press : Elsevier 1985.
2. Narsingh Deo, System Simulation with Digital Computers, Prentice Hall of India, 1979.
3. Geoffrey Gordon, System Simulation, 2ndEd., PHI, 1987
4. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, 3rdEd., Tata McGraw Hill, 2003

Suggestive readings

1. Raj Jain, Art of Computer Systems Performance Analysis, John Wiley and Sons, Inc,1991
2. Sheldon M. Ross, Simulation, 4thEd., Elsevier 2008
3. Jerry Banks and John S. Carson, Barry L Nelson, Discrete-Event System Simulation, 5thEd., Prentice Hall, 2010

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

DISCIPLINE SPECIFIC CORE COURSE – 7: Analytical Instrumentation I (INDSC3A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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 I (INDSC3A)	04	02	0	02	Course admission eligibility	Basic knowledge of chemistry

Learning Objectives

The Learning Objectives of this course are as follows:
- To familiarize with the classification of analytical methods
- To understand the fundamentals of qualitative and quantitative analysis concepts.
- To categorize and understand the principle behind various separation techniques (planar and columns) and their instrumentation.
- To understand the principle, instrumentation and applications of visible and ultraviolet molecular spectroscopy

Learning outcomes

The Learning Outcomes of this course are as follows:
- Understand the classification of analytical methods
- Comprehend fundamentals of qualitative and quantitative analysis
- Differentiate between principle, instrumentation and operation of PaperChromatography and Thin layer chromatography
- Identify various Column Chromatographic techniques and their instrumentation
- Understand the concept of UV-Visible spectroscopy

SYLLABUS OF DSC-7

UNIT – I **(8 hours)**

Introduction to Analytical methods: Classification of Analytical Methods: Classical and Instrumental, Types of Instrumental Methods, Various sample extraction techniques. Instruments for analysis, Calibration of instrumental methods, Selecting an analytical method

UNIT – II **(7 hours)**

Chromatographic Separation methods: Planar Chromatographic methods: Principle and applications of Paper Chromatography, Thin layer chromatography (TLC) and High-Performance Thin Layer Chromatography (HPTLC).

UNIT – III **(8 hours)**

Column Chromatography: General Description of column chromatography, Classification of Chromatographic Methods, Elution in Column Chromatography, Migration rate of solutes, Band Broadening and column efficiency, Optimization of Column Performance.
Gel Permeation Chromatography (GPC): Principle, Instrumentation and Applications.

UNIT – IV **(7 hours)**
Molecular Spectro-analytical Methods of Analysis: Colorimetry and Spectrophotometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and limitations, Instrumentation of single beam and double beam instrument.

Practical component: **(60 hours)**

1. Preparation of solutions and buffers.
2. Introduction to the use of Analytical Equipment (Analytical Balance, Volumetric Glassware, pH meter).
3. To extract the spinach pigments using liquid-liquid extraction.
4. Separation of plant pigments by paper chromatography.
5. Separation of food colours by paper chromatography.
6. Separation of pharmaceutical sample mixture using thin layer chromatography.
7. Separation of amino acids/sugar/carbohydrates by Thin Layer Chromatography.
8. Separation of cobalt chloride and Blue Dextran mixture by Gel Permeation Chromatography.
9. To study the effect of various solvents on membrane permeability of beetroot using visible spectroscopy
10. Determination of pKa value for a dye using visible spectroscopy.
11. Spectrometric determination of iron in water samples using double beam spectrophotometer.
12. To identify the given unknown colourless samples using UV spectrophotometer.

Essential/recommended readings

1. H.H. Willard, L.L Merrit, J.A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 2004.
2. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 7th edition, 2016.
3. James W. Robinson, Eileen Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, CRC Press, 7th edition, 2014
4. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 6th edition 2009.

Suggestive readings

1. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 2019.
2. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2015.
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 – 8: Operational Amplifiers and Applications (INDSC3B)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Operational Amplifiers and Applications (INDSC3B)	04	03	0	01	Course admission eligibility	Basics of Analog Electronics- BJT circuits

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide understanding of DC and AC characteristics of operational amplifiers (op-amp)
- Design various filters and oscillators circuits using op-amps
- Study linear and non-linear applications of op-amp
- Design multivibrators and other circuits using op-amp.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the DC and AC characteristics of operational amplifiers (op-amp) and its effect on output, significance of op-amp parameters, and compensation techniques
- Elucidate and design circuits to study linear and non-linear applications of op-amps and special application ICs
- Explain the working of signal generators using op-amp
- Explain and compare the working of multivibrators using general purpose op-amp

SYLLABUS OF DSC- 8

UNIT – I (11 hours)

Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output, Single input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741).

UNIT – II **(12 hours)**

Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

Op-Amp Circuits: Open and closed loop configuration, Limitations of open loop, characteristics of ideal op-amp, frequency response of op-amp in open loop and closed loop. Non-Inverting & Inverting amplifiers, Summing & Difference amplifiers, Log & antilog amplifiers, Instrumentation Amplifier, Integrator & Differentiator circuit, Voltage to current converter, Current to voltage converter.

UNIT – III **(11 hours)**

Comparators: Basic comparator, Level detector, Schmitt Trigger. Voltage limiters, Signal **Generators:** Phase shift oscillator, Wein bridge oscillator, square wave generator, triangle wave generator, saw tooth wave generator, and Multivibrators using opamp.

UNIT – IV **(11 hours)**

Signal conditioning circuits: Sample and hold systems, Active filters: Low pass and high pass Butterworth filter (first and second order), Band pass filter, Band reject filter, and All pass filter.

Practical component: **(30 hours)**

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a first order low-pass filter using op-amp and study its frequency response.
7. Designing of a first order high-pass filter using op-amp and study its frequency response.
8. Designing of a RC phase shift oscillator using op-amp.
9. Design an astable multivibrator using opamp.
10. Design a schmitt trigger circuit using op-amp and study its hysteresis loop.

Essential/recommended readings

1. R. A. Gayakwad, Op-Amps and Linear Integrated circuits, Pearson Education, 4th Edition, May 2015.
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, 6th Edition, Aug 2000, Pearson,
3. Pearson Education (2001).J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).

Suggestive readings

1. A.P.Malvino, David J Bates, Electronic Principals, 7th Edition, Tata McGraw-Hil Education, (July 2017).

DISCIPLINE SPECIFIC CORE COURSE – 9: Mathematical Techniques for Instrumentation (INDSC3C)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Techniques for Instrumentation (INDSC3C)	**04**	**03**	**0**	**01**	**Course admission eligibility**	**Basic knowledge of mathematics**

Learning Objectives

The Learning Objectives of this course are as follows:

- To give an ability to apply knowledge of mathematics to engineering problems.
- To introduce the basic concepts required to understand, construct, solve and interpret
- differential equations.
- To teach methods to solve differential equations of various types.
- To teach students to understand the Laplace transform method to solve ordinary differential equations.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Recognize ODEs of varying order and use these to solve engineering problems.
- Derive mathematical models of physical systems.
- Solve the most common PDEs, recurrent in engineering using standard techniques.
- Demonstrate the utility of Laplace transform in solving the ordinary differential equations

SYLLABUS OF DSC-8

UNIT – I **(12 hours)**

Ordinary Differential Equations: First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact and Non-Exact Differential Equations, Linear Ordinary Differential Equations. Linear Independence and Dependence, Linear Differential Equations of Second Order with Constant Coefficients and Variable Coefficients: Homogeneous and non-homogeneous.

Method of Variation of Parameters, Electric Circuits (RL, RC and RLC circuits).

UNIT – II **(11 hours)**

Partial Differential Equations: Formation of Partial Differential Equation, Partial Differential Equation of First Order: Linear and Non-linear. Method of Separation of Variables. Classification of Partial Differential Equations of Second Order, One-dimensional Heat equation, Modeling a Vibrating string and the Wave Equation.

UNIT – III **(11 hours)**

Laplace Transform: Laplace Transform and its properties, Convolution theorem, Laplace Transform of Periodic function, Inverse Laplace transforms and its properties. Application of Laplace Transform to Differential Equations with Constant Coefficients, Solution to System of Simultaneous Differential Equations.

UNIT – IV **(11 hours)**

Fourier series and Transforms: Fourier Series: Even and Odd functions, Half range expansions, Fourier Integral, Fourier Transforms: Fourier Sine and Cosine Transforms, Forced Oscillations.

Practical component: **(30 hours)**

1. Plot the trigonometric functions like sin (x), cos(x), tan(x).
2. Plot the following algebraic expressions log(x), exp(x), x^2, x^3, $x+x^2$+exp(x).
3. Plot the following unit step functions u(t), u(t-4) and u(t+2).
4. Solve the first-order ordinary differential equations.
5. Solve the linear differential equation of second order with constant coefficients.
6. Solve the linear differential equation of second order with variable coefficients.
7. Evaluate the Laplace Transform of a given function.
8. Evaluate the inverse Laplace transform of a given function.
9. Evaluate the Fourier series coefficients of a given function.
10. Computing the Fourier Transform of a given signals.

Essential/recommended readings

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition (2020).
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing ,7th Edition.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 43rd Edition (2017).
4. HK Dass, Higher Engineering Mathematics, S.Chand Publishing,22nd Edition.

Suggestive readings

1. Dennis G.Zill,Advanced Engineering Mathematics, Jones & Bartlett Publishers,6th Edition (2016).
2. John Bird, Higher Engineering Mathematics,2017

DISCIPLINE SPECIFIC ELECTIVE COURSE – 1: Signal and Systems (INDSE3A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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 Systems (INDSE3A)	04	03	0-	01	Course admission eligibility	Basic knowledge of mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To give information about signals and systems mathematically and perform mathematical operations on signals.
- To teach the properties and the response of the LTI system using convolution.
- To give knowledge about Laplace transform, Fourier Transform and Z-transform for analysing continuous-time and discrete-time signals and systems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concept and types of signals and systems and their properties which is useful to learn digital tele-communication
- Classify systems based on their properties and determine the response of LTI system using convolution
- Understand how to apply the Laplace transform, Fourier Transform and Z-transform for analyzing continuous-time and discrete-time signals and systems

SYLLABUS OF DSE-1

UNIT – I **(12 hours)**

Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and Unit step functions, Continuous-Time and Discrete-Time Systems.

UNIT – II **(11 hours)**

Linear Time-Invariant Systems (LTI): Continuous & discrete time LTI systems, Convolution Sum, Convolution integral, Properties of LTI Systems: Commutative, Distributive and Associative. LTI systems with and without memory, Invariability, Causality, Stability.Unit Step response of System, Differential and Difference equation formulation, Block diagram representation of first order systems.

UNIT – III **(11 hours)**

Sampling: The Sampling Theorem and its implications. Spectra of sampled signals.
Laplace Transform: Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

UNIT – IV **(11 hours)**

Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms and their inverses.
Z-transform: properties, transfer function representation, inverse Z transform of rational functions- transform of input/output difference equation, stability of discrete time systems- frequency response of discrete time systems.

Practical component: **(30 hours)**

Learning Scilab/MATLAB (Experiments based on available systems).
Exploration of Signals and Systems using Scilab/MATLAB.

1. Generation of Signals: continuous time
2. Generation of Signals: discrete time
3. Addition, multiplication, folding and reversal of signals.
4. Convolution of Signals.
5. Solution of Difference equations.
6. Introduction to SIMULINK and calculation of output of systems represented by block diagrams.
7. Determination of Fourier Series coefficients of the given signals.
8. Determination of Fourier transform of the given signals.
9. Determination of Z transform of the given signals

Essential/recommended readings

1. H. P. Hsu, Signals and Systems, 4th Edition Tata McGraw Hill (2019).
2. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, 4th EditionOrchard Publications (2008).
3. W. Y. Young, Signals and Systems with MATLAB, Springer (2014).
4. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2010).

