UNIVERSITY OF DELHI

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

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

Sub: Amendment to Ordinance V

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

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

Add the following:

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

DEPARTMENT OF BIOCHEMISTRY

Category-I

BSc. (Hons.) Biochemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-7

2.2 Course Contents

Theory

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

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

Unit 2. Degradation of lipids (10 Hours)

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

Unit 3. Synthesis of lipids (12 Hours)

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

Unit 4. Cholesterol metabolism (4 Hours)

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

2.3 Practical: 60 Hours

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

2.4 Essential readings:

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

Suggested readings:

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

4. Keywords

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

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

DSC-8 : BIOENERGETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-8

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

Unit I: Principles of Thermodynamics **(6 Hours)**

Laws of thermodynamics, Thermodynamic quantities: Gibbs free energy, enthalpy, entropy, Free energy change. Standard free energy change, equilibrium constant, actual free energy change, coupled reactions, energy charge, phosphorylation potential, ATP cycle. Chemical

basis of high standard free energy change of hydrolysis of ATP, phosphoenolpyruvate, 1,3 bisphosphoglycerate, phosphocreatine and thioesters. Bioluminescence.

Unit II: Biological Oxidation-reductions (4 Hours)

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

Unit III: Oxidative phosphorylation (10 Hours)

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

Unit VI: Photophosphorylation (10 Hours)

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

2.3 Practical: - 60 Hours

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

2.4 Essential readings:

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

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

Suggested readings:

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

3. Keywords

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

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

DSC-9: MEMBRANE BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

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

Learning outcomes

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

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

SYLLABUS OF DSC-9

Theory

Hours – 30 Hours

Unit I: Membrane composition and structure (10 Hours)

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

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

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

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

Unit II: Membrane dynamics (5 Hours)

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

Unit III: Membrane transport (9 Hours)

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

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

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

2.3 Practical:

Total Hours : 60 Hours

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

2.4 Essential readings:

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

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

3. Keywords:

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

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

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSEs)

DISCIPLINE SPECIFIC ELECTIVE (DSE-1)

credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

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

Learning outcomes

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

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

Theory

Credits: 2 **Total Hours- 30**

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

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

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

Unit 2: Environment and Xenobiotics (7 Hours)

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

Unit 3: Sustainability and its Enhancement (8 Hours)

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

Unit 4: Techniques to Analyse Pollutants (6 Hours)

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

2.3 Practical:

Credits: 2 Total Hours - 60

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

2.4 Essential readings:

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

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

3. Keywords

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

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

DISCIPLINE SPECIFIC ELECTIVE (DSE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

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

Learning outcomes

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

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

2.2 Course Contents

Theory

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

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

Unit II: Application of chemical sciences to forensic investigation (6 Hours)

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

Unit III: DNA Fingerprinting (6 Hours)

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

Unit IV: Recent advances in forensics (8 Hours)

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

2.3 Practicals – 60 Hours

1. Definition, Identification and Mapping of Crime scene
2. Collection, Preservation, Packaging, and Labeling of biological evidence for their forensic investigation.
3. Preliminary and Confirmatory test for blood/semen/saliva
4. Examination of Micro Evidences: fiber, hair, pollen and soil
5. Fingerprint development from various surfaces and their microscopic and chemical examination
6. Handwriting identification based on class characteristic and individual characteristics
7. Identification of dyes, drugs and ink by TLC

8. Blood spatter analysis
9. DNA Fingerprinting: Sex determination through Y specific STRs and Maternal lineage identification through mitochondrial DNA comparisons.
10. Field trip to a forensic laboratory

2.4 Essential readings:

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

Suggested readings:

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

3. **Keywords**

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

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

DISCIPLINE SPECIFIC ELECTIVE (DSE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

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

Learning outcomes

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

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

2.2 Course Contents

Theory

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

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

Unit II: Microbial Nutrition, Growth and Control (6 Hours)

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH,

temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics.

Unit III: Microbial Genetics **(6 Hours)**

Conjugation, Transformation and Transduction. Gene mapping in Bacteria

Unit IV: Application of Microbes **(10 Hours)**

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

2.3 Practical: 60 Hours

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

2.4 Essential readings:

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

Suggested readings:

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

4. Keywords

Microbiological Techniques, Media, Sterilization, Growth curve

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

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

GENERIC ELECTIVES (GE-4)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

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

Learning outcomes

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

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

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

2.2 Course Contents

THEORY – Total 30 Hours

UNIT I: Introduction to proteins (8 Hours)

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

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

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

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

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

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

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

PRACTICALS – 60 Hours

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

2.3 Essential Readings

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

Suggested Readings

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

3. Keywords

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

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

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

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

Learning outcomes

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

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

2.2 Course Contents

Theory – 30 Hours

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

Definition of Food, Nutrition, Nutrient, Nutritional status

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

Unit 2– Macronutrients **(10 Hours)**

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

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

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

Unit 4 – Food and Health **(5 Hours)**

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

2.3 Practicals – 60 Hours

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

2.4 Essential readings:

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

Suggested readings:

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

3. Keywords:

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

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

GENERIC ELECTIVES (GE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

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

Learning Objectives

To learn the changes in human body systems due to exercise and sporting activities in an integrated manner. To gain knowledge about sports training. Understanding the basic system physiology in sports. To understand the physiological adaptation and metabolic

changes during exercise at varying intensities. To gain skill in measurement of various physiological responses.

Learning outcomes

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

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

2.2 Course Contents

Theory – 30 Hours

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

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

Unit II: Cardiovascular and Pulmonary control in Sports Performance (Total Hours : 10)

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

Unit III: Hormonal Effects on Physical Activities (Total Hours : 8)

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

Unit IV: Drugs and Doping in Sports (Total Hours :8)

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

2.3 Practical: 60 Hours

1. BMI Estimation with and without software - Techniques of taking various anthropometric measurements; Skinfold measurement and Body Fat Percentage calculations.
2. Aerobic Power Field Assessments; Cooper 1.5-Mile Run/Walk Test and 12-Minute Run/Walk Test/Rockport Fitness Walking Test.

