UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/
Dated: 14.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 38-1/ (38-1-5) dated 08.12.2022]

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

DEPARTMENT OF BIOCHEMISTRY

Category-I

BSc. (Hons.) Biochemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: Enzymes

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Enzymes	04	02	0	02	Class XII passed with Biology	NIL

Learning Objectives

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

Learning outcomes

- Students will learn the nature and importance of enzymes in living systems

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

Unit I: Introduction to enzymes and features of catalysis **(6 Hours)**

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

Unit II: Enzyme kinetics and inhibition **(8 Hours)**

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

Unit III: Mechanism of action of enzymes and Regulation of enzyme activity **(8 Hours)**

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

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

Unit IV: Applications of enzymes **(08 Hours)**

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

2.3 Practical: 60 Hours

1. Assay to determine activity and specific activity of an enzyme.
2. Progress curve for an enzyme.
3. Partial purification of an enzyme using Ammonium sulfate fractionation.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of K_m and V_{max} of an enzyme using Lineweaver-Burk plot.
7. Calculation of inhibitory constant (Ki) for an enzyme.
8. Immobilization of enzyme using calcium alginate beads.

2.4 Essential readings:

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

Suggested reading:

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

2. Keyword

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

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

DISCIPLINE SPECIFIC CORE COURSE – 5

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Metabolism of Carbohydrates	04	02	0	02	Class XII passed with Biology	NIL

Learning Objectives

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

Learning outcomes

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

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

Unit 1 - Glycolysis and Gluconeogenesis **(12 Hours)**

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

Unit 2 - Fates of Pyruvate and Pentose phosphate pathway **(04 Hours)**

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

Unit 3 - Glycogen metabolism **(06 Hours)**

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

Unit 4 - Citric acid cycle **(08 Hours)**

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

2.3 Practical: 60 Hours

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

2.4 Essential readings

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

Suggested readings

Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

3. Keywords

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

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

DISCIPLINE SPECIFIC CORE COURSE – 6:

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Cell Biology	04	02	0	02	Class XII passed with Biology	NIL

Learning Objectives

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

Learning outcomes

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

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

Theory

Unit 1: Tools of cell biology **(04 Hours)**

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

Unit 2: Structure and Function of Cell Organelles **(12 Hours)**

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

Unit 3: Extracellular matrix and Cell Junctions **(06 Hours)**

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

Unit 4: Cytoskeletal proteins **(08 Hours)**

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

2.3 Practical: 60 Hours

1. Differentiate prokaryotic and eukaryotic cells and visualization of animal, plant cell, bacteria cells by light microscope .
2. Study of Mitosis and Identification of different stages of mitosis in onion root tip.
3. Study of Meiosis and Identification of different stages of meiosis in grasshopper testis.

4. Micrographs of different cell components (dry lab).
5. Cells as experimental models: Study life cycle of one animal model drosophila/ zebrafish/ nematode.
6. Cytochemical staining of any one biomolecule (Protein/Polysaccharide/RNA)

2.4 Essential readings:

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

Suggested readings:

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

3. Keywords:

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

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

Category-IV

Pool of Generic Electives (GE) Courses

Offered by Department of Biochemistry

GENERIC ELECTIVES (GE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Techniques in Biochemistry	04	02	0	02	Class XII passed with Biology	NIL

Learning Objectives

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

Learning outcomes

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

SYLLABUS OF GE-2

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

2.2 Course Contents

THEORY

Unit I: Separation techniques **(08 Hours)**

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

Unit II: Purification techniques **(08 Hours)**

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

Unit III: Electrophoretic techniques **(07 Hours)**

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

Unit IV: Spectroscopic techniques **(07 Hours)**

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

2.3 PRACTICALS – 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 (λ_{max}).
5. Calculate molar extinction coefficient of the given sample.
6. Demonstration of PAGE and Agarose gel electrophoresis.

2.4 Essential Readings

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

- Plummer, D. T. (1998). An Introduction to Practical Biochemistry (3rd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Suggested Readings

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

3. Keywords

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

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

GENERIC ELECTIVES (GE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Public Health Biology -	04	02	0	02	Class XII passed with Biology	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

- 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.

2.2 Course Contents

Theory

Unit 1: Understanding public health issues **(04 Hours)**

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

Unit 2: Public Health Nutrition **(10 Hours)**

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

Unit 3: Infectious biology and sanitation **(06 Hours)**

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

Unit 4: Environmental Health & Community Health **(10 Hours)**

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

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

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

2.3 Practical: 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.

2.4 Essential reading:

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

Suggested readings:

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

4. Waste Water Microbiology by D.H. Bergey. 2nd Edition. Medtech, India. 2019.

3. Keywords

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

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

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

GENERIC ELECTIVES (GE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Protein and Enzymes	04	02	0	02	Class XII passed with Biology	NIL

Learning Objectives

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

Learning outcomes

On successful completion of the course students will be:

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

2.2 Course Contents

THEORY

UNIT I: Introduction to proteins (08 Hours)

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

UNIT II: Three-dimensional structures and protein folding (07 Hours)

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

UNIT III: Introduction to enzymes and enzyme kinetics (08 Hours)

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

UNIT IV: Regulation of enzyme activity and applications of enzymes (07 Hours)

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

PRACTICALS - 60 Hours

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

2.3 Essential Readings

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

Suggested Readings

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

2. Keywords

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

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

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Food Science	04	02	0	02	Class XII pass	NIL

Learning Objectives

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

Learning outcomes

Students will learn about

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

2.2 Course Contents

Theory

Unit 1 –Basics of Food Science and Nutrition **(05 Hours)**

Definition of Food, Nutrition, Nutrient, Nutritional status

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

Balanced diet, fad diets

Unit 2– Macronutrients **(10 Hours)**

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

Unit 3 – Micronutrients **(10 Hours)**

Fat soluble vitamins: Sources, physiological importance and deficiency diseases

Water soluble vitamins: Sources, physiological importance and deficiency diseases

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

Unit 4 – Food and Health **(05 Hours)**

Food as medicine: medicinal value of functional foods such as garlic, ginger, turmeric, tulsi, fenugreek, ajwain, aloe vera, moringa, role of Gut microbiome in maintaining health, pre and probiotics, various types of food additives: emulsifiers, preservatives and food colors, benefits

and risks associated with these, food allergies, food spoilage, food poisoning, food borne diseases, Cholera, Hepatitis, Typhoid, Botulism

2.3 Practicals – 60 Hours

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

2.4 Essential readings:

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

Suggested readings:

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

2. Keywords:

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

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

Category I

BSc. (Hons.) Electronics

DISCIPLINE SPECIFIC CORE COURSE-4 (DSC-4) – : Basic Instrumentation and Measurement Techniques

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Instrumentation and Measurement Techniques	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of this subject is to provide insight into electronic instruments being used in the industries and labs. It details the basic working and use of different instruments used for measuring various physical quantities. Also, it details the identification, classification, construction, working principle and applications of various transducers used for displacement, temperature, pressure and intensity measurement.

Learning outcomes

After completion of the course, students will be able to-

Describe the working principle of different measuring instruments.

Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.

Understand the significance of different measuring instruments including oscilloscopes.

SYLLABUS OF DSC-4

UNIT – I Fundamentals of Electronic Measurements (12 Hours)

Qualities of Measurement: SI system of units. Specifications of instruments, their static and dynamic characteristics. Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis.

Basic Measurement Instruments: PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, ohm meter, AC measurement (rectifier type, electro dynamo meter), Watt meter. Digital voltmeter systems (integrating and non-integrating types), digital multimeter,

Connectors and Probes: low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.

UNIT – II Impedance Measurement and Power Supplies (12 Hours)

Measurement of Resistance and Impedance: Low Resistance: Kelvin's bridge method, Medium Resistance by Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Anderson's bridge, Measurement of Capacitance, De Sauty's bridge, Measurement of frequency, Wien's bridge.

Regulated Power Supplies: Power Supply characteristics, Fixed power supply (78XX based), Dual power supplies (78XX and 79XX based), Variable power supply (LM317 based), current limiting, short-circuit shut down. Introduction of switch mode power supply (SMPS)

UNIT – III Oscilloscopes and Signal Generators (12 Hours)

Electronic Displays: The Cathode Ray Oscilloscope (CRO): Block diagram of a General Purpose Oscilloscope and its basic operation. Measurement of voltage, frequency and phase by oscilloscope. Oscilloscope probes. Sampling Oscilloscope. Digital storage oscilloscope (DSO), advantages and applications, Oscilloscope specifications (bandwidth, sensitivity, rise time).

Signal Generators: Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generators.

UNIT – IV Transducers and Sensors (09 Hours)

Transducers and sensors: Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area, air gap and permittivity Type), Inductive (LVDT) and piezoelectric transducers. Measurement of displacement, Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

Practical component (if any) – Basic Instrumentation and Measurement Techniques Lab – 30 Hours

1. Design of ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge.
3. Measurement of Capacitance by De Sauty's bridge.
4. Measurement of Inductance by Anderson's bridge.
5. To determine the characteristics of resistance transducer - Strain Gauge.
6. To determine the characteristics of an LVDT.
7. To study the variations of thermo-emf of a thermocouple. (Type J/Type K)
8. To study the I-V characteristics of Solar Cell.
9. To study the Characteristics of LDR, Photodiode
   (i) Variable Illumination (ii) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor.

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

Essential/recommended readings

1. H. S. Kalsi, Electronic Instrumentation, 3rd Edition, Tata Mcgraw Hill, (2006).
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
3. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, 3rd Edition, Pearson Education (2005).
4. David A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford University Press (2013).
5. R. A. Witte, Electronic Test Instruments, Analog and Digital Measurements, 2nd Edition, Pearson Education (2004).
6. A. K. Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpatrai and Sons (2007).

   K. Lal Kishore, Electronic Measurements and Instrumentation, 1st edition, Pearson Education India (2009).

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Digital Electronics

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		
Digital Electronics	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To represent information in various number systems.
- To convert data from one number system to another and do various arithmetic operations.
- To analyze logic systems and to implement optimized combinational circuits using Karnaugh Map.
- To analyze and implement sequential circuits using state machines.
- To analyze various memories and programmable logic devices.
- To analyze and understand the working of data converters.

Learning outcomes

After completion of the course, students will be able to-

Understand the concept of the number system with emphasis on binary numbers, its algebra and minimization techniques.

Understand basic logic gates, concepts of Boolean algebra and techniques to reduce/simplify Boolean expressions.

Analyze and design combinational as well as sequential circuits.

Understand the concepts related to Memories and PLD's.

Understand the working of analog to digital converters, digital to analog converters.