Suggestive readings

1. Alan V. Oppenheim, Alan S. Willsky with S. Hamid, Signals and Systems, 2nd edition, Pearson, Inc. (2022).

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2: VHDL Programming(INDSE3B)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
VHDL Programming (INDSE3B)	04	02	0	02	Course admission eligibility	Understanding of Digital Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the basic understanding of VHDL Modules, entity and architectures.
- To familiarize with different VHDL elements, Keywords and Identifiers
- To describe hardware in VHDL using different Modeling styles.
- To understand concurrent and sequential assignments.
- To introduce built in primitive gates and understand Gate level Modelling

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn about HDL Modules and simulation tools.
- Apply the knowledge of entity, architectures, VHDL Modules to describe hardware.
- Write and analyze various VHDL codes for combinational and sequential logic circuits
- describe hardware using multiple modeling styles.

SYLLABUS OF DSE-2

UNIT – I **(8 hours)**

Introduction to VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, VHDL requirements, VHDL basic language elements, Keywords, Identifiers, White Space Characters, Comments, format, VHDL operators.

VHDL Modeling: Describing hardware in VHDL, entity, architectures, VHDL Modules, Delays, data flow style, behavioural style, structural style, mixed design style, simulating design.

UNIT – II **(8 hours)**

BehavioralModeling: Introduction to behavioural modelling, Signal assignment, Concurrent and sequential assignments., Entity Declaration, Architecture Body, BehavioralModeling, Process statement, Loop control statements, Multiple Processes, Delay Models, inertial delay model, transport delay model, transport vs inertial delay, Signal Drivers.

UNIT – III **(7 hours)**

Dataflow and Structural Modeling: Data flow Modeling, Concurrent Assignment statements, Block statements, Structural Modeling, Component declaration and Instantiation, generate statements, Process, IF, CASE, LOOP, NEXT, EXIT and ASSERT statements.

UNIT – IV **(7 hours)**

Gate level modeling: Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

Practical component: **(60 hours)**

Learning Scilab/MATLAB (Experiments based on available systems).
Exploration of Signals and Systems using Scilab/MATLAB.

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4-bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 3-bit Ripple counter.

Essential/recommended readings

1. J. Bhasker, VHDL Primer, Pearson, 3rd edition ,2015.
2. Volnei. A.Pedroni, Circuit Design with VHDL, MIT Press; Third edition, 2020
3. Sudhakar Yalamanchili, Introductory VHDL-From Simulation to Synthesis, Pearson Education India. First Edition, 2000

Suggestive readings

1. Douglas Perry, VHDL, McGraw-Hill Education; 4th edition, 2002
2. Charles.H.Roth, Digital system Design using VHDL, Cengage; 2nd edition, 2012

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3: Programming using MATLAB(INDSE3C)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Programming Using MATLAB (INDSE3C)	04	02	0	02	Course admission eligibility	Basic knowledge of mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize the student with MATLAB software.
- The objective of this lab is to introduce students to the basic operations of MATLAB.
- To enable the student on how to approach solving Engineering problems using simulation tools.
- To prepare the students to use MATLAB in their project works.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use MATLAB for interactive computations
- Generate plots and exports them for use in reports
- Familiar with inbuilt MATLAB functions and will be able to generate user defined functions for various applications
- Understands fundamental of digital image and signal processing

SYLLABUS OF DSE-3

UNIT – I **(8 hours)**

Introduction to MATLAB: MATLAB Features, MATLAB Windows, defining variables, variable naming, checking existence, different Operations on variables, clear Operations, data type, precedence, scalar, vectors and Arrays.

UNIT – II **(7 hours)**

Data and Data Flow in MATLAB: Operators in MATLAB, Matrix operations, Reshaping Matrices, Importing & Exporting of Data, Arrays, Data types, File Input-Output, Communication with External Devices.

Character and Strings: Defining character and string, accessing character or substring from string, string concatenation and comparing, conversion between strings and number. Defining and working with Multidimensional Array and Cell arrays.

UNIT – III (7 hours)

Programming: Writing Script Files and Functions files, Error Correction, M-Lint Automatic Code Analyzer, Saving Files. Flow control statement: Conditional or selection, error handling, loop control, program termination. Solution of simultaneous linear equations.

UNIT – IV (8 hours)

MATLAB Graphics: Simple Graphics, Graphic Types, Plotting Functions, Creating Plot & Editing Plot, multiple plots, labeling graph, line colors, style and Marker. Introduction of Graphical User Interface (GUI), Generation and implementation of various functions on image.

Practical component: (60 hours)

1. Define variables, create a matrix of any size with all possible methods and perform various mathematical operations.
2. Create a multidimensional array and delete any Row/Column from it and create a new array.
3. Plot and label trigonometric functions using subplot command.
4. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.
5. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
6. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
7. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
8. Write a script to test whether a user defined no. is Prime or not.
9. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by the user.
10. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
11. Write a function to generate the AP series.
12. Write a function to generate the GP series.
13. Write a function to generate the Fibonacci series.
14. Write a function to generate the amplitude and frequency modulated signal.

Essential/recommended readings

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, (2019) PHI Learning, New Delhi.
2. Fausett, L. V., Applied Numerical Analysis Using MATLAB, (2005) Prentice Hall, Upper Saddle River, New Jersey.
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, (2019) Ellis-Horwood.

Suggestive readings

1. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey

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 DEPARTMENTS

GENERIC ELECTIVES (GE-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
		Lecture	Tutorial	Practical/ Practice		
Virtual Instrumentation (INGE3A)	04	02	0	02	Course admission eligibility	Basic knowledge Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic structure of virtual instrumentation
- To learn the basic programming concepts in LabVIEW
- To understand the basics of data acquisition for designing a Virtual Instrument

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 GE-3

UNIT – I **(8 hours)**

Graphical System Design: Graphical system design model, Design flow with GSD, Virtual Instrumentation, Virtual instrument, and traditional instrument, Hardware and software in virtual instrumentation, Virtual instrumentation for Test, control & design, Graphical system design using LABVIEW, Graphical programming & textual programming.

UNIT – II **(7 hours)**

LabVIEW Basics: Introduction, advantages of LABVIEW software environment, palettes, front panel controls & indicators, Block diagram, Data flow program. Repetition and Loops: For loops, while loops, structure tunnels, terminals inside or outside loops, shift registers, feed-back nodes, control timing, case structure.

UNIT – III **(8 hours)**

Arrays and Clusters: Arrays, Introduction, arrays in LABVIEW, creating one – dimensional array controls, indicators, and constants, creating two-dimensional arrays, creating multidimensional arrays, initializing array, deleting, inserting, and replacing elements, rows, columns, and pages within arrays, arrays functions. Clusters: Cluster controls and indicator, order of cluster elements, Cluster operations.

Plotting Data: Types of waveforms, waveform graphs, waveform charts, XY graphs, Intensity graphs & charts, Digital waveform graphs, 3D graphs, customizing graphs & charts, configuring a graph or chart, Displaying special planners on the XY graph.

UNIT – IV **(7 hours)**

File Input/ Output: File formats, file write &read, generating filenames automatically, String handling,string functions, LABVIEW string formats, parsing of strings. Instrument Control: Introduction, GPIB communication, Hardware specification, software architecture, Instrument I/O assistant, VISA, Instrument drivers, serial port communications, using other interfaces.

Practical component: **(60 hours)**

1. Build a VI to compute the expressions Y = (A*B*C) + (D*E) and Y = mx + c.
2. Split an input string into two outputs with reference to a separating character. Find the length of the input string and reverse the string.
3. Build a VI to perform various Boolean Operations (AND, OR, NAND, NOR, XOR).
4. Write a program in LabVIEW to find whether the given number is odd or even.
5. Create a VI to find the sum of first n natural numbers using a While Loop with a feedback node.
6. Create a VI to compute full adder logic using half adder logic as subVI.
7. Write a program in LabVIEW to find the square of the numbers from 1 to 100 using (a) a For Loop and (b) a While Loop.
8. Create a VI to compare the element of two clusters if the value of the corresponding elements are the same switch on LED in the output cluster.
9. Create a VI to compare clusters and Switch ON an LED in the output cluster if the nth element of cluster 1 is greater than the nth element of cluster 2.
10. Create a 2D numeric array (5 x 5) containing random numbers and find its transpose.
11. Create a VI to read a two-dimensional array and find the sum of the elements

in the row-wise and column-wise separately and display the sums of the rows and columns.

12. Create a 1D array and find its reverse.
13. Build a VI to plot a circle in the XY graph using a For Loop.
14. 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.
15. 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 in a cluster indicator.
16. Using For loop determine the number of odd numbers between a range of numbers entered by the user.
17. Build a VI to plot different colors in an intensity graph using an array.
18. 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.
19. Write a program to solve x2+bx+c=0.
20. Build a VI to generate two waveforms of different amplitude and frequencies add the signal to find the resultant and plot it on a separate waveform graph.
21. Create a VI to read a two-dimensional array and find the sum of the elements in the row-wise and column-wise separately and display the sums of the rows and columns.

Essential/recommended readings

1. Jovitha Jerome,Virtual Instrumentation Using Labview,PHI Learning Pvt. Ltd. (2010)
2. John Essick, Hands-on Introduction to LabVIEW for Scientists and Engineers, 3rd Edition, 2015.
3. Gupta, Virtual Instrumentation Using Labview 2E, McGraw Hill. (2010)

Suggestive readings

1. Jeffrey Travis, LabVIEW for everyone, Prentice-Hall PTR,2007.

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

GENERIC ELECTIVES (GE-3): Industrial and environmental techniques (INGE3B)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/		

				Practice		
Industrial and environmental techniques (INGE3B)	**04**	**02**	**0**	**02**	**Course admission eligibility**	**Basic knowledge of chemistry or analytical chemistry**

Learning Objectives

The Learning Objectives of this course are as follows:

- Demonstration of a clear and exhaustive understanding of the basic concepts of Industrial analysis of different industrial products.
- Impart theoretical and practical knowledge of Analysis of food and food products
- Learn analysis of various pharmaceutical drugs as per the standard pharmacopeia
  To expose to different types of Environmental pollutants and their analysis:

Learning outcomes

The Learning Outcomes of this course are as follows:

- Identify the key environmental factors shaping an industry
- Demonstrate ability to use tools and methodologies for performing analysis for various types of industries
- Develop a detailed professional report of Industry Analysis conducted.

SYLLABUS OF GE-3

UNIT – I **(8 hours)**
Industrial analysis
Paints: Definition, constituents and their functions, flash point of paints, separation of pigments, binder and thinner. Analysis of vehicle and thinner.
Pigments: General outline of identification and analysis of pigments -organic and inorganic pigments, their qualitative chemical test, analysis of white and tinted pigments.
Pesticides: Definition and classification of pesticides, analysis of the following in outline – DDT, Malathion, Diagionon.
Alloys: Composition and estimation of main constituents in in the following – Stainless steel, Brass, Solder and Gun metal
Rubber and Polymers: Mechanical, Thermal, Electrical and Optical properties, Analysis and Characterization.

UNIT – II **(8 hours)**
Analysis of food and food products
Composition and analysis of the following: Milk- Specific gravity, total solid, fat, proteins, lactose, contaminants in milk (QAS, artificial color and antibiotic), Wheat flour- Moisture, ash, oil, fat, protein, fiber, acidity, starch and maltose. Beverages-

Alcohol contents. Tea- Moisture, ash, tannin and caffeine. cyclamate. Honey- Moisture, HMF, Free acid, pH and carbohydrate.

UNIT – III **(7 hours)**

Pharmaceutical analysis

Drug, classification of drugs, introduction to Indian pharmacopoeia. Analysis of following drugs as per IP and BP (monograms) - Amoxycillin, Analgin, Proponolol, Pilocarbine nitrate, Rifampicin, Paracetamol, Nimuselide, Ranitidine.