3. Tests for anaerobic power; Wingate Test/Anaerobic Cycling Power
4. High-Intensity Fitness Testing/ AAHPER health related physical fitness test Léger 20 m Shuttle Run Test/ Margaria - Kalamen Stair Climb Test,
5. Pulmonary Function Testing: Ratio of Forced expiratory volume (FEV1/FEV6) by spirometry, Lung Volumes and Capacities
6. Determination of age by Radiography (Dry lab)
7. Blood Pressure Measurements: Effects of Body Position, Dynamic Exercise and Isometric Contractions on BP.
8. Determination of Physiological adaptation with training through Submaximal Exercise Testing; Submaximal Bench Step Test/Submaximal Cycle Ergometer Test

2.4 Essential readings:

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

Suggested readings:

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

3. Keywords

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

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

DISCIPLINE SPECIFIC CORE COURSE – 7: BASIC CONCEPTS OF CELL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC301: BASIC CONCEPTS OF CELL BIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the structure of the cell wall and cell membrane, membrane transport mechanisms, cell-matrix and cell-cell interactions, and the importance of the cytoskeleton.
- Student will be able to describe the organization and functioning of various cell organelles and gain insights into the internal organization of the nucleus.
- Student will be able to discuss the mechanisms of protein sorting, intracellular trafficking, and protein export.
- Student will be able to analyse the structure of the plant and animal cell by microscopic observation and the ultrastructure of cell organelles by electron microscopy.

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

SYLLABUS OF DSC-7

UNIT – I (12 hours)

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

UNIT – II (6 hours)

Cytoskeleton: structural organization of actin filaments, microtubule structure and dynamics, structure of centriole, cilia, flagella. Microtubule motor proteins: kinesins and dyneins.

UNIT – III (12 hours)

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

UNIT – IV (15 hours)

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

Practical component **30 Hours**

UNIT 1: (20 hours)

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

Unit 2: (10 hours)

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

Essential/recommended readings

Theory:

1. Molecular Cell Biology by H. Lodish, A. Berk, C. Kaiser, M. Krieger, A. Bretscher, H.Ploegh, A. Amon and K.C. Martin. 9th edition. W.H. Freeman, UK. 2021.
2. Essential Cell Biology by B. Alberts, K. Hopkin, A.D. Johnson, D. Morgan, and M. Raff. 5th edition. W.W. Norton & Co, USA. 2019.
3. Karp's Cell and Molecular Biology by G. Karp, J. Iwasa and W. Marshall. 9th edition. Wiley, USA. 2019.
4. The Cell: A Molecular Approach by G.M. Cooper. 8th edition. Sinauer Associates, UK. 2018.
5. Cell Biology by T.D. Pollard, W.C. Earnshaw, J. Lippincott-Schwartz and G.T. Johnson. 3rd edition. Elsevier, USA. 2016.
6. Becker's World of the Cell by J. Hardin and G. Bertoni. 9th Edition. Pearson, USA. 2015.
7. Cell and Molecular Biology by E.D.P. De Robertis. 8th edition. Lippincott, Williams and Wilkins, USA. 2006.

Practicals:

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

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

DISCIPLINE SPECIFIC CORE COURSE –8:
MICROBIAL PHYSIOLOGY AND METABOLISM- I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC302: **MICROBIAL PHYSIOLOGY AND METABOLISM- I**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

SYLLABUS OF DSC-8

UNIT – I (10 hours)

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

UNIT – II (12 hours)

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

UNIT – III (12 hours)

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

UNIT – IV (11 hours)

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

Practical component **30 Hours**

UNIT 1: (20 hours)

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

Unit 2: (10 hours)

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

Essential/recommended readings

Theory:

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

Practicals:

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

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

DISCIPLINE SPECIFIC CORE COURSE – 9: ENVIRONMENTAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

SYLLABUS OF DSC-9

UNIT – I (11 hours)

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

UNIT – II (9 hours)

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

UNIT – III (9 hours)

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

UNIT – IV (9 hours)

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

UNIT – V (7 hours)

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

Practical component **30 Hours**

UNIT 1: (15 hours)

Soil microflora:

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

Unit 2: (15 hours)

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

Essential/recommended readings

Theory:

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
2. Microbial bioremediation by P. Rajendran and P. Gunasekaran. 1st edition, MJP Publishers, India. 2019.
3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4. Environmental microbiology by K.V. Ramesh. MJP Publisher. 2019.
5. Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
6. Wastewater Microbiology by D.H. Bergey. Medtech, India. 2014.
7. Environmental Biotechnology by M. Jain. 1st Edition. Alpha Science International Ltd. 2014.
8. Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition.Academic Press, USA. 2014.
9. Microbial ecology by L.L. Barton and D.E. Northrup. 1st Edition. John Wiley & Sons. 2011.
10. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA.2011.
11. Environmental Biotechnology: Basic Concepts and Applications by I.S. Thakur. 2nd Edition. I K International Publishing House Pvt. Ltd. 2011.
12. Advances in Applied Bioremediation edited by A. Singh, R.C. Kuhad and O. P. Ward.Springer-Verlag, Germany. 2009.
13. Microbial Ecology: Fundamentals and Applications by R.M. Atlas, R. Bartha. 4th edition.Benjamin Cummings, USA. 2000.
14. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA.1997.

