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, (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.

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.) Electronic Sciences

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, Randoin 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