UNIT – IV **(7 hours)**

Environmental analysis

Analysis of water- color, Odor, pH, taste, conductivity, dissolved solid, hardness, DO, COD, BOD, chlorides, sulphates, nitrites and phosphates.

Analysis of air- Sampling, particulate matter, gaseous pollutants-SOX, NOX, COX and organic pollutant

Practical component: **(60 hours)**

1. Determination of physical parameters of wastewater: pH, color, conductivity and Oxidation reduction potential.
2. Determination of dissolved oxygen in given water sample.
3. Estimation of phosphorous in fertilizer
4. Determination of calcium in cement sample (Titrimetry)
5. Estimation of calcium and Magnesium in dolomite ore.
6. Analysis of water for COD.
7. Colorimetric estimation of trace of nitrogen in the given water sample using Nessler's reagent.
8. Analysis of tea and coffee.
9. Determination of refractive index of given edible oil/solvents and determine its percentage purity.
10. Determination of Ascorbic acid.
11. Colorimetric estimation of Rifampicin (IP 1996)
12. Assay of Aspirin.
13. Estimation of specific gravity and total solids present in milk samples.
14. Estimation of lactose content of milk.
15. Determination of glucose in honey.
16. Quality assessment of Rubber/polypropylene/polyethylene samples

Essential/recommended readings

1. Analytical chemistry: an introduction: D. A. Skoog, D. M. West and F. J. Holler, Saunders the College publishers, 6th edition.
2. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 6th edition 2009.
3. Indian Pharmacopeia (2018)
4. A.B. Mathur and I.S. Bhardwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt Limited, 2003
5. Rao, E. S. (2013). Food Quality Evaluation (I ed.). New Delhi: Variety Book Publishers.
6. DeMan. (2007). Principles of Food Chemistry. Springer, 3rdedition.

Suggestive readings

1. Rao, E. S. (2013). Food Quality Evaluation (I ed.). New Delhi: Variety Book Publishers.
2. DeMan. (2007). Principles of Food Chemistry. Springer, 3rd edition.
1.

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

Semester-III

Department of Physical Education & Sports Sciences

BSc. (Hons.) Physical Education, Health Education and Sports

B.Sc.-PE- DSC-7 (4) Kinesiology

Sl. No.	Course Title &Code	Credits	Credit Distribution of the Course			Eligibility Criteria	pre- Requisite ofthe Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Kinesiology	04	3	0	1	XII Passed	NIL

Objective: To impart the knowledge, practices, Applications and analyses related to Kinesiology.

Learning Outcome: Students will learn the science of movement for better sports performance and the basic knowledge practices, Applications and skills of Kinesiology will help to create a strong foundation for Physical Education and Sports to engage human subjects of all ages, sex, and ability.

The student will learn the concepts and applications meaning, aim & objectives, importance of kinesiology for physical education and sports, Fundamental concepts and Applications Centre of gravity, line of gravity, axis and planes of motion, fundamental starting positions, terminology of fundamental movements, and classification of muscles.

The student will develop the understanding skill and practices about Location & Action of Muscles at Various Joints:- a) Upper extremity – shoulder girdle, shoulder joints, elbow joint, b) Neck, trunk (Lumboth oracic region and c) Lower extremity – Hip joint, knee joint, ankle joint and Muscular analysis of fundamental movements:- Walking, running, jumping, throwing, catching, pulling, pushing, striking, hanging.

The student will gain knowledge and Applications of Structure of Motor Actions: - Structure of cyclic and acyclic motoraction and movement combination, functional relationship of different phases of motor action.

The student will gain knowledge and applications of Qualities & Physiological Principles of Movements such as movement rhythm, movement coupling movement flow, movement precision and movement amplitude.

The Student will be able to analyze (Muscular) the Fundamental, Sports Skills, as their innovative applications.

THEORY SYLLABUS (45 hours/Lectures)

UNIT-I **(11 Hours/lectures)**

Meaning, aim & objectives, importance of kinesiology for physical education and sports
Fundamental concepts: Centre of gravity, line of gravity, axis and planes of motion, fundamental starting positions, terminology of fundamental movements, and classification of muscles

UNIT-II **(11 Hours/lectures)**

Location & Action of Muscles at Various Joints:-

a) Upper extremity – shoulder girdle, shoulder joints, elbow joint
b) Neck, trunk (Lumboth oracic region)
c) Lower extremity – Hip joint, knee joint, ankle joint Muscular analysis of fundamental movements:- Walking, running, jumping, throwing, catching, pulling, pushing,striking, hanging

UNIT-III **(12 hours/lectures)**

Structure of Motor Actions: - Structure of cyclic and acyclic motor action and movement combination, functional relationship of different phases of motor action.

UNIT-IV **(11 hours/lectures)**

Qualities & Physiological Principles Of Movements:- Movement rhythm, movement coupling movement flow, movement precision and movement amplitude.

Practical **(30 hours/lectures)**

1. Demonstration of planes & axes of a given movement.
2. Determination of the location of muscles at various joints:
   - i. Shoulder girdle
   - ii. Shoulder joints
   - iii. Elbow joint
   - iv. Hip joint
   - v. Knee joint
   - vi. Ankle joint
3. Muscular analysis of the techniques of game of your specialization
4. Measurement Demonstration of qualities of movement.

SUGGESTED READINGS

1. Bartlett, R. (2007). Introduction to Sports Biomechanics. Routledge Publishers, USA.
2. Blazevich, A. (2007). Sports Biomechanics. A & C Black Publishers, USA.
3. Breer & Zarnicks (1979). Efficiency of human movement. WIB Sounders Co. USA.
4. Hamill, J. and Knutzen, K.M. (2003). Biomechanical Basis of Human Movement. Lippincott Williams and Wilkins, USA.
5. Hay (1993). The biomechanics of sports techniques. Prentice Hall Inc. New Jersey.
6. McGinnis, P. (2004). Biomechanics of Sports & Exercise. Human Kinetics, USA.
7. Oatis, C.A. (2008). Kinesiology.2nd Ed. Lippincott, Williams & Wilkins, USA.

8 Lakshmi, V. (2005), Biomechanics of Body Movement in Sports. Khel Sahitya Kendra: New Delhi

9. Shaw, D. (2014). Mechanical Basis of Biomechanics. Sports Publication: New Delhi
10. Margaria, R. (1979). Biomechanics and Energetics of Muscular Exercise. University Press, Oxford: Great Britain
11. Rai, R. (2003). Biomechanics Mechanics Aspects of Human Motion. Agrim Publication: Mohali
12. Uppal, A.K., Kumar, V.L.G. & Panda, M.M. (2004). Biomechanics in Physical Education and Exercise Science. Friends Publication: New Delhi
13. Shaw, D (2018). Pedagogic Kinesiology. Sports Publication: Delhi
14. Wells, K.F. & Luttgens, K. (1976). Kinesiology: Scientific Basic of Human Motion (6th Ed.) Saunders College Publishing. Philadelphia
15. Robertson, D.G.E. Caldwell, G.E., Hamil, J. Kamen G., & Whittlesey, S.N. (2014). Research Methods in Biomechanics. (2nd ed.) Edwards Brothers Malloy: USA
16. Shaw , D (2003). Sports Biomechanics. Khel Sahitya Kendra: New Delhi.
17. Shaw, D (1998). Biomechanics and Kinesiology of human motion. Khel Sahitya Kendra: New Delhi.

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

Semester III

DSC-8 (4) EXERCISE & SPORTS PSYCHOLOGY

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Exercise & Sports Psychology	4	3	0	1	XII Pass	NIL

Objective: - The student is provided with the knowledge Practices Applications and Innovative of psychological aspects of sports performance.

Learning Outcome: - The student learns the psychological aspects to apply to improve the performance in sports. Such core knowledge and skills helps to create a strong foundation to engage human subject of all ages, sex, and ability

The student will learn about Sports and Exercise Psychology and understanding Practices and Applications, motivation, arousal and anxiety and personality.

The student will gain knowledge applications and practices of about the Group, Dynamic, aggression, psychological preparation and performance enhancement.

The learner will able to create data and its interpretation

THEORY SYLLABUS (45 Hours/Lectures)

Unit-I (i) Sports and Exercise Psychology (ii) Concept, Scope, role of sports and exercise psychologist (iii) Importance of Sports and exercise psychology. (iv) Historical development and future of Sports and Exercise Psychology, **(12 Hours/Lectures)**

Unit-II (i) Motivation: guidelines for building motivation, achievement motivation.
(ii) Arousal and Anxiety: Types, phenomena of Anxiety in relation to performance – Drive Theory, Inverted U Theory and IZOF. **(11 Hours/Lectures)**

Unit-III (i) Personality: approaches to personality – Trait, types and psychodynamic theories, determinants of personality, assessment of personality.
(ii) Team Cohesion: a conceptual model of Cohesion, assessment of Cohesion, relationship of Cohesion with performance. **(11 Hours/Lectures)**

Unit-IV (i) Aggression in sports: types, phenomena of Aggression – Instinct Theory and Social Learning Theory, Assessment of Aggression and Leadership in Sports
(ii) Psychological preparation – Long term and short term psychological preparation, Goal setting and self-confidence **(11 Hours/Lectures)**

Practical Syllabus (30 Hours/ Lectures)

1. Measurement of Motivation
2. Measurement of Anxiety
3. Measurement of Personality
4. Measurement of Team Cohesion
5. Measurement of Aggression

SUGGESTED READINGS:

1. Coaklay, J.J. (2009). Sporting Sociology, Issues and controversies, Mcgraw Hill International (Uint-1,3,4&5) Dixit S (2006). Khel- Manovigyan. Sports Publications. Delhi
2. Cohen RJ and Swerdlik ME (2002). .Psychological testing and Assessment: An Introduction to Tests and Measurement. McGraw Hill. New York. U.S.A.
3. Cox RH (2002). Sport Psychology. McGraw Hill. London.
4. Liukkonen JED (2007). Psychology for Physical Educators. Human Kinetics. U.S.A. Mortin GL (2003). Sports Psychology, Sports Science. Press. USA.
5. Sahni SP (2005). Psychology and Its Application in Sports. D.V.S. Delhi. Shaw D and Other (2005). Sport & Exercise Psychology. Bios. U.K.
6. Verma V (1999). Sport Psychology & All Round Development. Sport Pub. New Delhi.
7. Wann DL (1997). Sport Psychology. Prentice Hall. New Jerey.

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

Semester-III
BSc-PE-DSC-9(4)-101: ATHLETICS

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Athletics	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency in a game of one's choice.

After the Completion of First Month:

The student will be able to gain knowledge with respect to Historical Development, Organizational Structure and Playfield Technology of the respective sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of psychological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports, gain knowledge about different tests of fitness andskill evaluation as well as the evaluation of player's performance. The technical practice of sprint races, middle and long distance races, hurdles races, jumping event- long jump, throwing events- shot put, hammer throw.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components. Track marking and marking of different arenas for selected events in unit-III.

THEORY SYLLABUS (60 hrs lectures)

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation of the sport.
- Warming up and psychological basis of Warming up.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match competition Coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game- – sprint races, middle and long distance races, hurdles races, jumping event- long jump, throwing events- shot put, hammer throw.
- Motor Fitness Components Testing
- Skill/Technique Evaluation
- Evaluation of Player's Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components related to sport: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.

- Track marking and marking of different arenas for selected events in unit-III.

Practical - **(60 hrs.)**

1. Learning and demonstrating various skills/techniques of sports- sprint races, middle and long distanceraces, hurdles races, jumping event- long jump, throwing events- shot put.
2. Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.
3. Track marking and marking of different arenas for selected events in unit-III.