Practicals:

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja. 5th edition. New Age International Publishers, India. 2017.
4. Manual of Environmental Microbiology by C. J., Hurst, R. L., Crawford, J. L., Garland and D. A. Lipson. American Society for Microbiology Press. USA. 2007.
5. Microbial Ecology: Fundamentals and Applications by R.M. Atlas and R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.
6. Methods in Applied Soil Microbiology and Biochemistry by K. Alef and P. Nannipieri. Ist edition. Academic Press, USA. 1995.

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

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

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Theory component

Unit 1: (10 hours)

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

Unit 2: (10 hours)

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

Unit 3: (10 hours)

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

Practical component **60 Hours**

Unit 1: (24 hours)

Isolation, identification and pigment analysis of algae: Study of the following algae by temporary mounts/permanent slides/photographs (at least one alga to be studied by making temporary mounts): *Chlorella, Porphyra, Gracilaria,* diatoms*, Sargassum, Dunaliella, Caulerpa, Ulva.* Comparison of the vegetative thallus organization. Isolation

of green algae from pond water and their identification by making temporary mounts. Recording of macroscopic and microscopic characterteristics of isolated algae. Extraction of pigment (chlorophyll) from algae and its analysis using chromatography or spectrophotometry. Study of the structure of *Euglena* cell highlighting its algal and protozoa characteristics discussion of its 'taxonomic enigma' status.

Unit 2: (16 hours)

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

Unit 3: (20 hours)

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

Suggested Reading (Theory & Practical):

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

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

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

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

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

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

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

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

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2:
Applications of Statistics in Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE2: Applications of Statistics in Biology	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

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

Unit 2: (10 hours)

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

Unit 3: (10 hours)

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

Practicals: **60 hours**

Unit 1: (20 hours)

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

Unit 2: (20 hours)

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

Unit 3: (20 hours)

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

Suggested reading (Theory & Practical):

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

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

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

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
MICROB-DSE 3: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology / Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

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

Contents:

Theory: **30 hours**

Unit 1. (8 hours)

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

Unit 2: (14 hours)

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

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

Unit 3: (8 hours)

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

Practicals: **60 hours**

Unit 1: (20 hours)

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

Unit 2: (30 hours)

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

Unit 3: (10 hours)

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

Suggested Reading (Theory & Practical):

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 4: BIOTECHNIQUES AND INSTRUMENTATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Theory: **30 hours**

Unit 1: (10 hours)

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

Unit 2: (12 hours)

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

Unit 3: (8 hours)

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

Practicals: **60 hours**

Unit 1: (24 hours)

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

Unit 2: (20 hours)

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

Unit 3: (16 hours)

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

Suggested Reading (Theory & Practical):

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 5: PLANT-PATHOGEN INTERACTIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 5: PLANT-PATHOGEN INTERACTIONS	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Contents:

Theory: **30 hours**

Unit 1: (5 hours)

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

Unit 2: (19 hours)

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

Unit 3: (6 hours)

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

Practicals: **Duration: 60 hours**

Unit 1: (24 hours)

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

Unit 2: (24 hours)

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

Unit 3: (12 hours)

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

Suggested Reading (Theory & Practical):

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

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

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

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

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

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

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 6: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Contents:

Theory: **30 hours**

Unit 1: (12 hours)

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

Unit 2: (12 hours)

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

Unit 3: (6 hours)

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

Practicals: **60 hours**

Unit 1: (24 hours)

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

Unit 2: (16 hours)

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

Unit 3: (20 hours)

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

Suggested Reading (Theory & Practical):

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

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

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

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

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

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

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

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

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Contents:

Theory: **30 hours**

Unit 1: (12 hours)

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

Unit 2: (12 hours)

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

Unit 3: (6 hours)

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

Practicals: **60 hours**

Unit 1: (20 hours)

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

Unit 2: (20 hours)

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

Unit 3: (20 hours)

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

Suggested Reading (Theory & Practical):

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

Germany. 2009.

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 8: SCIENTIFIC WRITING AND COMMUNICATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

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

Unit 2: (13 hours)

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

Unit 3: (7 hours)

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

Practicals: **60 hours**

Unit 1: (15 hours)

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

Unit 2: (30 hours)

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

Unit 3: (15 hours)

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

Suggested Reading (Theory & Practical):

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 9: AGRICULTURAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 9: AGRICULTURAL MICROBIOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Theory: **30 hours**

Unit 1: (14 hours)

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

Unit 2: (8 hours)

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

Unit 3: (8 hours)

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

Practicals: **60 hours**

Unit 1: (28 hours)

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

Unit 2: (16 hours)

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

Unit 3: (16 hours)

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

Suggested Reading (Theory & Practical):

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. E. Brown and H. Smith.15th edition. McGraw-Hill Education, USA. 2022.
2. Biopesticides and Bioagents: Novel tools for pest management by M. A. Anwer. Ist edition. Apple Academic Press, USA. 2021.
3. Bioprocess Technology by P. T. Kalaichelvan and I. A. Pandi. 1st edition. MJP Publishers, India. 2021 (reprint).
4. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
5. Soil Microbiology by N.S. Subba Rao. 5th edition. Oxford & Ibh Publishing, USA. 2020.
6. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGraw Hill Higher Education, USA. 2019.