SYLLABUS OF DSC- 5

UNIT – I Introduction to Digital Electronics (09 Hours)

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, Octal and Hexadecimal arithmetic, Addition, subtraction by Complements (1's and 2's) method, Binary Multiplication by computer method, Signed

numbers, Binary Codes (BCD, 84-2-1, excess-3, Gray) BCD addition, Error detecting/correcting code (Parity, Hamming).
Logic Gates and Boolean Algebra: Truth table and symbolic representation of logic gates and their implementation using Universal gates, Basic postulates and fundamental theorems of Boolean algebra.

UNIT – II Combinational Circuit Design (12 Hours)
Canonical and Standard forms, Standard representation of logic functions (SOP and POS), Simplification of Boolean functions (up to 5 variables) using (i) Kmap (ii) Tabulation method, Binary Adder, Binary subtractor, parallel adder/subtractor, BCD adder, Code convertors.
Encoder, Decoder, Multiplexer, Demultiplexer, Implementing logic functions with Decoder and multiplexer.

UNIT – III Sequential Circuits (12 Hours)
Sequential logic design: Latches and Flip flops, S-R, D, J-K, master slave, T Flip flops and their characteristic equation, Clocked and edge triggered Flip flops, conversion between flip flops, Shift Registers, Universal Shift register, Bidirectional Shift Register, Ring counter and Johnson counter, Counters (synchronous, asynchronous and modulo-N) and their timing sequence.
Synchronous Sequential circuit synthesis: State Tables, State Transition Diagrams, minimization, state assignments, realization with T, D and JK flip flops, Finite state machine- Mealy and Moore model

UNIT – IV Signal Conversion, Memories and Logic Families (12 Hours)
A-D and D-A Conversion: 4 bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all).
Memories: ROM, PROM, EPROM, EEPROM, Bipolar RAM, static and dynamic RAM, Memory Expansion (Word size and Word Capacity).
Programmable Logic Devices: Combinational circuit Implementation using PROM, PLA and PAL.
Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison

Practical component (if any) - Digital Electronics Lab *(Hardware and Circuit Simulation Software)* – 30 Hours

1. To verify and design AND, OR, NOT, XOR and XNOR gates using NAND gates.
2. To convert a Boolean expression into a logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.

6. Implement a Boolean function using 4 X 1 multiplexer.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type, JK, JK Master slave).
8. Design a SISO, SIPO shift register.
9. Design an asynchronous/ synchronous Up/Down counter using D/T/JK Flip-Flop.
10. Design a non sequential counter using D/T/JK Flip flop.
11. Design a R-2R DAC.
12. Design an ADC circuit using ADC0804.

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

Essential/recommended readings

1. M. Morris Mano, "Digital System Design," Pearson Education Asia.
2. Thomas L., "Flyod, Digital Fundamentals," Pearson Education Asia.
3. W. H. Gothmann, "Digital Electronics: An Introduction To Theory And Practice," Prentice Hall of India.
4. Millman & Grabel, "Microelectronics," Tata McGraw Hill.
5. Donald D. Givone, " Digital Principles and Design," Tata McGraw- Hill.
6. R. P. Jain, "Modern digital Electronics," Tata McGraw- Hill.

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

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Analog Electronics-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		
Analog Electronics-I	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand diodes (pn diode and Zener diode) and its applications in clipping and clamping circuits, rectifiers and voltage regulation (using Zener diodes) and concept of Power Supply.
- Understand frequency response of BJT and MOSFET amplifiers.
- Understand the concept of feedback and design feedback amplifiers and oscillators.
- Understand different power amplifiers and single tuned amplifiers.

Learning outcomes

After completion of the course, students will be able to-
Illustrate about rectifiers, transistor and MOSFET amplifiers and its biasing. Also compare the performances of its low frequency models.
Describe the frequency response of MOSFET and BJT amplifiers.
Explain the concepts of feedback and construct feedback amplifiers and oscillators.
Summarizes the performance parameters of amplifiers with and without feedback

SYLLABUS OF DSC-6

UNIT – I Diode applications (09 Hours)

Diode Circuits: Ideal diode, piecewise linear equivalent circuit, dc load line, static and dynamic resistance, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, Voltage doubler

Filters: Circuit diagram and explanation of shunt capacitor filter with waveforms.

Voltage Regulator: Zener diode regulator circuit diagram and explanation for load and line regulation

UNIT – II BJT based Amplifiers and Oscillator (12 Hours)

Transistor: Input and Output Characteristics, Concept of Biasing and its significance, Concept of DC and AC analysis. Overview of Common Emitter BJT amplifier, Concept of Darlington pair

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers (Class A, Class B, Class AB, Class C, Class D), Concept of Class A single ended power amplifier, Transformer coupled Class A power amplifier and complementary symmetry Class B push pull power amplifier, overall efficiency, concept of crossover distortion, harmonic distortion and heat sinks.

Feedback Amplifiers: Concept of feedback, negative and positive feedback, voltage (series and shunt), feedback amplifiers gain, input and output impedances. Barkhausen criterion for oscillations, RC phase shift oscillator

UNIT – III MOSFET Fundamentals (12 Hours)

MOSFET: Operation of n-channel and p-channel MOSFETs, Overview of Depletion and Enhancement MOSFET, Transfer Characteristics, Drain Characteristics, MOSFET as a switch. short channel effects, non-ideal effects in MOS transistors: the finite output resistance in the saturation region, the body effect, subthreshold conduction, breakdown effects, and temperature effects.

MOSFET DC analysis: Biasing circuits- drain feedback, voltage divider, source feedback, bias stability, Graphical analysis, load line.

UNIT – IV MOSFET based Amplifiers (12 Hours)

MOSFET AC analysis: AC equivalent circuit of MOSFET, MOSFET parameters,

MOSFET Amplifiers: circuit and small signal model of Common Source amplifier, small signal parameters: input resistance, output resistance and voltage gain, circuits of Common Drain and Common Gate configurations. Comparison of BJT based (CE, CB and CC) and MOSFET based (CS, CD, CG) - Qualitative only.

Multistage MOSFET circuits: Cascaded circuits and Cascode circuits, effect of multistage circuits on gain and bandwidth.

MOSFET Application circuits: CMOS as inverter circuit, depletion mode n-MOSFET and p-MOSFET as load device

Practical component (if any) - Analog Electronics-I Lab – 30 Hours

(Hardware and Circuit Simulation Software)

1. Study of the half wave or full wave rectifier
2. Study of Zener diode as voltage regulator.
3. Study of any two types of
   (a) clipping circuits
   (b) clamping circuits.
4. Study of a Single Stage CE amplifier.
5. Study of Class A or Class B Power Amplifiers.
6. Study of Voltage divider bias for MOSFET
7. Study of the frequency response of Common Source MOSFET amplifier.
8. Study of MOSFET based Phase Shift Oscillator

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. Electronic Devices and circuit theory, Robert Boylestad and Louis Nashelsky, 9th Edition, 2013, PHI
2. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)
3. Electronic devices, David A Bell, Reston Publishing Company
4. Giovanni Saggio, Principles of Analog Electronics, CRC Press (2014)
5. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
6. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
7. J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw

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

Category I

BSc. (Hons.) Instrumentation

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Fundamentals of Digital Circuits

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Digital Circuits	4	3	0	1	Class XII pass with Science	Nil

Learning Objectives

- To impart the knowledge of Number systems and codes.
- To familiarize with concepts of Boolean algebra, logic gates.
- To minimise and design various combinational logic circuits.
- To develop the basic understanding of flip flops and use them to design sequential circuits.
- To differentiate between various digital logic families.

Learning outcomes

At the end of this course, students will be able to

Learn various number systems, binary codes and concepts of Boolean algebra.
Apply the knowledge of Boolean algebra to solve real time problems and determine how to interconnect logic gates to convert the circuit input signals to desired output signals.
Analyse the combinational and sequential circuits using flip flops and show how they can be used for designing various types of digital circuits used for processing and transmission of data.
Compare various digital logic families with respect to their speed, power consumption and cost

SYLLABUS OF DSC-4

Unit-1 **(09 Hours)**

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems,

base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code, gray code, excess-3 code.

Unit-2 **(12 Hours)**

Boolean algebra and Logic Gates: Introduction to Boolean Algebra and Boolean operators, Basic postulates and fundamental theorems of Boolean algebra, construction, and symbolic representation of OR, AND, NOT, XOR, XNOR Gate, Truth Tables, Universal (NOR and NAND) gates.

Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison.

Unit-3 **(12 Hours)**

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor.

Unit-4 **(12 Hours)**

Sequential logic design: Latches and Flip-flops, S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave Flip flop, Registers, Counters (synchronous and asynchronous and modulo-N), State Table, State Diagrams, counter design using excitation table and equations, Ring counter and Johnson counter.

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA

Practical component (if any) – Fundamentals of Digital Circuits Lab – 30 Hours

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate ICs.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a Seven Segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. Design a 2 X 4 Decoder using gates.
8. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
9. Design a counter using D/T/JK Flip-Flop.
10. Design a shift register and study Serial and parallel shifting of data.

Essential/recommended readings

1. M. Morris Mano, Digital Logic & Computer Design, Pearson Education Asia (2016)

2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Limited, 11th Edition, Global Edition (2015)
3. Kumar A. Anand, Fundamentals of Digital Circuits, 3rd Edition (2014), PHI Learning Private Ltd.
4. R. J. Tocci, Neal.SWindmer, Gregory L Moss, Digital Systems, Principles and Applications, 10th Edition, Pearson (2009)

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

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Sensors and Actuators

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		
Sensors and Actuators	4	2	0	2	Class XII pass with Science	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study different types of transducers – resistive, capacitive, inductive, light and temperature
- Be conversant in construction and working of various pressure and flow measuring instruments
- Get an exposure to actuators, micro actuators, and their different types

Learning outcomes

At the end of this course, students will be able to

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, light, capacitance and inductance

Be conversant in construction and working of various pressure and flow measurement devices used for industrial purposes

Classify and explain the different types of actuators
To study various processing techniques of micro actuators

SYLLABUS

Unit 1 **(7 Hours)**

Classification of transducers: Active, Passive, Mechanical, Electrical and their comparison. Selection of Transducers, Principle and working of following types: Resistive (Strain Gauge), Capacitive, Inductive (LVDT), Piezoelectric, light (photo-conductive, photovoltaic, LDR), Temperature (RTD, Thermocouple, Thermistor)

Unit 2 **(7 Hours)**

Sensors in nature (Vision, Hearing, touch, and smell) and how we can learn from nature. Principles of Sensing, Classification and Terminology of Sensors, Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Biomedical sensor, Mechanical Sensors, Acoustic sensors, Magnetic Sensors, Radiation detector (Gas-filled & Scintillation detectors), Chemical and Biosensors, Proximity sensor, Flow Sensor, Level Sensor.