SUGGESTED READINGS:

- Chauhan VS (1999). Khel Jagat Mein Athletics. A.P. Pub, Jalandhar.
- Bompa O. Tudor and Halff G. Gregory. (2009) “Periodization Theory and Methodology of Training” Human kinetics. NY.
- Evans DA (1984). Teaching Athletics. Hodder, London.
- Fox EL (1998). Physiological Basis of Physical Education and Athletics Brown Pub.
- Gothi E (2004). Teaching & Coaching Athletics. Sport Pub., New Delhi.
- Gupta R. (2004). Layout & Marking of Track & Field. Friends Publications. India. New Delhi.
- Handbook-Rules and Regulation. International Athletic Federation (2010).
- Herb Amato, DA ATC et al (2002). Practical Exam Preparation Guide of Clinical Skills of Athletic Training. Slack Incorporated. 1st ed., USA.
- Kumar, Pardeep. (2008). Historical Development of Track & Field. Friends Publication. New Delhi
- Maughan, R. and Gluson, M. (2004). The Biomechanical Basics of Athletic Performance. Oxford University Press, U.K.
- Prentice, W. and Arnheim, D. (2005). Arnheim"s Principles of Athletic Training 12th Ed. McGraw Hill. in place of Knight (1988).
- Renwick GR (2001). Play Better Athletics. Sports Pub, Delhi.
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III

BSc-PE-DSC-9 (4)-102: BADMINTON

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Badminton	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player's performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and its testing.

THEORY SYLLABUS **(30 hrs lectures)**

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- organizational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player's Performance.

Unit-IV

(07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS:

1. Bloss, M.V. et al (2000). Badminton. McGraw Hill,USA.
2. Bompa O Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology ofTraining" Human kinetics. NY.
3. Brahms Bernd-Voler. (2010). Badmnton Handbook. Mayer & Mayer Sports: UK. Unt-II, III &IV-p-9-14.
4. Daris Pal. (1988). Badminton-The complete practical guide. Dairs & Charles Inc.: USA. Unit-IIp-1-28 III- p-29-88, 109-152 & IV-p-97-108
5. Downey J (1990). How to Coach Badminton. Collins Pub.London.
6. Golds, M. (2002). Badminton: Skills of the Game. Growood Press,USA.
7. Grice, T. (2007). Badminton: Steps to Success. 2nd Ed. Human Kinetics,USA.
8. GuptaR.KumarP.andTyagiS.(2008).TextbookonTeachingSkillandProwess(Part-I&II). FriendsPublication. New Delhi.
9. Hoeger, W.W. Kand & Hoeger, S.A. (1997). Principles and Labs for physical fitness. (2nd Edi.).Morton Publishing Company. USA. Unit- II- p-127, 178-187, Unit- p-10-194.
10. Singh, Hardayal. (1991). Science of Sport Training. D.V.S Pub. Delhi.
11. Singh, MK. (2007). Comprehensive Badminton. Friends Pub. New Delhi.
12. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi.
13. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III
BSc-PE-DSC-9 (4)-103: BASKETBALL

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Basketball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one‟s choice.

After the Completion of First Month:
A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:
A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:
A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:
A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS **(30 hrs lectures)**

Unit-I **(07 hrs lectures)**
- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**
- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**
- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(08 hrs lectures)**
- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

- Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
- Drewett, J. (2007). How to Improve at Basketball. Crabtree Publishing Co., USA.
- Goldstein, S. (1998). Basketball Fundamentals. 2nd Ed. Golden Aura Publishing,USA.
- Jain Naveen (2003). Play and Learn Basket Ball. Khel Sahitya Kendra. NewDelhi.
- Nat BB (1997). Conditioning Coaches Association. NBA Power Conditioning. Human Kinetics.
- Sharma OP (2003). Basket Ball Skills and Rules. Khel Sahitya Kendra, Delhi.
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Wilmore & Costill (2004).Physiology of Sports &Exercise. Human Kinetics, US

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

Semester III
BSc-PE-DSC-9 (4)-104: CRICKET

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Cricket	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I **(07 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it"s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV **(08 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

<u>SUGGESTED READINGS</u>

1. Amarnath M. (1996). Learn to Play Good Cricket. UBS Publishers. New Delhi.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. Boycott, G. (2010). Play Cricket the Right Way. Great Northern Books Limited, U.K.
4. Cricket (2008). Sports Skills: Cricket Fielding (Know the Game). A & C Black Publishers.
5. Gupta, K. (2006). How to Play Cricket. Goodwill Publishing House, New Delhi.
6. Hobls, J. (2008). The Game of Cricket As it should be played. Jepson Press, USA.
7. Jain R. (2003). Fielding Drills in Cricket. Khel Sahitya Kendra. New Delhi.
8. Rachna (2002). Coaching Successfully: Cricket. Khel Sahitya Kendra. New Delhi.
9. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
10. Sharma P. (2003). Cricket.Shyam Parkashan.Jaipur.
11. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9(4)-105: FOOTBALL

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Football	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical – **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. American Football Coaches Association (2002). The Football Coaching Bible. 1st Ed., Human Kinetics, USA.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. Carling, C., Williams, M. and Reilling, T. (2006). Handbook of Soccer Match Analysis: A Systematic Approach to Improving Performance. Routledge Publishers, USA.
4. Long, H. and Czarnecki, J. (2007). Football for Dummies. For Dummies Publisher, USA.
5. N Kumar (2003). Play and Learn Football. K.S.K. New Delhi.
6. Reilly, T. (2006). The Science Training Soccer: A Scientific Approach to Developing Strength, Speed and Endurance. Routledge Publisher, USA.
7. Reilly, T. and J.C.D. Arau (2008). Science and Football V: The Proceedings of the 5th World Congress on Sports Science and Football, Volume5.
8. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
9. Sharma OP (2001). Teaching and Coaching –Football. Khel S.K.Delhi.
10. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-106: GYMNASTICS

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Gymnastics	04	2	0	2	XII Pass	NIL

Objective:-The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of Gymnastics.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of Gymnastics, gain knowledge about different tests of fitness and skill evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components.

THEORY SYLLABUS

Unit-I **(07 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation of the sport.
- Warming up and psychological basis of Warming up.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(08 hrs lectures)**

- Basic skills and techniques of the Artistic Gymnastics, trampoline, parko and rhythmic
- Motor Fitness Components Testing
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components related to sport: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.

- Practical - (60 hrs.)
  - Learning and demonstrating various skills/techniques of Artistic Gymnastics, trampoline, parko and rhythmic.
  - Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Brown (2009). How to Improve at Gymnastics. Crabtree Publishing Co., USA.
3. Chakraborty S and Sharma L (1995). Fundamental of Gymnastics. D.V.S. Pub. New Delhi.
4. Chakraborty S (1995). Fundamental of Gymnastics. DVS Pub. New Delhi.
5. Chakraborty S (1998). Women's Gymnastics. Friends Pub.Delhi.
6. Code of Points Trampoline Gymnastics (2005). Federation Int. DE Gymnastics
7. Federation International Gymnastics (2006). Federation Int. DE Gymnastics
8. Harvey FJ (1998). Physical Exercises & Gymnastics. Khel Sahitya. New Delhi.
9. Jain R (2005). Play and Learn Gymnastics. Khel SahitayaKendra
10. Mitchell, D., Davis, B. and Lopez, R. (2002). Teaching Fundamental Gymnastics Skills. Human Kinetics, USA.
11. Price, R.G. (2006). The Ultimate Guide to Weight Training for Gymnastics. 2ndEd. Sportsworkout.com.
12. Schlegel, E. and Dunn, CR. (2001). The Gymnastics Book: The Young Performer"s Guide to Gymnastics. Firefly Books, USA.
13. Smither Graham (1980). Behing the Science of Gymnastics. London.
14. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
15. Stickland, L.R. (2008). Gender Gymnastics. Trans Pacific Press, Japan.
16. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III
BSc-PE-DSC-9 (4)-107: HANDBALL

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Handball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Jain D (2003). Play & Learn Handball. Khel Sahitya Kendra. New Delhi.
3. Kleinman, I. (2009). Complete Physical Education Plans. 2nd Ed. Human Kinetics, USA.
4. Page, J. (2000). Ball Games. Lerner Sports Publisher, USA.
5. Phillips, B.E. (2009). Fundamental Handball. Kessinger Publishers, USA.
6. Schmottlach N Mcmanama J (1997). Physical Education Handbook. 9th Edition. Allyn & Bacon.London.
7. Schmottlach, N. and McManama (2005). Physical Education Activity Handbook. Benjamin Cummings, USA.
8. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
9. Surhone, L.M. et al (2010). Team Handball. Betascript Publishing,USA
10. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
11. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-108: HOCKEY

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Hockey	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.
Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it"s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs)

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. International Hockey Federation, Rules of the Game of Hockey with Guidance for Players and Umpires. International Hockey Federation.
3. Jain D (2003). Hockey Skills & Rules. khel Sahitya Kendra . New Delhi.
4. Narang P (2003). Play & Learn Hockey. Khel Sahitya Kendra. New Delhi.
5. Pecknold, R. and Foeste, A. (2009). Hockey : Essential Skills. McGraw Hills,USA.
6. Rossiter, S. (2003). Hockey the NHL Way : Goaltending Illustrated Edition. Sterling Publishers,USA.
7. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
8. Walter, R. and Johnson, M. (2009). Hockey Plays and Strategies. Human Kinetics,USA.
9. Weekes, D. (2003). The Biggest Book of Hockey Trivia. Greystone Books,USA.
10. Wukovits, J.F. (2000). History of Hockey 1st Ed. Lucent Books,USA.
11. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
12. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9(4)-109: JUDO

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Judo	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Diago, T. (2005). Kodokan Judo Throwing Techniques. Kodansha International Publishers,Japan.
3. Harrison EJ (2002). Coaching Successfully Judo. Sports.Delhi.
4. Jain D (2003). Play and Learn Judo. Khel Sahitaya Kendra. New Delhi.
5. Law, M. (2009). Falling Hard : A Journey into the World of Judo. Trumpeter Publisher,Japan.
6. Putin, V., Shestakov, V. ad Levitsky, A. (2004). Judo : History, Theory and Practice. Blue Snake Books, Moscow.
7. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
8. Takahashi, M. (2005). Mastering Judo. Human Kinetics,USA.

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

SemesterIII
BSc-PE-DSC-9 (4)-110: KABADDI

Credit = 4(2 THz + 2 P)
Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Kabaddi	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one"s choice.

After the Completion of First Month:
A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:
A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:
A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:
A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it"s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III

- Basic skills and techniques of the Sports/Game. **(07 hrs lectures)**
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV (07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

- Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
- Kumar, Dharmander. (2018). Kabaddi and It"s Playing Techniques. Writers Choice, New Delhi.
- Mishra , S.C. (2007). Teach Yourself Kabaddi. Sports Publications, New Delhi.
- Rao CV (1983). Kabaddi. Native Indian Sports. NSNIS. Patiala Publisher
- Rao EP (1994). Modern Coaching in Kabaddi.D.V.S.Pub
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Syal, M. (2004). Kabaddi Teaching. Prerna Parkashan, New Delhi.
- Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III

BSc-PE-DSC-9(4)-111: KHO-KHO

Credit = 4(2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Kho-Kho	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III

- Basic skills and techniques of the Sports/Game. **(07 hrs lectures)**
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV (07 **hrs** lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) “Periodization Theory and Methodology of Training” Human kinetics. NY.
2. Chakrabarty G (2002). Kho - Kho Aveloken. Khel Sahitya Kendra.Delhi.
3. Panday L (1982). Kho - Kho Sarvaswa. Metropolitan. New Delhi
4. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
5. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
6. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-112: VOLLEYBALL

Credit = 4(2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Volleyball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV (07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. American Volleyball Coaches Association (2005). Volleyball : Skills & Drills. Human Kinetics,USA.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. FIVB (1996). Backcourt Spiking in Modern Volley Ball. FIVB.Chennai.
4. Kenny, B. and Gregory, C. (2006). Volleyball : Steps to Success. Human Kinetics,USA.
5. Saggar SK (1994). Cosco Skills Statics - Volley Ball. Sport Publication. Delhi.
6. Scates AE (1993). Winning Volley Ball. WC Brown.USA.
7. Scates, A. and Linn, M. (2002). Complete Conditioning for Volleyball. Human Kinetics,USA.
8. Shondell, D. and Reynaud, C. (2002). The Volleyball Coaching Bible. Human Kinetics,USA.
9. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
10. The National Alliance for Youth Sports (2009). Coaching Volleyball. For Dummies Publishers,USA.
11. Volleyball, USA (2009). Volleyball : Systems and Strategies. Human Kinetics,USA.
12. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-113: YOGA Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Yoga	04	2	0	2	XII Pass	NIL

Objective:-The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one"s choice.