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

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

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

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

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

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

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

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 10:
PRINCIPLES OF GENETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 10: PRINCIPLES OF GENETICS	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

Theory: **30 hours**

Unit 1: (12 hours)

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

Unit 2: (9 hours)

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

Unit 3: (9 hours)

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

Practicals: **60 hours**

Unit 1: (30 hours)

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

Unit 2: (20 hours)

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

Unit 3: (10 hours)

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

Suggested Reading (Theory & Practical):

1. Introduction to genetic analysis by A. Griffiths, J. Doebley, C. Peichel and D. Wassarman. 12th edition. Macmillan Learning. 2020.
2. Laboratory Manual for Principles of Genetics by W. Mhiret. Lap Lambert Academic Publishing. 2020.
3. Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 12thedition. Pearson Education, USA. 2019.
4. Genetics: A Conceptual Approach By B. Pierce. 7th edition. W.H. Freeman and Co. 2019.
5. Genetics: Analysis of Genes and Genomes by D. Hartl and B. Cochrane. 9th edition. Jones and Bartlett Learning, USA. 2017.
6. Introducing Epigenetics : A graphic guide by C. Ennis. Icon Books Ltd, India. 2017.
7. iGenetics- A Molecular Approach by P.J. Russell. 3rd edition. Pearson Education India. 2016.
8. Principles of Genetics by D. Snustad and M. Simmons. 7th edition. Wiley and Sons, UK. 2015.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 11: MICROBIAL BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The Learning Objectives of this course are as follows:

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

Learning outcomes

The Learning Outcomes of this course are as follows:

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

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

Theory: **30 hours**

Unit 1: (4 hours)

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

Unit 2: (14 hours)

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

Unit 3: (12 hours)

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

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

Practicals: **60 hours**

Unit 1: (18 hours)

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

Unit 2: (30 hours)

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

Unit 3: (12 hours)

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

Suggested Reading (Theory & Practical):

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

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

Pearson Education, USA. 2020.

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

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

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

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

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

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

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

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

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

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

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

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

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 12: RESEARCH METHODOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 12: RESEARCH METHODOLOGY	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of the course is to give the students a broad understanding about research approaches and tools, and importantly, an ability to deploy them in their degree programme.
- This will impart skills for critical reading of research literature, various research methods, including theory of scientific research and qualitative and quantitative methods and for developing a research proposal. The course will outline all the fundamentals of carrying out research in an ethical manner.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the basics of research and hypothesis formulation, the different approaches of doing research, acquiring data, and performing data analysis.
- Student will be able to describe the process of scientific writing and presenting of research data.
- Student will be able to demonstrate the process of effective literature search and writing a review.
- Student will be able to analyse datasets and present them through tables, charts and graphs.
- Student will be able to describe the process of writing proposals for research grants.

Contents:

Theory **30 hours**

Unit 1: (8 hours)

Foundation of research and research ethics: What is research, benefits of research. Selection of research topic. Effective literature search. Problem identification and hypothesis building. Qualities of a good hypothesis, hypothesis testing, null hypothesis and alternative hypothesis, logic and importance. Ethics in research: indices for scientific rigor, honesty and integrity, respect for intellectual property, responsible publication of data.

Unit 2: (14 hours)

Approaches to research and research methods: Basic and applied research, descriptive and analytical research, quantitative and qualitative research, experimental and non-experimental research. Good laboratory practices (GLP): Standard Operating Procedures, Biosafety, Radiation safety. Experimental Design. Concept of Experiment Controls. Concept of independent and dependent variables. Recording experimental protocol and data in lab notebooks, preparation for experiments. Field experiments: sampling, types of sampling studies, characteristics of a good sample, sampling frame, sample size, sampling error, scales of measurement, double blind studies. Data analysis and representation: Use of Excel for tables and charts, Common statistical tests (hypothesis of association, student t test) and introducing popular

statistical packages.

Unit 3: (8 hours)

Research Communication: Knowledge dissemination. Effective presentation in scientific conferences (Poster/oral). Structure of research paper. Structure of a thesis/dissertation. Software for scientific paper formatting (LaTeX/MS Office). Software for management of references (Mendeley/Endnote). Software for image processing. Choosing a journal for publication. Impact factor of journals. Ethical issues related to publishing, plagiarism, software for detection of plagiarism.

Practicals: **60 hours**

Unit 1: (20 hours)

Literature Search and Review: General Search Engines, Bibliographic Databases, Digital Libraries, Types of publications, literature search on a given topic and writing a review.

Unit 2: (20 hours)

Analysis and presentation of given dataset: Training in the use of Microsoft Excel for data presentations in tables, graphs and charts. Training in the use of Microsoft Powerpoint for presenting scientific findings at meetings/conferences. Writing an Abstract for paper/conference based on given data.

Unit 3: (20 hours)

Planning and writing a research proposal: General considerations, finding a research problem. Major Funding agencies in India. Mandate of the call for proposals. How to write a proposal. **Student group project**: writing a research proposal on a given topic

Suggested Reading (Theory & Practical):

1. Research Methodology for Natural Sciences by S. Banerjee. I.I.Sc. Press, India. 2022.
2. Research Methodology and Scientific Writing by C.G. Thomas. 2nd edition. Ane Books, India. 2019.
3. Scientific writing and communication by A. Hoffman. 4th edition. Oxford University Press. 2019.
4. Research Methodology: Methods and Techniques by C.R. Kothari. 4th edition. New Age International Publishers, India. 2019.
5. Testing treatments: Better research for better healthcare by I. Evans, H. Thornton, I. Chalmers and P. Glasziou. 2nd edition. Pinter & Martin Ltd, UK. 2013.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 13:
Applications of Informatics in Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 13: **Applications of Informatics in Biology**	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to enable the students to develop a clear understanding of the various concepts and applications of bioinformatics, a field which encompasses diverse applied disciplines such as molecular biology, genomics, proteomics, transcriptomics and systems biology. Students will also learn applications of artificial intelligence in bioinformatics.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the goals of bioinformatics and its applications, diverse types of biological databases, concept and significance of sequence alignment, phylogeny, types of phylogenetic trees.
- Student will be able to describe the diversity of viral, prokaryotic, eukaryotic genomes and their organization, proteomics along with the details of structure of proteins, protein structure prediction, and energy minimizations.
- Student will be able to explain the significance of artificial intelligence and machine learning in various biological applications, computer-aided drug discovery, epitope prediction and its significance in vaccine development and allergen prediction.
- Student will be able to demonstrate how to work with biological databases, similarity searches, sequence alignments and phylogenetic analysis.