Unit 3 **(8 Hours)**

Actuators: Definition, types and selection of Actuators; linear; rotary; Electrical actuators: Electric motors, DC servomotors, AC motors, Stepper motors, Solenoids, Hydraulic actuators - Control valves, Construction, Characteristics and Types - Directional Control valves, Pressure control valves, proportional control valves and Process control valves.

Unit 4 **(8 Hours)**

Micro Actuators: Actuation principle, Types of micro actuators- Electrostatic, Magnetic and Fluidic, Inverse piezo effect. Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials. Processing techniques: Vacuum deposition, sputtering, chemical vapor deposition and photolithography.

Practical component (if any) - Sensors and Actuators Lab – 60 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. Measurement of flow rate using electromagnetic flow meter.
7. Measurement of flow rate measurement using orifice plate flow meter.
8. System identification of any one of the actuators

(a) Electrical Actuator
(b) Electromechanical Actuator
(c) Electromagnetic Actuator
(d) Hydraulic and Pneumatic Actuator

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

Essential/recommended readings

1. Nakra& Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd edition.
2. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition.
3. H.S Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition.
4. DVS Murthy, Measurement & Instrumentation, PHI, 2nd edition.
5. D. Patranabis, Sensors and Transducers, PHI, 2nd edition.
6. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, Dhanpat Rai& Co.
7. Mechanical and Industrial Measurements, 3rd Edition, Tenth Edition (1996), R.K. Jain, Khanna Publishers.
8. Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics, Design and Applications", Taylor & Francis Group, 2006.
9. Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, Mumbai
10. Robert H. Bishop, "Mechatronic systems, Sensors and Actuators Fundamentals and Modeling, Taylor & Francis Group, 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– 6 (DSC-6): Electronic Instrumentation

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Instrumentation INDSC2C	4	3	0	1	Class XII pass with Science	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study different AC and DC measurement instruments used in laboratory like ohmmeter, voltmeter, ammeter and multimeter
- To learn about different measuring instruments–Universal counter, Cathode Ray Oscilloscope and Signal Generator
- To study about different spectrum analyzers and learn about basic concept of wave analyzers

Learning outcomes

The Learning Outcomes of this course are as follows:

Designing of different AC and DC bridges and their applications
Construction of different measuring devices-Ammeter, Voltmeter, Ohmmeter and Digital Frequency Meter
Develop an understanding of construction and working of different measuring instruments-Signal Generators and CRO for appropriate measurement
Understand the concepts of Spectrum Analyzer and Wave analyzers

SYLLABUS OF DSC-6

Unit-1 **(12 Hours)**

DC and AC Bridges based measurements: Wheatstone bridge, Kelvin bridge, General form of AC bridge balance, comparison bridges, Maxwell's bridge, Hay bridge, Schering bridge, Wien bridge, Wagner ground connection

DC and AC indicating instruments: DC voltmeter, ammeter, ohmmeters, multimeter,

AC voltmeter, Digital type voltmeters

Unit-2 **(12 Hours)**

Digital frequency meter: Elements of frequency meter, Universal counter and its different measurement modes, measurement errors and frequency range extension

Signal Generators: Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generator, Sweep generator

Unit-3 **(12 Hours)**

Electronic Displays: Block diagram of a General-Purpose Cathode Ray Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections

Types of CROs and measurement of frequency and phase: Dual trace oscilloscope, Digital storage oscilloscope (DSO), Sampling oscilloscope, Lissajous figures

Unit-4 **(09 Hours)**

Spectrum and Wave Analyzers: Spectrum analyzer, Harmonic distortion analyzer, Wave analyzer **Q- Measurement:** Q-meter connections for low and high impedance measurements and errors

Practical component (if any) - Electronic Instrumentation Lab – 30 Hours

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO
2. Study the generation of Lissajous figures to find unknown frequency and phase shift
3. Measurements of Resistance Using Wheatstone/Kelvin Bridge
4. Measurements of Inductance Using Maxwell's Bridge/Inductance Comparison Bridge
5. Measurements of capacitance Using Capacitance Comparison Bridge/De Sauty's Bridge
6. Frequency measurement using Wein's Bridge
7. Study of R, L, C and Q meter
8. Study of Universal Counter
9. To study Loop tests for ground faults
10. To generate different signal waveforms

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. H.S. Kalsi, Electronic Instrumentation and Measurements, Tata McGraw Hill (2019), 4th edition.

2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education
3. (2005).
4. C.S. Rangan, G.R. Sarma and V.S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill(1998).
5. H. Cooper, Modern electronic instrumentation and measurement techniques, Pearson Education (2015).
6. R.A. Witte, Electronic test instruments: Analog and digital measurements, Tata Mc Graw Hill (2004).
7. S. Wolf and R.F.M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004).
8. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall of India, 2nd edition
9. U.A. Bakshi and A.V. Bakshi, Electronic Measurements and Instrumentation, Technical Publications

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

Category-IV

Pool of Generic Electives offered by Department of Electronic Science

GENERIC ELECTIVES (GE-2A): **Digital System Design**

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Digital System Design	4	3	0	1	Class 12th Pass with PCM or Physics, Comp. Sc. & Maths.	Nil	Electronic Science

Learning Objectives

In addition to familiarization with the combinational and sequential circuits, students will be adept in using simulation of digital circuits on software, which is in high demand, for designing combinational or sequential circuits. As there are lot of industrial and research-based job opening in the area, the course offers a hands-on in designing digital systems on hardware and testing with a holistic approach to the subject, making students ready for the industry or research

Learning outcomes

After completion of the course, students will be able to-

Understand and represent numbers in powers of base and concepts of Boolean algebra.
Understand basic logic gates and minimization techniques.
Analyze and design combinatorial circuits.
Analyze and design sequential circuits.

SYLLABUS

UNIT – I Number Systems and Boolean Algebra (09 Hours)

Number System and Boolean algebra: Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1's and 2's), Signed and unsigned numbers, addition and subtraction, Gray Code. Boolean algebra- Positive and negative logic. Boolean laws, De Morgan's theorems, simplification of Boolean expressions-SOP and POS

UNIT – II Logic Gates and Minimization (12 Hours)

Logic gates and Karnaugh map: Logic gates- basic logic gates-AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map minimization of 3 and 4 variable functions/expressions.

UNIT – III Combinational Circuits (12 Hours)

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full), Subtractor (half and full), Parallel adder/subtractor, Encoder and Decoder, Understanding VHDL program of a Full Adder and 3 to 8 decoder

UNIT – IV Flip Flops and Counters (12 Hours)

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (synchronous and asynchronous, ring and Johnson)

Practical component (if any) - Digital System Design Lab – 30 Hours

(Hardware and Circuit Simulation Software)

To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. Design a Half and Full Adder.
3. Design a Half and Full Subtractor.
4. Implement Boolean functions using 8X1 and 16X1 Multiplexers.
5. Implement Boolean functions using decoder.
6. Implement an encoder.
7. Study of counters using dedicated counter ICs.
8. Study of registers (SISO, SIPO, PISO and PIPO) using universal shift register IC.

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. M. Morris Mano Digital System Design,Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum_s Outline Series, Tata McGraw- Hill (1994)

GENERIC ELECTIVES (GE-2B): Data Visualization 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	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Data Visualization Techniques	4	3	0	1	Class XII Passed with Maths	Basic Knowledge of Python Programming Language	Electronic Science

Learning Objectives

This course is all about data visualization, the art and science of turning data into readable graphics. It enables the students to design and create data visualizations based on data available and tasks to be achieved. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding. Students will create their own data visualizations, and learn to use Open-Source data visualization tools.

Learning outcomes

After completion of the course, students will be able to-

Design and create data visualizations.
Conduct exploratory data analysis using visualization.
Craft visual presentations of data for effective communication.
Use knowledge of perception and cognition to evaluate visualization design alternatives.
Design and evaluate color palettes for visualization based on principles of perception.
Apply data transformations such as aggregation and filtering for visualization.
Identify opportunities for application of data visualization in various domains.

Tools Required: Open-source Visualization tools, Python, Plotly, Tableau

SYLLABUS

UNIT – I Understanding Data Visualization (09 Hours)

Introduction to Data Visualization, Various tools for Data Visualization. Introduction to Numpy, Pandas and Matplotlib. Structured & Semi-structured Dataset, Data Cleaning and Preparation. Handling Missing Data, Data Transformation. Basic Plotting with Matplotlib, Dataset on Immigration e.g. Canada (source: https://open.canada.ca)/ any other. Univariate and Multivariate Visualization. Introduction to cloud computing.

UNIT – II Data Visualization Techniques (12 Hours)

Data Visualizations Techniques: Line Plots, Area Plots, Histograms, Bar Charts, Pie Charts, Box Plots, Scatter Plots, Bubble Plots, Waffle Charts, Word Clouds, Seaborn and Regression Plots, Creating Maps and Visualizing Geospatial Data - Introduction to Folium, Maps with Markers, Choropleth Maps.

UNIT – III Creating Dashboards with Plotly (12 Hours)

Introduction to Seaborn, Basic plotting with Seaborn. Introduction to Plotly. Scatter chart, Bubble Plot, Pie chart, Gantt chart, Contour plotting, Sunburst and Polar charts, Heatmaps.

UNIT – IV Data Visualization using Tableau (12 Hours)

Introduction to Tableau Desktop, connecting to dataset, Data preparation, Filtering and sorting data, Creating basic chart types (bar charts, line charts etc.), Assembling a dashboard layout, Using dashboard filters, Transform the data, Simple calculations in Tableau, Creating advanced chart types. Introduction to Data Story.

Practical component (if any) - Data Visualization Techniques Lab – 30 Hours

(Perform practical on Dataset available at Kaggle / Github / UCI Machine Learning Repository)

1. Visualization of Spreadsheet Models.
2. Visualization of Semi-Structured Data.
3. Interactive Plots in Python and Tableau.
4. Hierarchical and Topographical Data Visualizations in Tableau.
5. Calendar Heatmaps and Flow Data Visualizations in Python.
6. Time Series Data Visualization in Plotly.
7. Creating cloud account Amazon/Azure/Google/IBM to store images /files / programs.
8. Use a dataset that contains immigration details e.g. Canada for a given duration of 30 years (Canada Immigration Dataset, source: https://open.canada.ca) or any other
    a. Create an area plot for top 6 immigrant countries in a given duration.
    b. Create and year-wise immigrant bar chart from India to Canada in a given duration.
    c. Create a boxplot of immigrants for three given countries.

d. Show the total no. of immigrants using Area Chart and Pie chart for two given countries.
e. Create a scatter Histogram for the immigrants in the given year for two specific countries.