After the Completion of First Month:

The Students will develop the understanding and knowledge of Origin of yoga, definition and scope of yoga, limitations and misconceptions, importance of yoga in physical education and other fields, Yoga asana completion at:- State, National, International, SGFI, AIU etc. Philosophical aspects of Yog. Pre-Vedic, Vedic period; Buddhism, Upanishad period, Jainism & tantra, qualifications, qualities and responsibilities of a coach, Duties/responsibilities of technical official, Scoring system and judgment criteria, Protocols for referees, judges and officials.

The student will learn about the prayer.

After the Completion of Second Month:

The Students will develop the understanding and knowledge of Meaning, techniques, precautions & effects of the following:-Asanas : padmasana, vajrasana, sidhasana, paschimottanasa, halasana, sarvangasana, shalabhasana, ardh-matsyendrasana, bhujangasana, tadasana, vrikshasana, matsyasana, gomukhasana, ushtrasana, shavasana, makarasana, vrishchikasana, dhanurasana, purna matsyendrasana, chakrasana, ek pad sikandasana, bakasana, mayurasana, shirshasanaPranayama : anulom-vilom, bhastrika, suryabhedhen pranayama, sheetali, sheetkari, bhramari, ujjayiShatkarma : neti, dhauti, nauli, basti, kunjal, kapal bhati, shankh prakshalanaBandhas : jalandhar, uddyana, mool bandha.

The student will be able to perform Asanas, pranayama, shatkarma, bandha.

After the Completion of Third Month:

The Students will gain knowledge of Disease wise treatment through yoga therapy- Asthma, high & lowB.P, diabetes, obesity, heart disease, insomania, arthritis, backache & female disease.

The student will learn Yoga-nidra/relaxation techniques

After the Completion of Fourth Month:

The Students will gain knowledge of Diet & constitution, components of nutrition, water, natural diet,balanced diet, fasting-its benefits, types & preparation. Importance of vegetarianism in yogic diet.

The student will learn Visit to yoga centers/institutes

THEORY SYLLABUS

UNIT-I **(07 hrs lectures)**

- Origin of yoga, definition and scope of yoga, limitations and misconceptions of Yoga
- Importance of yoga in physical education and other fields
- Yoga asana competition at:- State, National, International, SGFI, AIU etc.

UNIT-II **(07 hrs lectures)**

- Philosophical aspects of yoga-Pre-Vedic, Vedic period; Buddhism, Upanishad period, Jainism & tantra
- Qualifications, qualities and responsibilities of a coach,
- Duties/responsibilities of technical official, Scoring system and judgment criteria,

- Protocols for referees, judges and officials.

UNIT-III **(09 hrs lectures)**

- Meaning, techniques, precautions & effects of the following:-
- Asanas : padmasana, vajrasana, sidhasana, paschimottanasa, halasana, sarvangasana, shalabhasana, ardh-matsyendrasana, bhujangasana, tadasana, vrikshasana, matsyasana, gomukhasana, ushtrasana, shavasana, makarasana, vrishchikasana, dhanurasana, purna matsyendrasana, chakrasana, ek pad sikandasana, bakasana, mayurasana, shirshasana
- Pranayama : anulom-vilom, bhastrika, suryabhedhen pranayama, sheetali, sheetkari, bhramari, ujjayi
- Shatkarma : neti, dhauti, nauli, basti, kunjal, kapal bhati, shankh prakshalana
- Bandhas : jalandhar, uddyana, mool bandha

UNIT-IV **(07 hrs lectures)**

- Disease wise treatment through yoga therapy- Asthma, high & low B.P, diabetes, obesity, heart disease, insomania, arthritis, backache & female disease
- Diet & Nutrition, components of nutrition, water, natural diet, balanced diet, fasting-its benefits, types & preparation, importance of vegetarianism in yogic diet.

PRACTICALS (60 hrs.)

1. Prayer
2. Asanas, pranayama, shatkarma, bandha (as mentioned in theory)
3. Yoga-nidra/relaxation techniques
4. Visit to yoga centers/institutes

SUGGESTED READINGS

- Anand Omprarkash (2001). Yog Dawra Kaya Kalp, Kanpur. Sewasth Sahitya Perkashan
- Iyengar, B.K.S. (1995). Light on Yoga : The Bible of Modern Yoga. Schocken Publishers, USA.
- Kaminoff, L. et al (2007). Yoga Anatomy. Human Kinetics, USA.
- Kirk, M. (2005). The Hatha Yoga Illustrated. Human Kinetics, USA.
- Sharma JP and Ganesh S(2007). Yog Kala Ek Prichya. Friends Publication. New Delhi
- Sharma J. P. (2007). Manav jeevan evam yoga. Friends Publication. New Delhi.
- Sharma Jai Prakash And Sehgal Madhu(2006). Yog-Shiksha. Friends Publication. Delhi.
- Sharma Jai Prakash and Rathore Bhupender Singh (2007). Yoga Ke Tatva. Friends Publication. Delhi
- Mukerji, A.P. (2010). The Doctorine and Practice of Yoga. General Books, LLC, New Delhi.
- Norton, W.W. (2010). Yoga for Osteoporosis : The Complete Guide. W.W. Norton & Company, USA.
- Sarin N (2003). Yoga Dawara Rogoon Ka Upchhar. Khel Sahitya Kendra
- Sri Swami Rama, (2001). Breathing. Rishikesh Sadhana Mandir Trust.
- Swami Ram (2000). Yoga & Married Life. Rishikesh Sadhana Mandir Trust
- Swami Swatma Ram: Patanjali Yoga Sutra
- Swami Veda Bharti (2000). Yoga Polity. Economy and Family. Rishikesh Sadhana Mandir Trust
- Text Book Hath Yoga Pradipika
- Text Book Patanjali Yoga Sutra

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

Pool of Generic Electives

Semester III

GE-3(4)-301 Olympic Education

GE-3(4)-301

4 Credits (3 THz+1Tutorial)

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Olympic Education	4	3	1	0	XII	---

Objective: To impart the knowledge, practices and applications about the Olympism its functions through the various International sportsfederation, National committees and IOC commissions.

Learning Outcome: Students will learn the deep knowledge about ancient and modern Olympics, administration,organisation of Olympics Games and functions of IOC.

After the Completion of First Month:

The students will develop the understanding practices, applications and knowledge of Concept of Olympics movement, the ancient Olympic Games and the Modern Olympic Games and its movement. It also helps to know about the aims and symbols of the Olympic movement and International Olympic Committee (IOC).

After the Completion of Second Month:

The students will develop the understanding practices, applications and knowledge of The National Olympic Committee (NOC), International Sports Federations (IFs), National Sports Federations (NFs), Volunteerism and Olympics games.

After the Completion of Third Month:

The students will gain understanding practices, applications and knowledge of the Organization of Olympics games, international bid process for selecting sites / city for the games, Participation in Olympic Games and about Women & sports.

After the Completion of Fourth Month:

The students will gain knowledge, practices, applications and understanding of the Olympic museum, Olympic academy and Olympic solidarity programme, Paralympics games and concept of Sports for all. It also helps to know about Culture, Olympism, winning, participation and universality of the games, drug abuse and doping in sports and games.

THEORY SYLLABUS: (60 Hours/Lectures)

UNIT-I THE OLYMPIC MOVEMENT (15 Hours/Lectures)

1 Concept of Olympics movement, the ancient Olympic games and the Modern Olympic games and itsmovement.
2 Aims and symbols of the Olympic movement.
3 The International Olympic Committee (IOC).

UNIT-II STRUCTURE OF THE OLYMPIC MOVEMENT (15 Hours/Lectures)

1. The National Olympic Committee (NOC).
2. The International Sports Federations (IFs).
3. The National Sports Federations (NFs).
4. Volunteerism and Olympics games.

UNIT-III THE OLYMPIC GAME (15 Hours/Lectures)

1. Organization of Olympics games.
2. The international bid process for selecting sites / city for the games.
3. Participation in Olympic Games.
4. Women and sports.

UNIT-IV IOC PROGRAMMES (15 Hours/Lectures)

1. Olympic museum, Olympic academy and Olympic solidarity program.
2. Paralympics games and concept of Sports for all.
3. Culture, Olympism, winning, participation and universality of the games.
4. Drug abuse and doping.

SUGGESTED READING:

- Carto, J.E.L. And Calif, S.D. (1984). Medicine & Sport Science: Physical Structure of OlympicAthletes. London: Karger.
- Cliw, Gifford, (2004). Summer Olympic.
- Daw, Anderson. (2008). The Story of the Olympics.
- Kumar, Pardeep. (2008). Historical Development of Track & Field. Friends Publication. New Delhi.
- Maranirs David, Rome 1960: The Olympics that changed the world, 2008.
- Osbome, Manpope, Ancient Greece and the Olympic, 2004.
- Oxlade, chris., Olympic, 1999.
- Perrottet, tony, The Naked Olympics: the true story of the Ancient Games, 2004.
- Toropove, Brandon., The Olympic for Beginners, 2008.
- Wallechineley, Davi, The Complete Book of the Olympic, 1992.

BA(PROG.) WITH PHYSICAL EDUCATION & SPORTS AS NON-MAJOR
SEMESTER-3
B.A.-PE-DSC-3 (MINOR)
HEALTH EDUCATION

DSC

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Health Education	04	3	0	1	XII	--

Objective: To acquaint the students with basic aspects and practices with application to health, health education and various health agencies.

Learning Outcomes of the Paper:

1. The learners will learn the basic concepts of developing the practices of health along with the dimensions, spectrum and determinant of health.
2. The learners will develop the ability to apply the scope and principles of health education in life.
3. The learners will be able to comprehend the role of personal and occupational hygiene for better health practices.
4. The learners will be able to understand and apply the causes and preventive measures of various communicable and non-communicable diseases.
5. The learners will gain knowledge and practices about the role and schemes of various health promoting agencies like WHO, UNICEF, UNDP, MHFW, Red Cross etc.
6. The learners will be able to change their behavioural aspects related to personal health.
7. The learners will be able to create the databases related to health and hygiene.