- Student will be able to demonstrate working with databases and analysis, gene prediction and other features, and primer designing.
- Student will be able to demonstrate how to identifying secondary structural features of proteins, prediction of protein structure models from amino acid sequences, molecular docking and epitope prediction.

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

Fundamentals of bioinformatics, sequence alignment and phylogeny: Aims and scope of bioinformatics. Concepts of genome, transcriptome, proteome, systems biology, metabolome, interactome and neural network. Biological databases and types. Sequence similarity and Sequence alignment (Local and Global Sequence alignment), pairwise and multiple sequence alignment. Phylogeny, rooted and unrooted trees.

Unit 2: (10 hours)

Genomics and Proteomics: Features of the viral, prokaryotic (*E. coli*) and eukaryotic (human) genomes. Gene Ontology, Hierarchy, and features of protein structure, Structural classes, motifs, folds and domains. Homology modelling of tertiary structure of protein, Molecular dynamic simulations and energy minimizations, Evaluation by Ramachandran plot.

Unit 3: (10 hours)

Artificial Intelligence in bioinformatics: Role of AI and machine learning in biology (proteomics, structural biology, disease management, drug discovery and genomics). Computer-aided drug discovery and design. Bioinformatics in epitope mapping for vaccine design and allergen prediction.

Practicals: **60 hours**

Unit 1: (24 hours)

Biological Databases, similarity search, sequence alignments and phylogenetic analysis: Study of bioinformatics databases, File formats: FASTA, GenBank. Sequence submission tools: NCBI, PDB. Sequence retrieval and similarity search using BLAST, Multiple sequence (DNA/Protein) alignment using CLUSTAL omega. Phylogenetic analysis using MEGA.

Unit 2: (16 hours)

Identification and analysis of genome features: Picking out a given gene from genomes using

GENSCAN or other software (promoter region identification, repeats in the genome, ORF prediction, Gene finding tools), Genome browsing using Ensemble/Genome Data Viewer (NCBI) for features of E. coli and Human Genome (Search a genomic assembly to display a region annotated with a particular gene), Design and analysis of PCR primers using PRIMER BLAST or any other tool.

Unit 3: (20 hours)

Protein structure prediction and evaluation, molecular docking, epitope prediction: Primary structure analysis. Secondary structure prediction using psi-pred. Molecular visualization using JMOL/PyMOL, protein structure model evaluation, virtual screening of drugs using AUTODOC-VINA/ any other software, Demonstration of IEDB (https://www.iedb.org) server for the prediction of HLA class I and II binding epitopes.

Suggested Reading (Theory & Practical):

1. Bioinformatics: Tools and Techniques edited by L. Baker. 1st edition. Callisto. 2018.
2. Applied Bioinformatics: An Introduction by P. Selzer, R. Marhöfer and O. Koch. 2nd edition. Springer, USA. 2018.
3. Bioinformatics Techniques for Drug Discovery: Applications for Complex Diseases by A. Kaushik, A. Kumar, S. Bharadwaj and R. Chaudhary. 1st edition. Springer International, UK. 2018.
4. Foundations of Computing by P. Sinha and P.K. Sinha. 6th edition. BPB Publications, India. 2017.
5. Basic Applied Bioinformatics by C. Mukhopadhyay, R. Choudhary and M.A. Iquebal. 1st edition. Wiley-Blackwell, USA. 2017.
6. Bioinformatics: Principles and Applications by Z. Ghosh and V. Mallick. 1st edition. Oxford University Press, India. 2015.
7. Introduction to Bioinformatics by M.Lesk. 4th edition. Oxford Publication, UK. 2014.
8. Bioinformatics: methods and applications, genomic, proteomics and drug discovery by S. Rastogi, N. Mendiratta and P. Rastogi. 4th edition. Prentice Hall India Publication. 2007.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 14: ADVANCES IN MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 14: ADVANCES IN MICROBIOLOGY	**4**	**2**	**0**	**2**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to educate students about the latest developments in the field of microbiology and apprise them of the cutting-edge technologies being used for research and development.
- They will learn the uses of omics approaches, meta-omics, systems biology, and synthetic biology. They will become familiar with the development and applications of CRISPR-Cas technology and will gain insights into the versatile field of microbial nanotechnology.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss the host-microbe arms race, newer methods to combat challenges of antimicrobial resistance and biofilms, the use of meta-omics approaches in research, latest cutting-edge technology of CRISPR-Cas and its applications.
- Student will be able to explain the Systems and Synthetic Biology and their applications; the principles, techniques, and applications of the versatile field of nanobiotechnology.
- Student will be able to demonstrate soil metagenomics and PCR-based taxonomy analysis, and describe major metagenomics projects worldwide through case studies.
- Student will be able to demonstrate synthesis and testing of silver nanoparticles with antimicrobial properties from plant, fungal/bacterial

extracts; and explain about the analytical research tools to characterize the nanoparticles.

- Student will be able to describe Poliovirus synthesis, mRNA vaccine synthesis and Genome synthesis of mycoplasma through case studies.

Contents:

Theory: 30 hours

Unit 1: (10 hours)

Host- microbe interactions and use of microbes in healthcare: Host-Microbe arms race, genome- pathogenicity islands, Type Three Secretion System (T3SS), Quorum Sensing, and Biofilm formation in bacteria. Viral zoonosis and pandemics. Gene for Gene hypothesis, hypersensitive response, plant resistance genes, and signal transduction mechanism. Addressing the challenges of Anti-Microbial Resistance (AMR) and biofilms by phages, and of cancer through oncolytic viruses.