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. Data Visualization with Python for Beginners: Visualize Your Data using Pandas, Matplotlib and Seaborn by AI Publishing. ISBN: 1733042680-978
2. Learn and Practice Data Visualization using Python by Swapnil Saurav, Eka Publishers. ISBN: 8194633426-978
3. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: -978 9352134915
4. Data Visualization with Tableau by Praveen Kumar, Gurucool Publishing. ISBN: 8194746997-978
5. Interactive Dashboards and Data Apps with Plotly and Dash by Elias Dabbas, Packt Publishing Limited. ISBN: 1800568914-978

Suggestive readings -

1. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 9352134915-978
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.

Pool of Generic Electives (GE) offered by Department of Electronic Sciences in Instrumentation

Category-IV

GENERIC ELECTIVES (GE-2A): **MATLAB and its Applications**

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
MATLAB and its Applications	4	2	0	2	None	None	Electronic Science

Learning Objectives

- To learn to interact and perform the computations on MATLAB
- To plot the functions using various types of plot command
- To understand the difference between the functions & Scripts in MATLAB
- To familiarize with the fundamentals of digital image and signal processing

Learning outcomes

After completion of the course, students will be able to-

Interact with MATLAB for various computations
Generate plots and its use in reports
Familiar with inbuilt MATLAB functions and will be able to create user defined Functions and write scripts for various applications
Understands fundamental of digital image and signal processing

SYLLABUS

Unit-1 **(06 Hours)**

Introduction to MATLAB: MATLAB features, MATLAB Windows, defining variables, formatting output, types of operators, different operations on variables, checking existence, clear
Operations, data type, precedence.

Unit-2 **(08 Hours)**

Introduction to Arrays: Defining scalars, vectors, matrix, multi-dimensional arrays, different Operations (mathematical, logical, and relational) on array, reshaping matrices, importing & exporting of data.

Character and Strings: Defining character and string, accessing character or substring from string, string concatenation and comparing, conversion between strings and number. Defining and working with cell arrays.

Data Plotting: Graph, plot, types of plot, multiple plots, labeling graph, line colors, style and Marker.

Unit-3 **(08 Hours)**

Script and Function M File: M-file, writing script files, writing functions, error correction, saving files. Flow control statement: Conditional or selection, error handling, loop control, program termination.

Unit-4 **(08 Hours)**

Signal Processing: Generation of continuous time & discrete time signal, time shift, time scaling, amplitude scaling of signal. Generation of amplitude modulated signal, frequency modulated signal Image processing: Study of basic tools of Image Processing, Image segmentation, restoration, histogram processing, changing color of image.

Practical component (if any) - MATLAB and its Applications Lab- 60 Hours

1. Define variables, create a matrix of any size with all possible methods and perform various mathematical operations.
2. Create a multidimensional array and delete any Row/Column from it and create a new array.
3. Plot and label all the trigonometric functions using the subplot command.
4. Generate various kinds of continuous and discrete time signals. Plot them with different color, line style and markers and label the graph.
5. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.
6. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
7. Define a string and count the number of vowels, spaces and consonants in it. Also mention the size and length of the string.
8. Write a script to remove (i) all the alphabets from the alphanumeric string, (ii) all the spaces from a string.

9. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
10. Generate the (i) AP, (ii) GP and (iii) Fibonacci series.
11. Write a script to test whether a user defined no. is Prime or not.
12. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by the user.
13. Write a script to generate the amplitude and frequency modulated signal.
14. Create a function to change the colors of user defined images.

Essential/recommended readings

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, PHI Learning, New Delhi.
2. Mathews, J.H. and K.D. Fink, Numerical Methods Using MATLAB - Third Edition, Prentice Hall, Upper Saddle River, New Jersey.
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, Ellis- Horwood.
4. Van Loan, C.F., Introduction to Scientific Computing - A Matrix-Vector Approach Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
5. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey

GENERIC ELECTIVES (GE-2B): **Sensors and its Applications**

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Sensors and its Applications	**4**	**3**	**0**	**1**	**Class XII pass with Science**	**Nil**

Learning Objectives

- To understand the operation of commonly used sensors and actuators.
- To be able to analyze and select most appropriate sensors or actuators for an application.
- To analyze characteristics of sensors and actuators by knowing their basic laws and processes.

Learning outcomes

After completion of the course, students will be able to-

Identify and comprehend various sensors used in the real-life applications and paraphrase their importance.

Classify and explain with examples the utilization of sensors for measurement of temperature, strain, motion, position and light in the industry.

Understand the role of sensors and actuators to make sensitive measurements of physical parameters like pressure, flow, acceleration, velocity etc.

SYLLABUS

Unit 1 **(12 Hours)**

Mechanical and Electromechanical sensor: Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, Applications of electromechanical sensor: Human motion monitoring, Human health monitoring, Speech recognition, Human-machine interface

Unit 2 **(12 Hours)**

Transducers: Classification, Active and Passive. Principle, working and applications of following types: Resistive (Strain Gauge): Theory, type, materials, design consideration, sensitivity, gauge factor, Capacitive, Inductive (LVDT), Piezoelectric, Light (LDR), Temperature (RTD, Thermocouple, Thermistor). Magneto strictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type.

Unit 3 **(12 Hours)**

Flow meters, mechanical type: theory of variable head type flow meters-orifice plate, venturi tube, flow nozzle, Positive displacement flow meters. Rota meter: thermal mass flow meter, Principle and constructional details of electromagnetic flow meter, different types of ultrasonic flow meters.

Unit 4 **(9 Hours)**

Tachometers: Mechanical, Electric, Contact less, Frequency, Stroboscopic tachometers, Manometers: different types – elastic type pressure gauges, Bourdon type bellows, diaphragms.

Practical component (if any) - Sensors and its Applications Lab- 30 Hours

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of displacement using LVDT.
3. Measurement using load cells.
4. Measurement using capacitive transducer.
5. Measurement using inductive transducer.
6. Measurement of temperature using Temperature Sensors.
7. Characteristics of Hall effect sensor.

8. Measuring change in resistance using LDR
9. Discharge coefficient of orifice plate.
10. Measurement of flow using E.M. flow meter.
11. Measurement of flow using Ultrasonic flow meter.

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. A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai& Co, 12th edition, 2001.
2. R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996, 11th edition.
3. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition, 2012
4. Nakra& Choudhary, Instrumentation measurements and analysis, Tata McGraw Hill, 2nd edition, Revised 2016-2017

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

DEPARTMENT OF MICROBIOLOGY

Category-I

BSc. (HONS.) MICROBIOLOGY

DISCIPLINE SPECIFIC CORE COURSE – 4: Bacterial Diversity and Systematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is for students to acquire in-depth knowledge of bacterial cell structure and organization, cultivation methods and growth patterns, and reproduction.
- Further, the student gains insights into the vastness of bacterial diversity and its significance

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to classify bacteria based on their modes of nutrition and describe the diverse physiological types of bacteria as determined by variable environmental factors.
- Student will be able to describe the fundamental concepts and terminology of taxonomic organization and parameters used in classifying bacteria. Gain knowledge about the molecular analytic approaches used to classify diverse bacteria. Learn about the use of rRNA analysis as a means of developing phylogenetic relationships.

- Student will be able to explain the major groups of archaea, their stand-out physiological and structural features, as well as their ecological niches and economic significance.
- Student will be able to have discourse on the major groups of eubacteria, including bacteria with special features such as mycoplasma, rickettsia, chlamydia and spirochetes.
- Student will be able to enumerate bacteria by serial dilution and distinguish between different types of bacteria using various media.
- Student will be able to analyze bacteria microscopically using various staining methods.

SYLLABUS OF DSC-4

UNIT – I (3 Hours)

Bacterial diversity based on nutritional and physiological factors: Classification of bacteria based on nutrition: lithotrophs, organotrophs, phototrophs, chemotrophs. Diversity based on physiological factors: solutes, pH, temperature, oxygen, pressure, radiation.

UNIT – II (12 Hours)

Bacterial systematics: Definitions: Concepts of systematics, taxonomy, taxa, species, strains. Conventional and modern approaches to classification: Phenetic, phylogenetic, genotypic classification, evolutionary chronometers, rRNA oligonucleotide sequencing (ribotyping) and signature sequences, nucleic acid hybridization, genomic fingerprinting, MLSA, RFLP to study polyphasic bacterial taxonomy, FAME analysis

UNIT – III (12 Hours)

Diversity of Archaea: General characteristics with reference to genera belonging to Crenarchaeota (*Sulfolobus*) and Euryarchaeota: Methanogens (*Methanobacterium)*, thermophiles (*Pyrococcus)*, acidophiles (*Picrophilus*) and halophiles (*Halobacterium*). Key features of other groups: Thaumarchaeota, Lokiarchaeota, Nanoarchaeota

UNIT – IV (18 Hours)

Diversity of Eubacteria: Key features and significance of the following genera: Deeply Branching Bacteria**:** *Thermotoga, Deinococcus.* Proteobacteria: Classes and Types. Alphaproteobacteria: *Rhizobium, Ricketssia.* Betaproteobacteria: *Neisseria, Thiobacillus.* Gammaproteobacteria: *Escherichia, Yersinia.* Deltaproteobacteria: *Myxococcus* and *Bdellovibrio.* Epsilonproteobacteria: *Campylobacter, Helicobacter.* Zetaproteobacteria: *Mariprofundus ferrooxydans.* Non-Proteobacteria: Chlamydia, Spirochaetes. Gram Positive bacteria having genomes of low GC content: Firmicutes *Clostridium, Bacillus.* Tenericute

Mycoplasma. Gram Positive bacteria having genomes of high GC content: *Mycobacterium, Streptomyces*

Practical component

UNIT 1: (10 Hours)

Use of McConkey agar medium as a differential medium to distinguish between lactose- fermenting and lactose-nonfermenting gram negative bacteria. Enumeration of viable bacterial / CFU count using serial dilution and spread plate method/pour plate method.

Unit 2: (20 Hours)

Bacterial staining methods: Use of light microscope to observe bacteria. Simple staining, Gram staining, Negative staining and Acid-fast staining (permanent mount). Endospore staining using malachite green. Observation of bacterial capsules by negative staining. Demonstration of bacterial motility by hanging drop method/flagellar staining.

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.

Practicals:

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.