SYLLABUS

M.M.: 100
No. of Credits: 04 (Lecture-03, Practical-1)
Theory: 45 hours, Practical: 30 hours

Unit-1: Introduction to Health

1. Meaning, Definition & Importance of Health
2. Dimensions of Health
3. Spectrum of Health
4. Determinants of Health

Unit-2: Introduction to Health Education

1. Meaning and Definition of Health Education
2. Aim and Objectives of Health Education
3. Importance and Scope of Health Education
4. Principles of Health Education

Unit-3: Hygiene and Health Issues

1. Personal Hygiene
2. Occupational Hygiene
3. Communicable Diseases : Meaning, Spread and Prevention
4. Non-Communicable Diseases: Meaning, Spread and Prevention

Unit-4: Health Agencies

1. Introduction to International Health Agencies: WHO (World Health Organization), UNICEF (United Nations International Children's Fund), UNDP (United Nations Development Programme)
2. Introduction to National Health Agencies: Ministry of Health and Family Welfare; Indian Red Cross Society, Hind Kushth Nivaran Sangh, Indian Council for Child Welfare, Tuberculosis Association of India, Bharat Sevak Samaj, Central Social Welfare Board

PRACTICAL

1. Conduct a survey on personal hygiene Habits of your college students.
2. Visit to any one national health agency and preparation of a report.
3. Conduct a Survey on anyone of the following:
    a. Communicable Disease
    b. Non-Communicable Disease

SUGGESTED READINGS

1. Anspaugh, D.J.; Ezell, G. andGoodman, K.N. (2006).Teaching Today's Health.Mosby Publishers. Chicago, USA.
2. Balayan, D. (2007). Swasthya Shiksha Evam Prathmik Chikitsa. Khel Sahitya. Delhi.
3. Chopra,D. and Simon, D. (2001). Grow Younger, Live Longer: 10 Steps to Reverse Aging. Three Rivers Press. New York. USA.
4. Dewan, A.P. (1996). School Health Manual. Nature Cure and Yoga Health Centre. New Delhi.
5. Dixit, S. (2006). Swasthya Shiksha. Sports Publication. Delhi.
6. Donatelle, R.J. (2005). Health the Basics. Sixth Edition. Oregon State University.
7. Floyd, P. M. and Yeilding, C. (2003). Personal Health: Perspectives and Lifestyles. Thomson Wads Worth. Belmont. California. USA.
8. Hales, D. (2005). An Invitation to Health. Thomson-Wadsworth, Belmont. California.USA.
9. Park, K. (2007). Park‟s Text Book of Preventive & Social Medicine. Banarsi Das Bhanot & Company. Delhi.
10. Snehlata (2006). Shareer,Vigyan Evam Swasthya Raksha. Discovery Pub. Houses. New Delhi.
11. Uppal, A.K. & Gautam, G.P. (2008). Health & Physical Education. Friends Publication. New Delhi.

BA(PROG.) WITH PHYSICAL EDUCATION & SPORTS AS MAJOR
SEMESTER-3
B.A.-PE-DSC-3 (MAJOR)
SPORTS NUTRITION AND ERGOGENIC AIDS

DSC

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Sports Nutrition and Ergogenic Aids	04	3	0	1	XII	--

Objective: To acquaint the students with basic concepts, application and creativity related to sports nutrition and ergogenic aids.

Learning Outcomes of the Paper:

1. The learners will understand the basic concept and practices of Nutrition and its importance in the field of Sports.
2. The learners will be able to describe the functions of different types of Nutrients and their sources.
3. The learners will gain knowledge of application of nutrient-supplementation and nutrition guidelines.
4. The learners will understand the concept of Ergogenic Aids and their role in sports.
5. The learners will identify the list of prohibited substances to control doping.
6. The learners will be able to create / construct the diet chart/ plan as per individual needs.
7. The learners will be acquainted to the role of World Anti -Doping Agency (WADA) and National Anti-Doping Agency.

SYLLABUS

M.M.: 100
No. of Credits: 04 (Lecture-03, Practical-1)
Theory: 45 hours, Practical: 30 hours

Unit-1: Nutrition

1. Meaning, Definition & Importance of Nutrition
2. Nutrients: Classification, Function, Source
3. Balanced Diet, Dietary Aids, Dietary Gimmicks
4. Achieving a Healthy and Balanced Diet

Unit-2: Sports Nutrition

1. Role of Nutrition in Sports
2. Basic Nutrition Guidelines
3. Energy Balance Equations
4. Pre- and Post-performance Nutrition to athletes

Unit-3: Ergogenic Aids

1. Meaning and Definition of Ergogenic Aids
2. Types of Ergogenic Aids
3. Role of Ergogenic Aids in Sports
4. Nutrition and Ergogenic Aids

Unit-4: Doping and Sports

1. Meaning and Definition of Doping
2. Disadvantages of Doping in Sports
3. Introduction to WADA (World Anti-Doping Agency) and NADA (National Anti-Doping Agency)
4. List of prohibited substances by WADA (World Anti-Doping Agency)

PRACTICAL

1. Preparation of a regular Diet Chart/ Plan for Sportspersons.
2. Preparation of Diet Schedule for Competitive performance (before and after the competition)
3. Visit to Nutritional/ Medical institution and preparation of report.
4. Conduct survey on nutritional practices of sportspersons.

SUGGESTED READINGS

1. Anspaugh, D.J.; Ezell, G. and Goodman, K.N. (2006). Teaching Today's Health. Mosby Publishers. Chicago, USA.
2. Balayan, D. (2007). Swasthya Shiksha Evam Prathmik Chikitsa. Khel Sahitya. Delhi.
3. Chopra, D. and Simon, D. (2001). Grow Younger, Live Longer: 10 Steps to Reverse Aging. Three Rivers Press. New York. USA.
4. Dewan, A.P. (1996). School Health Manual. Nature Cure and Yoga Health Centre. New Delhi.
5. Dixit, S. (2006). Swasthya Shiksha. Sports Publication. Delhi.
6. Donatelle, R.J. (2005). Health the Basics. Sixth Edition. Oregon State University.
7. Floyd, P. M. and Yeilding, C. (2003). Personal Health: Perspectives and Lifestyles. Thomson Wads Worth. Belmont. California. USA.
8. Hales, D. (2005). An Invitation to Health. Thomson- Wadsworth, Belmont. California. USA.
9. Park, K. (2007). Park‟s Text Book of Preventive & Social Medicine. Banarsi Das Bhanot & Company. Delhi.
10. Snehlata (2006). Shareer, Vigyan Evam Swasthya Raksha. Discovery Pub. Houses. New Delhi.
11. Uppal, A.K. &. Gautam, G.P. (2008). Health & Physical Education. Friends Publication. New Delhi.

SEMESTER- III
BSc-PE-DSE-1(4)-101: (DSE)
ADAPTED PHYSICAL EDUCATION
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
ADAPTED PHYSICAL EDUCATION	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding and practices to the learners about adapted physical education in order to let them realize that Divyang student also are the part of active education system as well.

Learning Outcomes:

At the end of the course the student will be able to-

1. Acquire the knowledge of meaning definition and components of adapted physical educational in suitable modern aspects.
2. Understand the General educational styles, strategies, teaching style and adapted physical education.
3. Recognize suitable general and specific activities for early childhood adapted physical education.
4. Apply the knowledge of measuring & assessing students, Criteria for eligibility for adapted physical education.

PART – A Theory Syllabus

UNIT I - (09 Hours)

1.1 Definition of Adapted Physical Education and components of Individualized education Programme (IEP)
1.2 Measuring & Assessing students, Criteria for eligibility for adapted physical education, Alternative instructions in physical education and teaching in inclusive setting

UNIT II (09 Hours)

2.1 General educational styles and strategies,

2.2 Teaching style and adapted physical education
2.3 Ways of facilitating skill acquisition and behaviour management approaches emphasized in adapted physical education

UNIT III **(09 Hours)**

3.1 Children and youth with unique needs:-Intellectual disabilities
3.2 Learning disabilities and attention defects
3.3 behavior disorder
3.4 Visual impairment, Deafness, Cerebral palsy, shock
3.5 spinal cord disabilities and amputation
3.6 Students without disabilities with unique needs

UNIT IV **(09 Hours)**

4.1 Development Areas: -
- 4.1.1 Physical fitness
- 4.1.2 Motor Development
- 4.1.3 Perceptual- motor development

4.2 Early childhood adapted physical education

UNIT V **(09 Hours)**

5.1 Activity Areas and adapted physical education:
- 5.1.1 Team sports
- 5.1.2 Individual sports
- 5.1.3 Dual sports
- 5.1.4 Gymnastics
- 5.1.5 Aquatics

5.3 Adventure Sport, Dance, Rhythmic movements

PART – B Practical Syllabus **(30 Hours)**

To prepare Individual Education Programme of different challenged population.
1. To measure and Assess the degree of Help/Need
2. To facilitate special skill acquisitions
3. To prepare programme for: Visual impairment and Deafness
4. To prepare programme for: Spinal cord disability and Amputation
5. Development Areas: Physical Fitness & Motor Development

Note: Evaluation will be done on the basis of practical examination of the activities taught.

References:

1. Bhandani, R.K., An Overview of Natural and Man Made Disaster their Reduction CSIR New Delhi
2. Gupta, H.K. Disaster Management University Press India 2003
3. Gupta, MC Manuals on Natural Disaster Management in India, National Centre for Disaster Management IIPA, New Delhi 2001.
4. Singh, M.K., ‘A to Z Badminton’, Friends Publication, New Delhi

5. Arora S., Agarwal M Gupta B. (2018), “Fitness; Wellness And Nutrition”, Vivechan Publications (INDIA) ISBN: 978-93-83914-89-0.
6. Morris L R, Schulz L, (1989) “Creative play activities for children with disabilities” Human Kinetics books, campaign Illinois.
7. Davis RW, (2002) “Teaching Disability Sports.” Human Kinetics.
8. Mishra, S.C, (2007) “Viklang aur Khel”, Sports Publications.
9. Shaw D. (2018) “Fundamental Statistics in Physical Education and Sports Sciences” Sports Publication, ISBN: 81-86190-57-0.
10. Shaw D. (2020) “Physical Education Practical Manual for Class XI” Prachi Publication, ISBN : 978-8193-7698-0-5.
11. Shaw D. (2020) “Physical Education for Class XII” Prachi Publication, ISBN : 978-81-7730-848-8.
12. Shaw D. (2020) “Physical Education for Class XI” Prachi Publication, ISBN : 978-81-7730-847-1.
13. Shaw D. (2020) “Physical Education Practical Manual for Class XII” Prachi Publication, ISBN : 978-81-937698-1-2.

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

SEMESTER- III
BSc-PE-DSE-1(4)-102 (DSE)
PERSONALITY DEVELOPMENT
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
PERSONALITY DEVELOPMENT	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding and practices to the learners about Personality development.

Learning Outcomes:

At the end of the course the student will be able to-

5. Acquire the knowledge of meaning, definition and importance of Personality Development.
6. Understand the Components of Physical Personality, Physical Fitness, Self- Responsibility for Health & Personality Development.
7. Use the components of personality and its applications of self-evaluation for one's personality
8. Apply the knowledge of nutrition to enhance personality.

Theory Syllabus

UNIT I INTRODUCTION (09 Hours)

1.1 Definition, Meaning and Description of Personality, Components of Personality – Physical, Emotional, Cognitive, Social, Mental, Vital and Spiritual; Role of Physical Personality as Foundation of Personality.
1.2 Components of Physical Personality: Growth & Development; Nutrition, Exercise, Physical Fitness, Self- Responsibility for Health & Personality Development.

UNIT II PHYSICAL GROWTH & DEVELOPMENT (09 Hours)

2.1 Meaning and Definition – Physical Growth, Development, Differences between Growth and Development; Growth and Development patterns in various body systems. Role in Promoting Personality Development
2.2 Growth Patterns: Magnitude and Rate of Physical Growth, Distance and Velocity Curves, Classification of Human Growth Cycle – Baby, Child, Adolescent, Post-Adolescent, Adult and Old age.

UNIT III NUTRITION & PERSONALITY DEVELOPMENT (09 Hours)

3.1 Meaning & Definitions, Nutrients, Balanced diet for Health Needs and Personality Development, Micro & Macronutrients relation to Personality Development.