Unit 2: (10 hours)

Modern molecular techniques in Microbiology: Meta-Omics technology (Metagenomics, Metatranscriptomics, Metaproteomics, and Metabolomics): Principles, techniques deployed, and applications. CRISPR-Cas technology- History, mechanism, applications (in Health, Agriculture and other Industries) and limitations of this technology.

Unit 3: (10 hours)

Systems biology, Synthetic biology, and Nanobiotechnological Approaches in Microbiology: Systems biology approach for holistic perspectives and better outcomes. Types of Biological Networks. Cell signaling and interaction networks. Synthetic biology: principles and applications. Concept, methodology, and applications of Microbial Nanotechnology in health, agriculture, and food industry. Applications of Viral and Viral-like Nanoparticles.

Practicals: 60 hours

Unit 1: (20 hours)

Metagenomic technique to study soil microorganisms: Hands-on training in extraction of DNA from soil, and PCR amplification of metagenomic DNA using universal16S ribosomal gene primers. **Student group project:** Research and review on major metagenomic projects (Sargasso Sea Project, Viral Metagenomics and Human Microbiome Project)

Unit 2: (25 hours)

Synthesis and analysis of silver nanoparticles from plants extracts and microbes (fungi/bacteria). Hands-on training in synthesis of silver nanoparticles by any one method. Testing of antimicrobial properties of synthesized silver nanoparticles. Characterization of nanoparticles by UV-vis Spectroscopy, X-ray Diffraction (XRD), Scanning and Transmission Electron Microscopy (SEM and TEM) through virtual labs / videos. Visit to Sophisticated Instrumentation Facility of a research institution.

Unit 3: (15 hours)

Student research study project: Poliovirus Synthesis: a case study to understand how the poliovirus was synthesized in the laboratory. mRNA-Vaccine Synthesis: a case study of the steps involved in synthesis of mRNA vaccine and testing its efficacy. **Student group project**: Covid19 mRNA vaccines in the market in India and overseas. Genome synthesis of mycoplasma: a case study to develop a synthetic genome of mycoplasma.

Suggested Reading (Theory & Practical):

1. Brock Biology of Microorganisms by M.T. Madigan, and J.M. Martinko. 16th edition. Pearson., USA. 2021.
2. Microbiomes: Current Knowledge and unanswered Questions by E. Rosenberg. Springer Nature, Switzerland. 2021.
3. An Introduction to Systems Biology: Design, Principles of Biological Circuits by Uri Alon, 2nd edition. CRC Press. 2020.
4. Antimicrobial Resistance: Global Challenges and Future Interventions edited by Sabu Thomas. Springer. 2020.
5. Biological Synthesis of Nanoparticles and Their Applications, by L. Karthik, A. Vishnu Kirthi, S. Ranjan, V. M. Srinivasan. CRC Press, Taylor and Francis, USA. 2020
6. Genomic Engineering via CRISPR-Cas 9 system edited by Vijay Singh and Pawan K. Dhar. Academic Press. 2020
7. Microbial Nanotechnology edited by M. Rai and Golinsky P. CRC Press. 2020
8. Bacterial Pathogenesis: A Molecular Approach by B.A. Wilson, A.A. Salyers, D. D. Whitt, and M.E. Winkler. 4th edition. ASM Press, USA. 2019.
9. Implications of Quorum Sensing and Biofilm formation in Medicine, Agriculture and Food Industry by P. V. Bramhachari. Springer. 2019.
10. Nanotechnology in Food: Concepts, Applications, and Perspective by H.J. Malmiri. Springer. 2019.
11. Quorum Sensing: Molecular Mechanism and Biotechnological Applications by G. Tommonaro. Academic Press, USA. 2019.
12. Agricultural Nanobiotechnology: Modern Agriculture for a Sustainable Future by F. Lopez-Valdez and F. Fernandez-Luqueno. Springer. 2018.

13. Implications of Quorum Sensing System in Biofilm Formation and Virulence by Bramhachari. Springer. 2018.
14. Nanobiotechnology: Human Health and the Environment by A. Dhawan, S. Singh, A. Kumar, and R. Shanker (editors). CRC Press, USA. 2018.
15. Synthetic Biology: Omics Tools and their Applications by Shailza Singh. Springer. 2018
16. Viral Metagenomics: Methods and Protocol by V. Pantaleo and M. Chiumenti. Springer Protocols. Humana Press. 2018.
17. Virus Derived Nanoparticles for Advanced Technologies-Methods and Protocols by C. Wege and G. Lomonsoff. Humana Press, Springer, USA. 2018.
18. Microbial Biofilms: Omics Biology, Antimicrobials and Clinical Implications by C. J. Seneviratne. CRC Press. 2017.
19. Precision Medicine, CRISPR, and Genome Engineering: Moving from Association to Biology and Therapeutics by S. H. Tsang. Springer. 2017.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 15: MICROBIOME IN HEALTH AND DISEASE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 15: MICROBIOME IN HEALTH AND DISEASE	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to introduce the human microbiome to students and give them an understanding of its dynamics and function in maintaining homeostasis.
- Students will gain an understanding of the diversity of microbial communities present in various organs in humans. They will gain insights into our current understanding of the impact of microbiome alterations on host health and disease. Students will become aware of techniques used to analyze large omics data sets in investigating microbial communities colonizing humans.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain about human microbiome and methods to study microbiomes, the link between human microbiome and diseases
- Student will be able to describe microbiome-based therapeutic approaches and their challenges, human microbiome project and various databases and software for microbiome analysis
- Student will be able to discuss the basic workflow in a typical microbiome study and analyze microbiome data

- Student will be able to describe current knowledge on the role of microbiome in various diseases

Contents:

Theory **30 hours**

Unit 1: (14 hours)

The human microbiome: Understanding microbiome, importance of microbiome research, development of the microbiome. Vertical and horizontal transfer of human microbiomes, source of the organisms in the human microbiome. Diversity in oral, gut, respiratory and skin microbiome. Microbiome-Gut-Brain Axis. Methods to study the human microbiome: DNA-based analysis of microbial communities, 16S rDNA gene amplicon sequencing and whole metagenome shotgun sequencing methods. Data pre-processing and quality control. Microbiome data analysis: clustering and OTU picking, taxonomic analysis, alpha and beta-diversity. Comparing microbial communities: phylogenetic trees, UniFrac, principal coordinate analysis, Venn diagrams, heat maps. Functional and comparative analysis: metatranscriptome, metabolome, metaproteome.