Suggestive readings

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

DISCIPLINE SPECIFIC CORE COURSE – 5: Biochemistry of Nucleic Acids and Proteins

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC202: Biochemistry of Nucleic Acids and Proteins	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable 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 gain 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

The Learning Outcomes of this course are as follows:

- Student will be able to outline the chemical structures of the building blocks of nucleic acids and understand the structures of the different types of DNA.
- Student will be able to discourse on the composition of proteins, and the structure and chemical properties of the different amino acids.
- Student will be able to describe the structural attributes of some classical proteins.

- Student will be able to analyze the constituents of an active enzyme, the interactions at enzyme active sites, and steady- state kinetics, allosteric regulation, and will become aware of many different forms of enzymes found in living cells.
- Student will be able to analyze the structures of biomolecules using different types of models.
- Student will be able to analyze proteins qualitatively and quantitatively using different biochemical tests.

SYLLABUS OF DSC-5

UNIT – I (9 Hours)

Nucleic acids: Introduction to importance of nucleic acids. Structures of purines and pyrimidines, nucleosides and nucleotides. Formation of DNA chains by phosphodiester bonds. Structure of DNA: the double helix. Types of DNA: A, B and Z. Properties of DNA. Types of RNA:rRNA, mRNA, tRNA

UNIT – II (9 Hours)

Composition of Proteins: Introduction to the importance of proteins. Amino acids as building blocks: structures and properties of standard amino acids. Zwitterion, titration curves of amino acids, and determination of pKa and pI of monocarboxylic amino acid. Ninhydrin reaction. Essential amino acids, non-protein amino acids: beta-alanine, D-alanine and rare amino acids: selenocysteine, hydroxyproline. Oligopeptides: structure and functions of glutathione and aspartame

UNIT – III (6 Hours)

Protein structure: primary, secondary (α helix, β sheets), super secondary (collagen), tertiary (myoglobin) and quaternary (haemoglobin). Structure of insulin

UNIT – IV (21 Hours)

Enzymes: Concept of holoenzyme, coenzyme and apoenzyme. Cofactors: prosthetic group, Coenzyme: NAD, metal cofactors. Enzyme nomenclature and classification. Active site and activation energy. Lock and key hypothesis, induced fit hypothesis. Concept of steady state kinetics, Vmax and Km, significance of hyperbolic and double reciprocal plots. Enzyme unit, specific activity and turnover number. Temperature and pH effects on enzyme activity. Michaelis-Menten kinetics versus kinetics of allosteric enzymes. Competitive, non-competitive and uncompetitive enzyme inhibition. Allosteric enzymes: Phosphofructokinase. Multienzyme complex: pyruvate dehydrogenase. Isozyme: lactate dehydrogenase. RNA as enzymes: Hammerhead ribozyme

Practical component

UNIT 1: (10 Hours)

Study of biomolecules with the help of models: The use of different types of models for visualizing molecular structures of biomolecules: Space filling models,

Ball and stick models, Ribbon Models. Study of protein secondary and tertiary structures with the help of photographs/ models: collagen, myoglobin, hemoglobin.

Unit 2: (20 Hours)

Qualitative and quantitative analysis of proteins: Qualitative analysis of proteins using Xanthoproteic Test, Millon's Test, Biuret Test, Ninhydrin Test. Quantitative estimation of proteins by Lowry's method using bovine serum albumin as the standard. Demonstration of enzyme activity (amylase / urease / catalase) and effect of temperature, pH and heavy metal salt on activity.

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.

Practicals:

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.

Suggestive readings

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

DISCIPLINE SPECIFIC CORE COURSE – 6: Food and Dairy Microbiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC203: Food and Dairy Microbiology	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to familiarise students with the importance of microorganisms in food spoilage as well as in preparation of certain foods, and to acquaint the students with quality control and safety indices used in the food industry

Learning outcomes

After completion of the course, students will be able to-

- Evaluate the factors governing microbial growth in foods and sources of food contamination.
- Discuss the factors that govern spoilage of some common foods due to microbial activity.
- Describe various physical and chemical methods used for food preservation.
- Analyze the role of microorganisms in the production of fermented dairy and non-dairy food products. Will understand the health benefits of prebiotics, probiotics and synbiotics.
- Discourse on the common food-borne diseases and preventive measures to be used, as well as methods for detection of food-borne pathogens.
- Recognize the importance of quality control in the food industry and learn about various indices being used to measure quality and safety in the food industry.

SYLLABUS OF DSC-6

UNIT – I (9 Hours)

Foods as a substrate for microorganisms: Natural microflora and contamination sources of foods. Factors impacting growth and survival of microbes in foods. Intrinsic : pH, moisture content, nutrient availability, Eh values, antimicrobial substances and biological structures. Extrinsic: temperature, relative humidity and gaseous storage. Spoilage of foods by microorganisms: Factors responsible for food spoilage. Non-

perishable, -semi perishable and - highly perishable foods. Spoilage of vegetables, fruits, meat, eggs, milk, butter, bread, and canned foods

UNIT – II (9 Hours)

Food preservation methods: Physical methods of food preservation: Temperature control (low: refrigeration, freezing; high: boiling, blanching, pasteurization, UHT, aseptic packaging). Canning: home and commercial. Dehydration: natural drying, artificial drying, freeze drying, smoking and tying of water molecules, reduced water activity products. Irradiation: radicidation, radurization, radappertization. Hydrostatic pressure, high voltage pulse, microwave processing. Chemicals used in food preservation: salt, sugar, organic acids, SO2, nitrites and nitrates, ethylene oxide, antibiotics and bacteriocins

UNIT – III (9 Hours)

Fermented dairy and non-dairy foods: Starter cultures. Fermented foods: yogurt, acidophilus milk, kumiss, kefir, dahi, cheese, bread, dosa, kanji, sauerkraut, soy sauce, tempeh, and fermented meat (sausages). Concept, health benefits and limitations of prebiotics, probiotics and synbiotics. Selection criteria for probiotic. Probiotic foods available in the market.

UNIT – IV (12 Hours)

Food intoxications, food infections and detection of food borne pathogens. Causative agents, foods involved, symptoms and preventive measures in food-borne diseases caused by Clostridium botulinum, Shigella (bacillary dysentery), Vibrio cholerae, Escherichia coli, Yersinia enterocolitica, Salmonella (food infection), Entamoeba histolytica. Mycotoxins: aflatoxins (Aspergillus). Detection of food-borne pathogens: culture-based as well as rapid detection methods

UNIT – V (6 Hours)

Quality control in the Food Industry: Total Quality Management (TQM): concepts and approaches. Hazard Analysis of Critical Control Point (HACCP) for food safety: principles and limitations. Indices of food quality (IFQ): FSSAI standard, ISO certification.

Practical component

UNIT 1: (15 Hours)

Microbial spoilage of food and fermented foods:

Isolation and identification of spoilage fungi from various spoiled vegetables/ fruits: collection of spoilt food samples, point inoculation on suitable media, preparation of temporary mounts, and microscopic observations. Isolation and identification of spoilage fungi from spoiled breads using similar methods. Comparison of the fungi identified in the two categories of foods. Fermented foods: Production of fermented foods using starter cultures and normal microflora of food. Preparation of yogurt / dahi. Preparation of sauerkraut / kanji. Preparation of buttermilk and butter. Preparation of kefir using kefir grains.

Student research study project: unusual fermented foods from India and around the world.

Unit 2: (15 Hours)

Food Quality Control :

Methylene Blue Dye Reduction Test (MBRT) to assess the microbiological quality of raw versus pasteurized milk: principle of the method, performance of the test with various samples of milk, evaluation and grading of milk quality based on the results obtained. Evaluation of milk quality by assessing its bacterial load using the standard plate count with serial dilutions of the milk. 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. 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.

Essential/recommended readings

Theory:

1. Antimicrobials in Foods edited by P.M. Davidson, T.M. Taylor, and J.R.D. David. 4th edition. CRC Press, UK. 2020.
2. Food Microbiology by W.M. Foster. CBS Publishers & Distributors Pvt. Ltd. 2020
3. Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2017.
4. Food Microbiology by M.R. Adams, M.O. Moss and P. McClure. 4th edition. Royal Society of Chemistry, UK. 2015.
5. Fundamental Food Microbiology by B. Ray and A. Bhunia. 5th edition. CRC Press. 2013.
6. Basic Food Microbiology by G.J Banwart. 2nd edition. CBS Publishers and Distributors, India. 2004.
7. Modern Food Microbiology by J.M. Jay, M.J. Loessner and D.A. Golden. 7th edition. Springer, Switzerland. 2005.
8. The Microbiological Safety and Quality of Foods. Vol. 1-2 by B.M. Lund, T.C. Baird-Parker,and G.W. Gould. ASPEN Publication, USA. 2000.

Practicals:

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. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2nd edition. Scientific International Pvt. Ltd., Delhi. 2018.

Suggestive readings

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

Common Pool of Generic Electives (GE) Courses
Offered by the Department of Microbiology
Category-IV

GENERIC ELECTIVES (GE-6: MICROBES IN ENVIRONMENTAL MANAGEMENT)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
MICROBES IN ENVIRONMENTAL MANAGEMENT	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of the course is for students to appreciate how various microorganisms are bestowed with the capacity to modulate the environment.
- Students will get acquainted with the role of microbes in biodegradation, biogeochemical cycling, and production of biofuels.
- They will become aware of environmental problems and how microorganisms are used to manage these problems.
- This course will motivate them to think of novel ways to solve various environmental issues, including newer challenges such as e-waste management and plastic degradation using suitable microbes

Learning outcomes

After completion of the course, students will be able to-

- The student will be aware of the importance of microbes in any ecosystem with reference to nutrient cycling/ biogeochemical cycling, and will be acquainted with biofuels and the role of microbes in mineral recovery.
- The student will have gained knowledge about BOD, COD and various methods of waste treatment (solid and liquid) utilizing diverse microorganisms.
- The student will have learnt about microbial bioremediation, including petroleum products, microbial degradation of pesticides, plastics and e-waste management for a cleaner environment.
- The student will have understood the concept of potability of water and will have performed various tests to check the potability of given water samples.

- The student will have isolated several microorganisms with special and unique properties from natural reservoirs of soil and landfills etc. and will understand how they keep reclaiming and rejuvenating our environment.
- The student will be able to combine conventional methods with innovative solutions to preserve and enhance environmental sustainability.

SYLLABUS

UNIT – I (10 Hours)

Role of microbes in biodegradation, biofuels and bioleaching: Role of microbes in biodegradation and maintaining a continuous supply of nutrients like carbon, nitrogen (nitrogen fixation, ammonification and denitrification) and phosphorus in the ecosystem. Microbes as sources of Biofuels: bioethanol, algal biofuels, biogas, microbes in mineral recovery (iron, gold).