3.2 Nutritional Requirements: Nutritional requirements for Growing Age, Physical Activities, Sports, Sports Training, Food Groups: Classification of Food into various groups based on their nutrients, daily intake of various food groups, Nutrients of common foods

UNIT IV PHYSICAL FITNESS & PERSONALITY (09 Hours)

4.1 Meaning & Definition of Physical Fitness and its components. PAR-Q, Health Related Physical Fitness & Personality; Physical Performance components of Fitness, Personal needs and Personality Development

4.2 Personal Physical Fitness: Personal strengths and weaknesses in components of Physical Fitness, Development of weak components, Role of Behaviour changes for developing personal fitness strengths.

UNIT V SELF RESPONSIBILITY (09 Hours)

5.1 Meaning & concept of Self Responsibility

5.1.1Daily Schedules (DS) Awareness and Logbooks for practice of DS.

5.2 Physical Education: Role of Physical Education in promoting Self Responsibility

5.2.1 Self-Responsibility and Behaviour change, PE for Personality Development.

5.2.2 Foundations of Personality Development & Personal Strengths through Physical Education as the basis of self-responsibility

5.2.3 Principles of Self-Responsibility & their relation to art & science of health

5.2.4 Fitness & wellness promotion

PART- B Practical (30 Hours)

1. To demonstrate the components of personality with examples.
2. To demonstrate stages of behaviour change.
3. To demonstrate PAR-Q
4. To demonstrate daily physical log and methods its activities.
5. To demonstrate balanced nutrition with food items and quantity required
6. To demonstrate the application of self-evaluation of one’s personality
7. To demonstrate different methods of meditation (At least two)

REFERENCES:

1. Allen, B.P. Personality Theories: Development, Growth and Diversity. Allyn & Bacon, New York, USA., 2005.
2. Anspaugh, D.J., M. H. Hamrick and F.D. Rosato, Wellness: Concepts and Applications, McGraw Hill, Boston, USA
3. Deepak. C. and D. Simon. Grow Younger Live Longer: 10 Steps to Reverse Aging. Three Rivess Press, New York, USA, 2001.
4. Hales, D. An Invitation to Health, Thomson Wads worth, Texas, USA, 2005.
5. Herron, W.G. Personality Development and Psychotherapy in our Diverse Society: A Sourcebook. Jason Aronson, Boston, USA, 1998
6. Hogger, W.W.K., and S.R. Hogger, Fitness & Wellness, Wads worth Publishing, Belmont, USA, 2007.
7. Jelliffe, D.B. and Jelliffe, E.F.P.,Growth Monitoring and Promotion in young Children,

Oxford University Press, Oxford, U.K. (1990).
8. Kansal, D.K..Applied Measurement, Evaluation & Sports Selection, Sports & Spiritual Science Publications, Delhi (2008).
9. Olsen, L.K., Redican, K.J. and Baffi,C.R., Health Today, Ginn Pr. Publishers, (2002).
10. Robbins, G., D. Powers and S. Burgess. A Wellness Way of Life. McGraw Hill, Boston, USA, 2002.
11. Schwartz, D.J. The Magic of Thinking Big. Simon. & Schuster, New York, USA.
12. Shoffer, D.R. Social and Personality Development. Wads worth Publishing, Belmont, USA, 2004.
13. Shukla, A. The Mother on Education: From Reflections to Action, National Council for Teacher Education (NCTE), 2004.
14. Steven, C., The 8th Habit: From Effectiveness Greatness, Franklin Covey Co., New York, USA, 2004.
15. Tortora, G.J. & Grabowski,S.R., Principles of Anatomy and Physiology, John-Wiley & Sons, New York, USA (1996).
16. Vivekananda, S., Personality Development, Advaita Ashrama, Kolkata (2003).
17. Wrightsman, L.S. Jr., Adult Personality Development, Sage Publications Inc.
18. Wuest, D.A. and Bucher, C.A. Foundations of Physical Education, Exercise Science and Sports by McGraw Hill, (2006)

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

SEMESTER- 3
BSc-PE-DSE-1(4)-103 (DSE)
EXERCISE PRESCRIPTION FOR HEALTH AND FITNESS
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
EXERCISE PRESCRIPTION FOR HEALTH AND FITNESS	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding, skill and practices to the learners about exercise prescription for health and fitness.

Learning Outcomes:

At the end of the course the student will be able to-

9. Acquire the knowledge and practices of exercise prescription on the behalf of health status.
10. Deal with differentiation and relation between exercise & physical activity.
11. Understand and demonstrate the direct and indirect health benefits of the exercise
12. Get understanding and applications of acronyms FITT (Frequency, Intensity, Time (duration), type (Mode of Exercise) (Training principles for batter training)

Theory Syllabus

UNIT I - (09 Hours)

1.1 Background of exercise prescription to non-sports person, basis of exercise prescription and measurement of motivation for physical exercise/activity health status
1.2 Physical personality in relation to physique, attitude, interests.
1.3 Exercise for recreation, health, fitness, wellness and competition.

UNIT II - (09 Hours)

2.1 Meaning and definition of exercise & physical activity
2.1.1Differences between exercise & physical activity (chronic and acute effect for adaptation)
2.1.2 Relation between exercise & physical activity

UNIT III - (09 Hours)

3.1 Health benefits of exercise, exercise as pro-active health care.
3.2 Exercise for prevention of heart disease, osteoporosis, diabetes type-II, hypertension, obesity etc.

UNIT IV - **(09 Hours)**

4.1 Necessity of exercise prescription
  4.1.1 Sedentary population
  4.1.2 Different-population
  4.1.3 Self-responsibilities and behaviour change stages for exercise regularity

UNIT V - **(09 Hours)**

5.1 Steps for exercise prescription.
5.2 Exercise, stress test, physical fitness test,
5.3 Understanding acronyms FITT (Frequency, Intensity, Time (duration), Type (Mode of Exercise).
5.4 Principles of fitness training

PART- B Practical Syllabus **(30 Hours)**

1. Assessment of fitness (At least three)
2. Assessment of physical activity readiness of a person
3. Measurement of health status
4. Prescribing exercise / Programme
5. Evaluation of an exercise Programme

References:

1. American College of Sports Medicine (2000). ACSM's Guidelines for Exercise Testing and Prescription. Lippincott Williams & Wilkines. Philadelphia. USA.
2. Corbin C G Welk W Corbin & K Welk (2005). Concepts of Fitness and Wellness. McGraw Hill Company. New York. USA.
3. Goldberg L and DL Elliot (2002). The Power of Exercise. National Health & Wellness Club. USA.
4. Hales D (2006). An Invitation to Health. Thomson Wadsworth. Belmont. California. USA.
5. Harrison GA, Weiner JS Tanner JM and. Barnicot NA (1984). Human Biology. Oxford University Press. Oxford. U.K.
6. Howley ET and BD Franks (2003). Health Fitness Instructors Handbook, Human Kinetics. Champaign. Illinois. USA
7. Kolecki JE and DQ Thomas (2007). Activities and Assessment Manual. Jones and Barlett Publishers. Sandburg. Massachusetts. USA.
8. Powers S and E Howley (2006). Exercise Physiology- Theory and Applications. McGraw Hill Co. New York. USA.
9. Thomas DQ and JE Kotecki (2007). Physical Activity and Health –An Interactive Approach. Jones and Bartlett Publishers. Sndbury. Masschusett. USA.

10. USDHHS (2000) Healthy People 2010: National Health Services (USDHHS). Washingtons D.C. USA.

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

SEMESTER- 3
BSc-PE-DSE-1(4)-104.1 (DSE)
FUNDAMENTALS OF BASKETBALL
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF BASKETBALL	04	02	0	02	XII	--

Objective:

The learner will be able to understand and comprehend the fundamentals of Basketball game with its practices and skill for better pedagogy and performance in Basketball.

Learning Outcomes:

1. The learner will attain basic knowledge of Basketball for different applications.
2. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Basketball.
3. The learner will be able to perform the marking/ drawing/ material organizing for Basketball.
4. The learner will be able to understand, analyze and interpret the fundamental methods and score
5. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Basketball).
6. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Court, marking and General Rules **(8 hours)**

1.1 Court Layout (mention each and every specification)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Skills **(7 hours)**

2.1 Dribble
2.2 Passing
2.3 Shooting
2.4 Rebounding
2.5 Faking

Unit-3: Fundamental Defensive Skills **(8 hours)**

3.1 German drill and suicide drill
3.2 Lay-up shot
3.3 Zone-defence
3.4 Man to man technique
3.5 Attacking skills

Unit-4 Different tests in Basketball **(7 hours)**

4.1 Johnson Basketball Test
4.2 Knox Basketball test
4.3 Harrision Basketball test

PART-B: PRACTICAL **(60 hours)**

1. Court marking on paper and on the playfield as well.
2. General rules and their application and implementation in game situations.
3. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
4. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***"Physical education key learning for competitive exams".*** Iterative International Publishers.
2. Bompa O. Tudor and Halff G. Gregory. (2009) **"Periodization Theory and Methodology of Training"** Human kinetics. NY.
3. Drewett, J. (2007). **How to Improve at Basketball.** Crabtree Publishing Co., USA.
4. Goldstein, S. (1998). **Basketball Fundamentals.** 2 nd Ed. Golden Aura Publishing,USA.
5. Jain Naveen (2003). **Play and Learn Basket Ball. Khel Sahitya Kendra.** NewDelhi.
6. Nat BB (1997). **Conditioning Coaches Association.** NBA Power Conditioning. Human Kinetics.
7. Sharma OP (2003). **Basket Ball Skills and Rules.** Khel Sahitya Kendra, Delhi.
8. https://assets.website-files.com/5d24fc966ad064837947a33b/5fbf0802c279828240ffa81f_CBOC%20-%20FIBAOfficialBasketballRules2020_v1.0.pdf

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

SEMESTER- 3

BSc-PE-DSE-1(4)-104.2 (DSE)

FUNDAMENTALS OF CRICKET

DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF CRICKET	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Cricket game with its practices and skill for better pedagogy and performance in Cricket.

Learning Outcomes:

1. The learner will attain basic knowledge of Cricket for different applications.
2. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Cricket.
3. The learner will be able to perform the marking/ drawing/ material organizing for Cricket.
4. The learner will be able to understand, analyze and interpret the fundamental methods and score
5. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Cricket).
6. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY Syllabus (30 hours)

Unit-1 Ground, marking and General Rules (8 hours)

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Umpire, Referee Signals, soft signals, fouls and misconduct penalty.
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Batting Skills (7 hours)

2.1 Block
2.2 Cut
2.3 Drive

2.4 Hook
2.5 Leg Glance
2.6 Paddle Sweep
2.7 Pull
2.8 Sweep
2.9 Reverse Sweep
2.10 Slog Sweep
2.11 Slog

Unit-3: Demonstrate (By part and whole) Fundamental Bowling Skills (8 hours)

3.1 Fast bowling
- 3.1.1 Seam Bowling
- 3.1.2 Swing Bowling
- 3.1.3 Bouncer, Beamer & Full toss
- 3.1.4 In dipper
- 3.1.5 In swinger
- 3.1.6 Leg Cutter
- 3.1.7 Off Cutter
- 3.1.8 Slow Ball
- 3.1.9 Reverse

3.2 Spin Bowling
- 3.2.1 Off-Spin
- 3.2.2 Leg-Spin
- 3.2.3 Chinaman
- 3.2.4 Doosra
- 3.2.5 Googles
- 3.2.6 Leg Break
- 3.2.7 Teesra
- 3.2.8 Arm Ball

Unit-4 Fundamental Wicket keeping & fielding Skills (7 hours)

4.1 Wicket keeping (Stumping, runout & caught behind)

4.2 Fielding skills
- 4.2.1 Catching grip Indian style and Australian style
- 4.2.2 High & Low catch
- 4.2.3 Dive

PARTB: Practical Syllabus (60 hours)

1. Court marking on paper and on the playfield as well.
2. General rules and their application and implementation in game situations.
3. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
4. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***"Physical education key learning for competitive exams".*** Iterative International Publishers.
2. https://www.cricketbio.com/cricket/fundamental-skills-cricket/ [date of access 30-05-2023]
3. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.
4. https://www.icc-cricket.com/about/cricket/rules-and-regulations/playing-conditions

[date of access 30-05-2023]
5. Jain.,R.(2005) *Play & Learn Cricket* Khel Sahitya Kendra
6. Rachna.,(2002) *Coaching Successfully Cricket* Sports Publications
7. Amarnath.,M.(1996) *Learn to Play Good Cricket* UBS Publishers Distributors Ltd.
8. Amonkar.,S.(2000) *Fundamentals of Cricket Technology* The Marine Sports
9. Thani.,V.(2003) *Cricket Skills & Rules* Khel Sahitya Kendra

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

SEMESTER- 3
BSc-PE-DSE-1(4)-104.3 (DSE)
FUNDAMENTALS OF KABADDI
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF KABADDI	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of kabaddi game with its practices and skill for better pedagogy and performance in kabaddi.