Unit 2: (10 hours)

Microbiome and its relation to health and disease: Dysbiosis, correlation of dysbiosis with disturbance in microenvironment. Dysbiosis in progression of non-communicable diseases such as cancer, Inflammatory Bowel Disease (IBD), obesity, diabetes, Alzheimer's, and incommunicable diseases such as COVID-19, tuberculosis and typhoid. Nutritional modulation of the gut microbiome. Prakriti and gut bacteria: perspective of traditional ayurveda. Microbiome and host immune system interaction. Effect of antibiotics on microbiota, oral dysbiosis and oral diseases, skin microbiome alterations and cutaneous allergic diseases.

Unit 3: (6 hours)

Microbiome-based therapeutic approaches: Maintaining and restoring a healthy microbiome. Additive, subtractive, and modulatory microbiome-based therapies. Health benefits of prebiotics and probiotics. Fecal transplant and its applications. Challenges in the field of microbiome therapeutics. Microbiome-based diagnostics.

Practicals **60 hours**

Unit 1: (20 hours)

Tools and techniques to study microbiome: Human Microbiome project. Hands-on exposure to various databases (NCBI, HOMD) and opensource software related to microbiome analysis (microbiome analyst, QIIME 2.1, galaxy).

Unit 2: (20 hours)

Research strategy and experimental design in a typical microbiome study: Sample collection, DNA extraction, library preparation and DNA sequencing through virtual lab. Data analysis. Comparison of alpha and beta diversity in given data sets. Interpretations of given heat maps.

Unit 3: (20 hours)

Student group research study projects: Current knowledge on the role of microbiome in respiratory health, the impact of the human microbiome on auto-immune diseases, the interplay of bacteria and eukaryotic microbes in the human gut: presentation of the findings and submission of research study report.

Suggested reading (Theory & Practical):

1. Recent Advances in Understanding the Structure and Function of the Human Microbiome by W. Mousa, F. Chehadeh, and S. Husband. *Frontiers In Microbiology*, *13*. doi: 10.3389/fmicb.2022.825338. 2022.

2. *Microbiome-Gut-Brain Axis* by R. Sayyed and M. Khan. Springer, Singapore. 2022.

3. Targeting the Gut Microbiota for Remediating Obesity and Related Metabolic Disorders by B. Wang et al. J Nutr. 151:1703-1716. http://doi: 10.1093/jn/nxab103. 2021.

4. The human microbiome and COVID-19: A systematic review by S. Yamamota. *PloS One* 16;6. doi:10.1371/journal.pone.0253293. 2021.

5. Metagenomics: Techniques, Applications, Challenges and Opportunities by R.S. Chopra, C. Chopra and N.R. Sharma. Springer. 2020.

6. Gut-Brain Axis: Role of Gut Microbiota on Neurological Disorders and How Probiotics/Prebiotics Beneficially Modulate Microbial and Immune Pathways to Improve Brain Functions by K. Uganya and B.S. Koo. *International journal of molecular sciences*, *21*(20), 7551. 2020.

7. The Influence of the Gut Microbiome on Obesity in Adults and the Role of Probiotics, Prebiotics, and Synbiotics for Weight Loss by A. Aoun, F. Darwish and N. Hamod. Prev Nutr Food Sci., 25(2):113-123. doi: 10.3746/pnf.2020.25.2.113. 2020.
8. The gut microbiome in tuberculosis susceptibility and treatment response: guilty or not guilty? by Eribo, O. A., du Plessis, N., Ozturk, M., Guler, R., Walzl, G. and Chegou, N.N. *Cellular and molecular life sciences : CMLS*, *77*(8), 1497–1509. https://doi.org/10.1007/s00018-019-03370-4. 2020.
9. The influence of the microbiome on respiratory health by T.P. Wypych, L. Wickramasinghe and B. Marsland. *Nature Immunology*, *20* (10), 1279–1290. https://doi.org/10.1038/s41590-019-0451-9. 2019.
10. The microbiome, cancer, and cancer therapy by Helmink *et al*. *Nat Med* 25, 377–388. https://doi.org/10.1038/s41591-019-0377-7. 2019.
11. *Metagenomics* by M. Nagarajan. London: Academic Press. 2018.
12. The human skin microbiome by A.L. Byrd, Y. Belkaid, and J.A. Segre. *Nature reviews in Microbiology*, *16*(3), 143–155. https://doi.org/10.1038/nrmicro.2017.157. 2018.
13. Insights into the human oral microbiome by D. Verma, P.K. Garg and A.K. Dubey. *Archives of microbiology*, *200* (4), 525–540. https://doi.org/10.1007/s00203-018-1505-3. 2018.
14. Human Gut Microbiome: Function Matters by A. Heintz-Buschart and P. Wilmes. *Trends in microbiology*, *26*(7), 563–574. https://doi.org/10.1016/j.tim.2017.11.002. 2018.
15. *Functional Metagenomics: Tools and Applications* by T. Charles, M. Liles, A. Sessitsch, Springer. 2017.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 16:
MICROBIAL DIAGNOSIS AND PUBLIC HEALTH MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSE 16: MICROBIAL DIAGNOSIS AND PUBLIC HEALTH MANAGEMENT	4	2	0	2	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to introduce the students to diagnostic microbiology and public health management. Students will be exposed to various methods of sampling of specimens for laboratory diagnosis.
- Student will be introduced to various automated systems and methods of pathogen identification and microbial typing. Students will develop an understanding of basic concepts of epidemiology. They will be introduced to the role of environment in human health and key aspects of disaster management.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain the methods of collection and transport of clinical specimens, the automated systems for pathogen identification and various methods of microbial typing.
- Student will be able to describe epidemiology, types of epidemics and pandemics, the epidemiology of infectious diseases, the reservoirs of infectious agents and modes of transmission of various diseases.