UNIT – II (12 Hours)

Microbes in waste management: Sources and types of solid waste, sanitary landfill, composting. Liquid waste management: composition and strength of sewage (BOD and COD). Primary, secondary (aerobic: Oxidation pond, Trickling filter, Activated sludge process; anaerobic: Septic tank, Imhoff tank, anaerobic sludge digestor); and tertiary sewage treatment

UNIT – III (8 Hours)

Microbial bioremediation: Bioremediation of contaminated soils (heavy metals and petroleum) and marine pollutants. Microbial degradation of pesticides (2,4-D and 2,4,5-T). Role of microbes in e-waste management and plastic degradation

Practical component –

UNIT – 1 (20 Hours)

Determination of water potability: Water potability, Safety standards of drinking (potable) water. Methods to determine potability of water samples, standard qualitative procedure - presumptive test/MPN test, confirmed and completed tests for faecal coliforms; membrane filtration technique and Presence/Absence tests for coliforms using rapid detection kit

UNIT – 2 (24 Hours)

Isolation of microbes important in environment management: Detection of starch/ cellulose-degrading and dye (malachite green/ crystal violet/ methylene blue) decolorising microorganisms from the soil. Isolation of heavy metal-accumulating (copper/ nickel/ zinc/ cobalt/ aluminium) microorganisms from soil, and plastic-degrading microbes from landfills

UNIT – 3 (16 Hours)

Preparation of compost using composting pits on college premises or elsewhere. Student Idea Presentation on environment protection. Visit to a wastewater treatment plant/solid waste treatment site. Understanding eutrophication and algal blooms with the help of pictures

Essential/recommended readings

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. 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.
5. Advances in Applied Bioremediation edited by A. Singh, R.C. Kuhad and O. P. Ward.Springer-Verlag, Germany. 2009.
6. Microbial Ecology: Fundamentals and Applications by R.M. Atlas, R. Bartha. 4th edition.Benjamin Cummings, USA. 2000.
7. An Introduction to Soil Microbiology by A. Martin. 2nd edition. John Wiley and Sons Co, UK. 1991.

Suggestive readings (if any)

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

GENERIC ELECTIVES (GE-7: MICROBES IN INFECTIOUS DISEASES)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
MICROBES IN INFECTIOUS DISEASES	**4**	**2**	**0**	**2**	**Class XII Pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to gives students of other disciplines an overview of the fundamentals of principles of immunology, infection and disease.
- The students will become aware of the whole spectrum of infectious diseases caused by different classes of microbes.
- They will be become familiar with methods of disease diagnosis, the identification of the causative microbe and the latest immunological techniques.

Learning outcomes

After completion of the course, students will be able to-

- The student will have acquired knowledge about the basic concepts associated with infectious diseases and the principles and types of infection.
- The student will have been introduced to the different immune organs, immune cells, and their functions. Will understand the role of antigens and antibodies in fighting infection.
- The student will have learnt about the different types of microbial diseases, their symptoms, and mode of transmission.
- The student will know how to determine the complete blood count (TLC and DLC). Will be able to identify the human blood groups and different immune cells.
- The student will have gained knowledge about the different selective and differential media for culturing bacteria. Will have learnt the principle and working of PCR-based tests for disease diagnosis.
- The student will be able to identify pathogenic bacteria by performing biochemical tests.

SYLLABUS

UNIT – I (6 Hours)

Introduction to basic concepts of infection and disease: Infection, colonization, pathogenicity, virulence and its determinants (adhesion, enzymes, toxins - exotoxins and endotoxins), transmission (direct and indirect) of infectious diseases. Types of infections (acute, latent, chronic), opportunistic and nosocomial infections. Reservoir and source of infection.

UNIT – II (12 Hours)

Basic principles of immunology: Basic concepts of innate and adaptive immunity. Cells and organs of the immune system. Characteristics of antigen (foreignness, molecular size and heterogeneity), haptens, adjuvant. Structure, types and functions of antibodies. Cell mediated immunity. Primary and secondary immune response. Principles of immunization and types of vaccines

UNIT – III (12 Hours)

Infectious diseases and their transmission: Symptoms and mode of transmission of diseases. Bacterial: tuberculosis, tetanus, anthrax. Viral: chicken pox, measles, mumps, polio, COVID-19, AIDS, dengue. Fungal: athlete's foot, histoplasmosis, candidiasis. Protozoan: malaria, amoebiasis

Practical component – 60 Hours

UNIT – 1 (20 Hours)

Immunological techniques: Use of the haemocytometer. Analyzing total leucocyte count and differential leukocyte count in blood sample: determining percent count neutrophils, lymphocytes, eosinophils, basophils and monocytes in a blood smear. Identification of human blood groups and different immune cells

UNIT – 2 (20 Hours)

Culturing of microorganisms and diagnosis: Use of various selective and differential media for culturing and identification of bacteria: mannitol salt agar, deoxycholate citrate agar / Salmonella Shigella (SS) agar, MacConkey / EMB Agar. Use of PCR based techniques to identify the infectious agent. Student group project: Different methods used to diagnose the following diseases: COVID19, tuberculosis

UNIT – 3 (20 Hours)

Biochemical tests for identifying bacteria: Bacterial identification based on morphological features: Gram staining, capsule, endospore and motility characteristics. Bacterial identification based on biochemical characteristics: IMViC (Indole test, Methyl Red test, Voges-Proskauer test, Citrate test), Triple Sugar Iron (TSI) test, and catalase test. Kit based identification of a microbial pathogen.

Essential/recommended readings

1. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 11th edition. Universities Press, India. 2020.
2. Prescott's Microbiology by J. M. Willey, K. Sandman, K. and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019
3. Basic Immunology: Functions and Disorders of the Immune System by A. K. Abbas, A. H. Lichtman, S. Pillai. 6th edition. Elsevier, India. 2019.
4. Kuby Immunology by J. Punt, S. Stranford, P. Jones, and J. Owen. 8th edition. W.H. Freeman and Company, USA. 2018.
5. Jawetz, Melnick and Adelberg's Medical Microbiology by K.C. Carroll, S. A. Morse, T.A. Mietzner, and S. Miller. 28th edition. McGraw Hill Education, USA. 2016. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.

Suggestive readings (if any)

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

GENERIC ELECTIVES (GE-8: APPLICATIONS OF MICROBES IN BIOTECHNOLOGY)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
APPLICATIONS OF MICROBES IN BIOTECHNOLOGY	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to provide the students a clear understanding on the biotechnological potential of microorganisms in production of important industrial products like amino acids, antibiotics, vitamins, biopolysaccharides, bioplastics, pharmaceutical products, high fructose corn syrup, biofertilizers, biopesticides, transgenic plants, biofuels and biogas.
- They will also learn about the use of microorganisms for detoxification of industrial effluents, biogas production and extraction of metals from even low-grade ores.

Learning outcomes

After completion of the course, students will be able to-

- The student will become familiar with the concept of genetic manipulation of microbes by metabolic engineering and the production of important microbial products of immense industrial and medical/therapeutic value.
- The student will understand the use of microbes in agricultural biotechnology for the formulation of biopesticides, biofertilizers, transgenic plants with desirable traits like disease resistance etc. Will learn the importance of microorganisms in environmental management and biofuels production.
- The student will learn about whole cell and enzyme immobilization techniques with strategies of dye decolorization using microorganisms.
- The student will learn about the isolation and screening of enzyme producers from soil and symbiotic & asymbiotic nitrogen fixers.

- The student will gain expertise in collecting, analyzing and interpreting data on commercially available microbial products. Will become familiar with cultivation and importance of edible mushrooms as well as single cell proteins.

SYLLABUS

UNIT – I (4 Hours)

General Microbial Biotechnology: Scope of microbial biotechnology in agriculture, healthcare, environmental management, genomics, and proteomics, with suitable examples. Microbes commonly used in microbial biotechnology: viruses, bacteria, fungi. Relevance of natural, laboratory-selected mutant and genetically engineered microbes (GEMs), primary and secondary metabolites, metabolic engineering.

UNIT – II (12 Hours)

Biotechnological potential of microbes in industry and medicine: Production and applications of microbial products: amino acids (glutamic acid), antibiotics (streptomycin), vitamins (vitamin B12), polysaccharide (xanthan gum), bioplastic (PHB), high fructose corn syrup using immobilized microbial enzyme glucose isomerase. Production and applications of important medicinal products: Insulin, recombinant vaccine (Covishield) and Microbial biosensor (glucose oxidase), gene therapy for SCID in humans using virus

UNIT – III (14 Hours)

Agricultural and Environmental Biotechnology: Biofertilizers and biopesticides in agriculture: definition, classification with examples, advantages and disadvantages. Fertilizers from agricultural waste. Development of transgenic crops with important traits such as resistance to insects and viruses, herbicide resistance and environmental stress (drought and frost). Brief description of Bt cotton and Golden rice. Biofuel production from lignocellulosic waste and algal biomass, biogas (methane and hydrogen) production using microbes. Role of microbes in bioremediation (superbug, oilzapper, concentration of uranium from waste using bacteria). Biodegradation of xenobiotics (types of xenobiotics, hazards from xenobiotics, origin of microbial capacity to degrade xenobiotics and suitable examples) and microbial mining (mineral recovery of metals by bioleaching)

Practical component – 60 Hours

UNIT – 1 (16 Hours)

Microbial enzyme immobilization and dye degradation: Performing yeast cell immobilization and enzyme immobilization in suitable polymers by calcium alginate method, studying the activity and reuse of the immobilized enzyme for recycling purpose, observing dye decolorization/degradation using bacteria or fungi.

UNIT – 2 (24 Hours)

Enzymes and microbes from soil: Screening of soil samples for isolation of hydrolytic enzymes: protease, lipase, cellulase, xylanase (any two) producing microorganisms using plate assay, isolation of symbiotic nitrogen fixer: Rhizobium from root nodules, isolation of asymbiotic nitrogen fixers from soil: Azotobacter and Azospirillum

UNIT – 3 (20 Hours)

Microbial products: Student group project: Conducting a market survey to identify any five popular microbial products and working to identify the microbe(s) involved in its production and the method of its preparation. Study of mushroom cultivation: importance, types of edible mushrooms and their cultivation, introduction to medicinal mushrooms. Single cell protein from algae Spirulina & Chlorella: medicinal importance, advantages, disadvantages and production strategies.