Learning Outcomes:

7. The learner will attain basic knowledge of Kabaddi for different applications.
8. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Kabaddi.
9. The learner will be able to perform the marking/ drawing/ material organizing for Kabaddi.
10. The learner will be able to understand, analyze and interpret the fundamental methods and score
11. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Kabaddi).
12. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Court, marking and General Rules **(8 hours)**

1.1 Court Layout (Mid line, Baulk line, Bonus line, Boundary line, Lobbies)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet (Scoring- Bonus, Lonna and all out points)

Unit-2: Demonstrate (By part and whole) Fundamental Offensive Skills **(8 hours)**

2.1 Hand Touch
2.2 Toe Touch

2.3 Side Kick
2.4 Back Kick
2.5 Mule Kick
2.6 Leg Thrust

Unit-3: Fundamental Defensive Skills **(7 hours)**

3.1 Ankle Hold
3.2 Thigh Hold
3.3 Knee Hold/Double Knee Hold
3.4 Waist/Back/Trunk Hold
3.5 Block Tackle
3.6 Wrist Hold

Unit-4 Different tests in Kabaddi **(7 hours)**

4.1 Johnson Kabaddi Test
4.2 Knox Kabaddi test
4.3 Harrision Kabaddi test

PART-B: PRACTICAL **(60 hours)**

5. Court marking on paper and on the playfield as well.
6. General rules and their application and implementation in game situations.
7. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
8. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Kumar, Dharmander. (2018). Kabaddi and It"s Playing Techniques. Writers Choice, New Delhi.
3. Mishra , S.C. (2007). Teach Yourself Kabaddi. Sports Publications, New Delhi.
4. Rao CV (1983). Kabaddi. Native Indian Sports. NSNIS. Patiala Publisher
5. Rao EP (1994). Modern Coaching in Kabaddi.D.V.S.Pub
6. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
7. Syal, M. (2004). Kabaddi Teaching. Prerna Parkashan, New Delhi.
8. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.
9.http://www.indiankabaddi.org/administrator/components/com_rules/rules/d2fa88d827bea5fc12073bf9db1f10fb-Rulebook-Downloadedon08Nov2017-19MB.pdf

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

SEMESTER- 3
BSc-PE-DSE-1(4)-104.5 (DSE)
FUNDAMENTALS OF HANDBALL
DSE

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical		
9.	**FUNDAMENTALS OF HANDBALL**	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Handball game with its practices and skill for better pedagogy and performance in Handball.

Learning Outcomes:

13. The learner will attain basic knowledge of Handball for different applications.
14. The learner will be able to gain knowledge and practices with respect to historical development, organizational structure and playfield technology of Handball.
15. The learner will be able to demonstrate the marking/ drawing/ material organizing for Handball.
16. The learner will be able to understand, analyze and interpret the fundamental methods and score.
17. The learner will be able to learn, demonstrate and acquire fundamental skills (offensive and defensive) of game/sports (Handball).
18. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY (30 hours)

Unit-1 Ground marking and General Rules (8 hours)

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Attacking Fundamental Skills (7 hours)

2.1 Attacker with the ball
2.1.1 Creating space
2.1.2 Passing & Catching

2.1.3 Faking
2.1.4 Shooting
2.1.5 Dribbling/ bouncing
2.2 Attacker without the ball
2.2.1 Receiving the ball
2.2.2 Available for teammate
2.2.3 Move without ball
2.2.4 Creating space

Unit-3: Demonstrate (By part and whole) Fundamental defensive Skills (7 hours)

3.1 Defending position
3.2 Intercepting the ball
3.3 Blocking

Unit-4 Different Offensive & Defensive skills of goal keeper (8 hours)

4.1 Offensive skills of goal keeper
4.1.1. Movement in the goal
4.1.2 Offensive posture, positioning
4.1.3 Passing to initiate fast break, attack, throws.
4.1.4 Execution of free throw, goalkeeper throw, throw-in.
4.2 Defensive skills of goal keeper
4.2.1. Defensive posture, positioning
4.2.2 Using hands, legs and torso for saves
4.2.3 Catching, deflecting and knocking down shots

PART- B Practical Syllabus (60 hours)

9. Court marking on paper and on the playfield as well.
10. General rules and their application and implementation in game situations.
11. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
12. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.
2. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
3. Bana, P., Späte, D., Lund, A., Strub, P., & Khalifa, A. (2011). Teaching Handball at school, Introduction to handball for students aged 5 to 11. International Handball Federation.
4. Buchheit, M. The 30-15 Intermittent Fitness Test: accuracy for individualizing interval training of young intermittent sport players. J Strength Cond. Res., 22: 365-374, 2008.
5. Bunker, B. & R. Thorpe. The curriculum model. Rethinking games teaching. R. Thorpe, Bunker, D., & Almond, L. Loughborough, University of Technology, Loughborough: 7-10, 1986.
6. Czerwinski, J., & Táborský, F. (1997). Basic Handball: Methods, Tactics, Technique. European Handball Federation.
7. Estriga, L. (2019). Teaching and learning handball: step-by-step. A teacher ‘s guide.
8. Hapkova, I. (2009). Handball does not always mean Handball. European Handball Federation. Lund, J., & Tannehill, D. (2010). Standards-based physical education curriculum development. Burlington, MA: Jones and Bartlett Publishers. Marczinka, Z. (2016). Playing Handball: A Comprehensive Study of the Game. Hungarian Handball Federation.

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

SEMESTER- 3
BSc-PE-DSE-1(4)-104.6 (DSE)
FUNDAMENTALS OF HOCKEY
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF HOCKEY	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Hockey game with its practices and skill for better pedagogy and performance in Hockey.

Learning Outcomes:

19. The learner will attain basic knowledge of Hockey for different applications.
20. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Hockey.
21. The learner will be able to perform the marking/ drawing/ material organizing for Hockey.
22. The learner will be able to understand, analyze and interpret the fundamental methods and score
23. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Hockey).
24. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Ground marking and General Rules **(8 hours)**

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Skills **(7 hours)**

2.1 Holding of stick
2.2 Ball carrying and elimination
    2.2.1 Running / rolling the ball
    2.2.2 Dribbling (Indian dribble)
    2.2.3 Jinking
2.3 Distribution
    2.3.1 Pushing
    2.3.2 Hit & Slap Hit
    2.3.3 Reverse Push and Reverse slide
2.5 Tomahawk and Overhead

Unit-3: Fundamental Receiving & Blocking Skills (8 hours)

3.1 Fore stick receive
3.2 Reverse stick receive
3.3 Receive with deception
3.4 Receive Arial balls
3.5 Tackling (Block & reverse block)
3.6 Penalty corner skills (Drag out & Trap)

Unit-4 Different tests in Hockey (7 hours)

4.1 SAI Hockey Skill Test
4.2 Harbans Singh Field Hockey Test
4.3 Fridel Field Hockey test

PART-B: PRACTICAL SYLLABUS (60 hours)

13. Court marking on paper and on the playfield as well.
14. General rules and their application and implementation in game situations.
15. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
16. Evaluation / testing of fundamental skills (performance analysis).

References:

9. International Hockey Federation (2003). ***Rules of the Game of Hockey with Guidance for Players and Umpires***. International Hockey Federation. India.
10. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
11. Pecknold, R. and Foeste, A. (2009). Hockey: Essential Skills. McGraw Hills,USA.
12. https://www.nios.ac.in/media/documents/Physical_Education_and_Yog_373/practical/15.pdf [access date 30-05-2023].
13. https://www.sportzyogi.com/friedel-field-hockey-test/[access date 30-05-2023].
14. https://fih.wildapricot.org/resources/Documents/Skills_of_hockey_tiers.pdf [access date 30-05-2023].
15. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.

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

SEMESTER- 3
BSc-PE-DSE-1(4)-104.4 (DSE)
FUNDAMENTALS OF KHO-KHO
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF KHO-KHO	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Kho-Kho game with its practices and skill for better pedagogy and performance in Kho-Kho.

Learning Outcomes:

25. The learner will attain basic knowledge of Kho-Kho for different applications.
26. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Handball.
27. The learner will be able to perform the marking/ drawing/ material organizing for Handball.
28. The learner will be able to understand, analyze and interpret the fundamental methods and score
29. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Handball).
30. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY (30 hours)

Unit-1 Ground marking and General Rules (8 hours)

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Chasing Fundamental Skills (7 hours)

2.1 Giving Kho
2.2 Sudden change
2.3. Turning round the post
2.4 Diving
2.5 Late Kho
2.6 Taking direction
2.7 Taping
2.8 Trapping
2.9

Unit-3: Demonstrate (By part and whole) Fundamental running Skills **(8 hours)**

3.1 Position on court
3.2 Running
3.3 Avoiding trapping
3.4 Positioning near the post

Unit-4 Tactical fundamental skills **(7 hours)**

4.1 Fake Kho
4.2 Dodging
4.2.1 Front dodge
4.2.2 Back dodge
4.2.3 Round the post dodge

PART-B: PRACTICAL **(60 hours)**

17. Court marking on paper and on the playfield as well.
18. General rules and their application and implementation in game situations.
19. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
20. Evaluation / testing of fundamental skills (performance analysis).

References:

16. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.
17. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
18. https://www.ultimatekhokho.com/static-assets/pdf/rules-season1.pdf [date of access 30-05-2023]
19. Kishore.,N.(2016) *How to Play Kho-Kho* Prerna Prakashan

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

REGISTRAR

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

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

3. Keywords

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

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

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. (2^{nd} 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* (2^{nd} 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 (8^{th} 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 (9^{th} ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
2. Coico, R. (2021). Immunology: A Short Course (8^{th} 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 (11^{th} ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

1. Sherwood, L. (2012). Introduction to Human Physiology (8^{th} ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
2. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6^{th} 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 (7^{th} 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 (4^{th} ed.), ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
- Michael R Green and J. Sambrook (2014) Molecular Cloning: A laboratory manual, (4^{th} 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. (2^{nd} 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* (2^{nd} 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 (8^{th} 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 (9^{th} ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
6. Coico, R. (2021). Immunology: A Short Course (8^{th} 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 (11^{th} ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

4. Sherwood, L. (2012). Introduction to Human Physiology (8^{th} ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
5. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6^{th} 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. 5thedition. 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. 3rdedition. 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 programming

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, 2^{nd} Edition, Prentice Hall (2010).
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, 4^{th} Edition, Pearson Education Inc (2010).
3. Khandpur R.S., Handbook of Biomedical Instrumentation, 2^{nd} 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, 1^{st} 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.

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

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