Essential/recommended readings

1. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
2. Biotechnology: A Textbook of Industrial Microbiology by W. Crueger, A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.
3. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rdedition. Elsevier Science Ltd, Netherlands. 2016.
4. A Textbook of Biotechnology by R.C. Dubey. 5th edition. S. Chand and Co, India. 2014.
5. Molecular Biotechnology by B.R. Glick, J.J. Pasternak and C.L. Patten. 4th edition, ASMPress, USA. 2009.
6. Microbial Biotechnology by A.N. Glazer and H. Nikaido. 2nd edition. Cambridge UniversityPress, UK. 2007.
7. Elements of Biotechnology by P.K. Gupta. 2nd edition. Rastogi Publications, India. 2009.
8. Basic Biotechnology by C. Ratledge and B. Kristiansen. 3rd edition. Cambridge UniversityPress, UK. 2006.
9. Modern Industrial Microbiology and Biotechnology by Naduka Okafor. Science Publishers, USA. 2007.
10. Manual of Industrial Microbiology and Biotechnology by A.L. Demain, J.E. Davies and R.M. Atlas. 2nd edition. ASM Press, USA. 1999.

Suggestive readings (if any)

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

GENERIC ELECTIVES (GE-9: FUNDAMENTALS OF AGRICULTURAL MICROBIOLOGY)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
FUNDAMENTALS OF AGRICULTURAL MICROBIOLOGY	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning Objectives

After completion of the course, students will be able to-

- The major objective of this paper is to develop clear understanding of the role of soil and soil microbes in agriculture.
- The student will get an overview of plant microbe interaction and the role of microbes in nutrient cycles and their importance in agriculture.
- The students will have an in- depth knowledge of biofertilizers, composting and their importance for improving crop productivity.
- They will get familiarized with the significance of biocontrol agents and organic farming.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will have acquired an overview of soil and its characteristics and will become aware of the important microorganisms involved in mineralization of essential nutrients present in the soil and their significance in agriculture. Students will understand various plant-microbe interactions including symbiotic and non-symbiotic associations.
- The student will acquire knowledge of various microorganisms acting as biofertilizers including bacterial, fungal and algal biofertilizers. Students will understand the benefits of biofertilizers as compared to chemical fertilizers in terms of increased crop productivity and will become familiar with mass culturing of biofertilizers. Students will have an in-depth knowledge on various aspects of composting.
- The student will understand types and applications of bacterial and fungal biocontrol agents in agriculture and will get an overview of importance of organic farming.

- The student will be able to determine soil type, texture and its characteristics. Students will learn about the microbial interactions with plants. They will get knowledge about the different stages of nodules in leguminous plant roots and will observe nodule forming bacteria under microscope. They will also get to know the stages of Mycorrhizal colonization through pictures.
- The student will gain an understanding of soil microbiology and microbial ecology, including the types of organisms living in soil. Students will get hands-on experience and learn about the presence of microorganisms in soil by CO2 evolution and enzyme activity.
- The student will become aware of recycling of organic matter for an easy and cheap way to make compost to enhance soil quality. They will also know about the antagonistic potential of Trichoderma spp. as biological control agent against other fungi.

SYLLABUS

UNIT – I (12 Hours)

Microbes and soil fertility: Study of soil properties and microbial interactions: Study of soil types and its texture with the help of Sieve method/Mason jar method. Hands-on analysis of different soil characteristics - pH, moisture content, water holding capacity, percolation, capillary action of a soil sample. Isolation of phylloplane microflora on nutrient agar and potato dextrose agar by leaf impression technique. Demonstration of stages of nodule formation in leguminous plant with the help of photographs. Slide preparation of crushed nodule to observe nodule forming bacteria. Study of mycorrhizal association through pictures

UNIT – II (12 Hours)

Biofertilizers and composting: Introduction and scope of biofertilizers. Types, characteristics, mass production and methods of applications of the following: Bacterial biofertilizers: *Rhizobium*, *Azotobacter*, *Azospirillum*. Algal fertilizer: blue green algae, Azolla- Anabaena. Fungal biofertilizers: mycorrhiza. Quality testing of biofertilizers (ISI standards). Role of microbes in organic matter decomposition and different methods of composting.

UNIT – III (6 Hours)

Biocontrol agents and organic farming: Importance, potential and types of biocontrol agents. Application of *Trichoderma spp*. and *Bacillus thuringiensis* as biocontrol agents in agriculture. Concept of organic farming, types, methods and advantages.

Practical component – 60 Hours

UNIT – 1 (28 Hours)

Study of soil properties and microbial interactions: Study of soil types and its texture with the help of Sieve method/Mason jar method. Hands-on analysis of different soil characteristics - pH, moisture content, water holding capacity, percolation, capillary action of a soil sample. Isolation of phylloplane microflora on nutrient agar and potato

dextrose agar by leaf impression technique. Demonstration of stages of nodule formation in leguminous plant with the help of photographs. Slide preparation of crushed nodule to observe nodule forming bacteria. Study of mycorrhizal association through pictures.

UNIT – 2 (20 Hours)

Evaluation of microbial activity in soil: Study of microbial activity in soil by CO2 evolution: determination of CO2 by trapping it in alkali solution and its estimation by titration. Detection of microbes in soil by Dehydrogenase/Urease/Amylase activity: reduction of triphenyl tetrazolium chloride (TTC) by dehydrogenases/ detection of ammonia by phenol red or Nessler's reagent/ detection of amylase using iodine solution

UNIT – 3 (12 Hours)

Biodegradation of organic matter and Trichoderma as biocontrol agent: Demonstration of steps of organic matter decomposition: composting of plant and food wastes containing organic compounds-lignin, cellulose, hemicellulose, polysaccharides, proteins, lipids, etc. into simple inorganic compounds/elements to be used as soil conditioner. Demonstration of antagonistic activity of *Trichoderma sp.* against different fungi (any 2) using dual culture plate technique.

Essential/recommended readings

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith.15th edition. McGraw-Hill Education, USA. 2022.
2. Biopesticides and Bioagents: Novel tools for pest management by M. A. Anwer. 1st edition.Apple Academic Press, USA. 2021.
3. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
4. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
5. Soil Microorganisms and plant growth by N.S., Subba Rao. 4th edition. Oxford & IBH Publishing Co. Pvt. Ltd. India. 2020.
6. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.
7. Biofertilizers in Agriculture and Forestry by N.S., Subba Rao. 4th edition. Biogreen Publisher, India. 2009.
8. Agricultural Microbiology by G. Rangaswami. and D. J., Bagyarai. 2nd edition, Prentice-Hall of India Private Limited, New Delhi. 2005.
9. Principles and Applications of Soil Microbiology by D.M., Sylvia. J.J., Fuhrmann. P.J. Hartel and D.A., Zuberer. 2nd edition Pearson, Prentice Hall, USA. 2005.
10. Agricultural Biotechnology by S.S., Purohit. 2nd edition. Agrobios Publisher, Jodhpur, India. 2003.

Suggestive readings (if any)

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

GENERIC ELECTIVES (GE-10: MICROBIAL PRODUCTS IN THERAPEUTICS)

Credit 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 PRODUCTS IN THERAPEUTICS	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to give students an in-depth knowledge of the commercially available microbial products used in the treatment of human diseases and their management.
- Students will be acquainted with the large-scale culturing of microorganisms to produce various metabolites used for therapeutic purposes.
- Students will get an hands-on experience in the production of enzymes by microorganisms and production of fermented foods.
- They will learn to use bioassay for detecting an antibiotic in a sample and they will get familiar with the technique to determine antibiotic sensitivity of any bacterial culture..

Learning outcomes

After completion of the course, students will be able to-

- The student would gain knowledge about the techniques involved in isolation, screening and mass culturing of microorganisms to produce microbial metabolites at the industrial scale.
- The student would become conversant with microbial therapeutics used in the management of infectious diseases in humans.
- The student would become familiar with microbial therapeutics in the treatment of non-infectious diseases.
- The student would learn about extracellular enzyme production by microorganisms and its detection in the broth. They will also become conversant with the production of fermented food products involving microorganisms.
- The student would be able to understand the concept of bioassay for the detection of an antibiotic in the sample. They will also be able to differentiate between antibiotic sensitive and antibiotic resistant bacteria.

- The student would gain experience in data collection and analysis of commercially available therapeutic products and also on locally available fermented foods.

SYLLABUS OF MICROB-GE10

UNIT – I (10 Hours)

Isolation, screening and mass culturing of microorganisms to produce useful metabolites: Sources of industrially important microbes, their isolation and screening (primary and secondary). Fermentation techniques for large scale culturing: batch, fed-batch, continuously stirred tank reactor, solid-state fermentation. Different methods for recovery of microbial products

UNIT – II (10 Hours)

Microbial therapeutics in the treatment of infectious diseases: Antibiotics: mode of action, uses, and producer organisms of penicillin, streptomycin, tetracycline, cephalosporin, neomycin, erythromycin, augmentin, vancomycin and griseofulvin. Antimicrobial Resistance (AMR) phenomenon. Enzybiotics: Mode of action, uses and producer microorganisms of bacteriocins and lysozyme. Probiotics: Features of effective probiotics, benefits, commonly used probiotic microorganisms (Lactobacillus sp., Bifidobacterium sp., Saccharomyces boulardii). Bacto therapy by microbiota transplant.

UNIT – III (10 Hours)

Microbial therapeutics in the treatment of non -infectious diseases: Mode of action, uses and producer microorganisms of the following biopharmaceuticals: anti-inflammatory agents (serratopeptidase and collagenase), thrombolytic agents (streptokinase, nattokinase, tissue plasminogen activator), digestive aids (fungal amylase and lipase), anticancer agents (asparaginase, methioninase), vitamins (cyanocobalamin,riboflavin), hormones (insulin and somatostatin). Production of steroid- based pharmaceuticals by microbial transformation: dehydrogenation (cortisol to prednisolone), hydroxylation (progesterone to11α hydroxyprogesterone).

Practical component – 60 Hours

UNIT – 1 (24 Hours)

Production of enzymes and fermented foods: Production of amylase from fungi and its detection in the culture broth: medium preparation, sterilization by autoclaving, inoculation, fermentation under specified condition of temperature and product harvesting from the broth by filtration. Production of any fermented product having probiotic bacteria or yeast (sauerkraut /curd / kanji). Estimation of lactic acid produced during curd formation by titration

UNIT – 2 (24 Hours)

Detection of antibiotics and determination of antibiotic susceptibility: Bioassay to detect the presence of an antibiotic in the broth/ provided samples: spreading an

antibiotic sensitive bacterial culture on nutrient agar plates, making wells in the plates and dispensing antibiotic dilutions in the wells. Measuring zone of inhibition following incubation. Determination of the sensitivity of a bacterial culture to antibiotics using Kirby -Bauer disc diffusion method: spreading a bacterial culture using sterile swab on Mueller -Hinton agar and determination of susceptibility of the bacterial culture to different antibiotic discs

UNIT – 3 (12 Hours)

Data collection and report preparation: Student research study project: Market survey of commercially available pharmaceutical products of microbial origin. Report preparation of locally fermented food and dairy products. Presentation of main findings.

Essential/recommended readings

1. Industrial Microbiology by A.H. Patel. 2nd edition. Laxmi publication Pvt Ltd/Trinity Press. 2022.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Industrial Microbiology by L.E. Casida. 2nd edition. New Age International publisher. 2019.
4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
5. Crueger's Biotechnology: A Textbook of Industrial Microbiology by W. Crueger,
6. A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.
7. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rd edition. Elsevier Science Ltd, Netherlands. 2016.
8. Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
9. Pharmaceutical Biotechnology: Fundamentals and Applications edited by J. Crommelin, R. Sindelar and B Meibohm B. 4th edition. Springer, UK. 2013.
10. Manual of Industrial Microbiology and Biotechnology edited by R.H. Baltz, A.L. Demain, and J.E. Davies. 3rd edition. American Society for Microbiology. 2010.
11. Pharmaceutical Biotechnology: Concepts and Applications by G. Walsh. John Wiley and Sons. 2007.

Suggestive readings (if any)

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UGCF for Courses of Study with more than One Core Discipline (Earlier B.A. Prog.) Bachelors of Physical Education in the Field of Multidisciplinary Study

B.Sc. in P

(Hons.) (2022-23)

SEMESTER-II

B.A.-PE-DSC-2- (4)-2.1-ANATOMY AND PHYSIOLOGY

DSC-2- (4)-ANATOMY AND PHYSIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ANATOMY AND PHYSIOLOGY	04	03	0	01	Class XII pass	Nil

Learning Objective: To provide learners with the basic knowledge and practices of anatomical structures and functions of the human body.

Learning Outcomes:

1. The learner will acquire the basic knowledge of anatomy and physiology of the human body. They will develop understanding about the functions of each system and organs of the body. Such core knowledge and skill will help to create a strongfoundation to engage human subject of all ages, sex, ability in different games/ sports/ fitness programs.
2. The learner will develop the understanding and knowledge of definition of anatomy & physiology, cell- microscopic structure & functions of its organelle, tissue-classification & functions, organs, systems of the body, bone classification and structure, joints-classification, structure of synovial joints, movements at various joints. The learner will also learn to count the pulse rate. The learner will be able to compare (individual differences), correlate (different systems/games for physical education) to analyze performance.
3. The learners will develop the understanding and knowledge of muscular system - classification, s tructure, functions & properties of skeletal muscle, smooth muscle & cardiac muscle. types of muscular contractions, Name of various muscles acting on

various joints, cardio-vascular system structure of heart, cardiac cycle, blood pressure, cardiac output, composition& function of blood, athlete's heart, respiratory system-structure and function, second wind, oxygen debt. The learners will be able to learn the measurement of blood pressure and study of various bones of human body. The learner will also be able to compare (individual differences), correlate (different systems/ games as per syllabus for physical education) to analyze performance.

4. The learner will be able to explain different body system (as per syllabus) with the help of models and various movements of the joints. The learner will also be able to compare (individual differences), correlate (different systems/ games for physical education) to analyze performance.

Unit-1: Introduction to Anatomy and Physiology (15 Hours)

1. Meaning and Definition of Anatomy, Physiology and Exercise Physiology
2. Importance of Anatomy and Physiology in Physical Education and Sports
3. Description of Cell and Tissues

Unit-2: Introduction to Various Systems-I (15 Hours)

1. Skeletal System: Structural and Functional Classification of Bones, Types of Joints, Different types of Movement around the Joints, Effects of Exercise on Skeletal System
2. Muscular System: Structural and Functional Classification of Muscles, Properties of Muscles, Types of Muscular Contraction, Effects of Exercise on Muscular System, Metabolism

Unit-3: Introduction to Various Systems-II (15 Hours)

1. Circulatory System: Structure and Function of Human Heart, Circulation of Blood, Functions of Blood, Effects of Exercise on Circulatory System, Blood Pressure, Cardiac Output
2. Respiratory System: Structure and Function of Respiratory System, Effects of Exercise on Respiratory System, Second Wind, Oxygen Debt

Part-B: Practicals (30 Hours)

1. Microscopic identification of Cell/ Tissue.
2. Identification of different parts of Skeletal System.
3. Identification of different parts of Muscular System.
4. Identification of different parts of Circulatory System.
5. Identification of different parts of Respiratory System.
6. Measurement of resting heart rate.
7. Measurement of blood pressure.
8. Measurement of respiratory rate.

Suggested Readings:

1. Jain, A.K.(2002), Anatomy & Physiology for Nurses. Arya Publishers, Delhi.
2. Moried, E.N.(2007), Essentials of Human Anatomy & Physiology. Ed.8th Dorling Kindersley, India.
3. Prives, M. and others (2004), Human Anatomy Vol. I & II Paragon, Delhi.
4. Seeley & others (2008), Anatomy & Physiology. McGraw Hill, Boston.
5. Tortora (2003), Principles of Anatomy & Physiology, NewYork: John Willy &Sons.

6. William, C.S. (2000), Essentials of Human Anatomy & Physiology, Benjamin.
7. Wilson and Waugh (1996), Anatomy & Physiology in Health & Illness. Churchill Livingstone.

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SEMESTER-II

B.A.-PE-DSC-2- (4)-2.2-EXERCISE PHYSIOLOGY

DSC-2- (4)-EXERCISE PHYSIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
EXERCISE PHYSIOLOGY	04	03	0	01	Class XII pass	Nil

Learning Objective: The learner will acquire knowledge and understanding with applications and skills (field and laboratory) in exercise physiology.

Learning Outcomes:

1. The learners will be able to understand the physiological basis of physical activities and functioning. The learners will attain knowledge, understanding, ability of interpreting the concepts and practices in exercise physiology.
2. The learners will learn the changes/adaptations in body systems in response to exercise & training. Such core knowledge and skill will help to create a strong foundation to engage human subject of all ages, sex for exercise, health, fitness, sports performance. The learner will be able to correlate, compare and analyze the cause (exercise) and effect (physiological changes) for best practices.
3. The learners will be able to understand the concept of exercise physiology and its significance in the fieldof Physical Education & Sports, acute physiological response, and

chronic physiological adaptation. The learner will be well acquainted with the practical aspect of assessing resting heart rate and blood pressure of the subject. The learners will also be able to correlate, compare and analyze the cause (exercise) and effect (physiological changes) for best practices in regard to above.

4. The learners will develop the understanding and knowledge and practices of hormonal regulation in exercise & training: The endocrine glands and their hormones, acute response and chronic adaptation. The learners will be able to measure vital capacity using Spirometer and assess the Body Mass Index of the subjects including digestive system, temperature regulation, nervous system, sensory system, excretory system and reproductive system. The learners will also be able to correlate, compare and analyze the cause (exercise) and effect (physiological changes) for best practices in regard to above.
5. The learners will gain knowledge of cardiovascular function during exercise and training: structure & function of the heart, acute response and chronic adaptation, respiratory function during exercise and training: respiratory parameters, second wind, acute response and chronic adaptation. The learners will be also able to correlate, compare and analyze the cause (exercise) and effect (physiological changes) for best practices in regard to above.

Unit-1: Introduction to Physiology **(11 Hours)**

1. Meaning and Definition of Physiology and Exercise Physiology
2. Minute Structure and Functions of Cell and its Organelles
3. Structure and Classifications of Tissues
4. Essential Properties of Living Organisms
5. Physiological Concept of Health and Fitness

Unit-2: Cardio-Pulmonary System **(12 Hours)**

1. Cardio-vascular System and Blood: Cardiac Cycle, Pumping action of Heart and its Regulation; Blood Pressure, Its Maintenance and Regulation; Cardiac Output and its Regulation; Functions of Blood and Blood Clotting; Effect of Exercise on Circulatory System
2. Respiratory System: Mechanism of Respiration; Pulmonary Ventilation and its Regulation; Second-wind and Oxygen Debt; Effect of Exercise on Respiratory System

Unit-3: Digestive, Nervous and Sensory Systems **(11 Hours)**

1. Digestive System: Secretion and Function of the Digestive Juices; Functions of Liver; Absorption of Food; General Metabolism, Metabolism of Carbohydrates, Fats and Proteins; Temperature Regulation; Effect of Exercise on Digestive System
2. Nervous System: Functions of the important parts of the Nervous System, Cerebrum, Medulla Oblongata, Thalamus, Cerebellum and Spinal Cord; Functions of the Autonomic Nervous System; Basic Physiological Mechanism governing Posture and Equilibrium; Effect of Exercise on Nervous System
3. Sensory System: General Sensations (Cutaneous and Kinesthetic); Various forms of Senses with special reference to Vision and Hearing

Unit-4: Excretory, Endocrine and Reproductive Systems **(11 Hours)**

1. Excretory System: Excretion of Water from the Body through Skin (Sweating), Lungs, Kidney and GI Tract; Effect of Exercise on Excretory System

2. Endocrine System: Secretion of Endocrine Glands (Pituitary, Thyroid, Adrenal & Pancreas); Role of their secretion in Growth, Development and Body Functions; Effect of Exercise on Endocrine System
3. Reproductive System: Physiology of Human Reproduction, Basic Knowledge of Transmission of Hereditary Characteristics

Part-B: Practicals **(30 Hours)**

1. Measurement of fitness.
2. Measurement of exercise heart rate.
3. Measurement of exercise blood pressure.
4. Measurement of respiratory rate.
5. Calculation of cardiac output.
6. Measurement of reaction time.

Suggested Readings:

1. Jain, A.K. (2002), Anatomy & Physiology for Nurses. Arya Publishers, Delhi.
2. Koley, Shyamal (2007), Exercise Physiology – A Basic Approach. New Delhi: Friends Publications.
3. Kumari, Sheela, S.; Rana, Amita; and Kaushik, Seema (2008), Fitness, Aerobics and Gym Operations. New Delhi: Khel Sahitya Kendra.
4. Moried, E.N.(2007), Essentials of Human Anatomy & Physiology. Ed.8th Dorling Kindersley, India.
5. Prives, M. and others (2004), Human Anatomy Vol. I & II Paragon, Delhi.
6. Seeley & others (2008), Anatomy & Physiology. McGraw Hill, Boston.
7. Tortora (2003), Principles of Anatomy & Physiology, NewYork: John Willy &Sons.
8. William, C.S. (2000), Essentials of Human Anatomy & Physiology, Benjamin.
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