- Student will be able to explain the concept of one health, various types of zoonoses, overview of air and water pollution and its impact on human health, the key aspects of disaster management.
- Student will be able to describe the significance of various parameters determining health, the methods of blood sampling used for various animals, and demonstrate rapid diagnostic techniques.
- Student will be able to analyze epidemiological data to calculate mortality and morbidity rates, explain about epidemics through case studies.
- Student will be able to describe various disease control regulatory agencies (National and International), genome and disease surveillance.

Contents:

Theory: **30 hours**

Unit 1: (10 hours)

General principles of diagnosis and microbial typing methods: Challenges of diagnosis. General principles of specimen collection. Choice of clinical samples and methods of collection. Transportation of clinical samples. Evaluation of a diagnostic test based on specificity, sensitivity, positive predictive value, negative predictive value. Automated systems of pathogen identification: a brief outline of BACTEC, MALDI-TOF, VITEK, and their advantages and disadvantages. Microbial typing: phage typing, bacteriocin typing, serotyping, antibiogram typing, plasmid profile analysis.

Unit 2: (12 hours)

Basic concepts of epidemiology: Definitions: health, epidemiology, prevalence, birth rate, morbidity, mortality, sero-prevalence, genome surveillance, R^o value, quarantine, endemic, epidemics and types (common source, propagated/progressive, mixed), pandemic, travel notice, public health guidelines. Uses of epidemiology. Infectious disease epidemiology. Modes of transmission of disease and its dynamics, human reservoirs, animal reservoirs, carriers. Investigation of an epidemic. Role of immunization in public health. Clinical trials: randomized control trials (multiple treatment arms, factorial design, cluster design), nonrandomized trials.

Unit 3: (8 hours)

Environment and Health: The concept of one health. Definition, history and socio-economic impact of zoonotic diseases. Classification of zoonoses with examples (based on transmission cycle: orthozoonoses, cyclozoonoses, metazoonoses, saprozoonoses;

based on reservoir hosts: anthrapozoonoses, zooanthroponoses, amphixenoses). Air pollution and its effects. Water pollution and its effect. Disaster management: key aspects.

Practicals: **60 hours**

Unit 1: (30 hours)

Health indicators, blood sampling methods and diagnostic methods: Student individual project: preparation of a short report on indicators of health. Guidelines and collection sites for sampling of blood from humans, cattle, sheep and goat. **Student group study project:** preparation of a flow chart for detection of microbial pathogens for two diseases prevalent in India. Principles and working of rapid antibody detection test using COVID-19 as example. Principles and working of antigen and antibody detection kits for HIV. Principle and working of slide agglutination test for typhoid. Principles and working of quantitative real time PCR test for COVID-19 through virtual lab.

Unit 2: (15 hours)

Epidemiological Data Analysis: Student group research study: Case studies of a common source epidemic (Cholera outbreak, London, 1854) and progressive epidemic (SARS 2002, MERS 2012, and COVID-19). **Student group research project**: Measurement of disease: determination of morbidity and mortality rates/ratios. Generation of epidemiological protocols and reports.

Unit 3: (15 hours)

Case Studies through student group research projects: INSACOG: role in SARS- CoV-2 genome surveillance, Role of WHO and National Centre for Disease Control in disease management, AMR stewardship and National Action Plan, CDC –EOC levels (www.cdc.gov).

Suggested Reading (Theory & Practical):

1. Park's Textbook of Preventive and Social Medicine by K. Park. 26th edition. Banarsidas Bhanot Publishers, India. 2021.

2. Brock Biology of Microorganisms by M.T. Madigan, K.S. Bender, D.H. Buckley, W.M.Sattley and D.A. Stahl. 16th edition. Pearson Education, USA. 2021.

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

Pearson Education, USA. 2020.

4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
5. National Centre for Disease Control: Anti-Microbial Resistance and COVID National Action plan: https://ncdc.gov.in/index1.php?lang=1&level=2&sublinkid=389&lid=347
6. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
7. Textbook of Microbiology by R. Ananthanarayan and C.K.J. Paniker. 10th edition.Universities Press, India. 2017.
8. Veterinary Microbiology by D. Scott McVey, Melissa Kennedy and M.M. Chengappa. 3rd edition. Wiley – Blackwell, USA. 2013.
9. An Introduction to Public Health and Epidemiology by S. Carr, N. Unwin and T. Pless-Mulloli. 2nd edition. Open University Press, UK. 2007.
10. Handbook of Good Dairy Husbandry Practices. National Dairy Development Board (NDDB). https://www.nddb.coop/sites/default/files/handbook_of_good_dairy_husbandry_practices_low.pdf
11. Mackie and McCartney Practical Medical Microbiology by J. Collee, A. Fraser, B. Marmion and A. Simmons. 14th edition. Elsevier. 1996.

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

DISCIPLINE SPECIFIC CORE COURSE – 7: Engineering Mathematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Engineering Mathematics ELDSC-7	**4**	**3**	**00**	**1**	**Course Admission Eligibility**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide the students with the skill and knowledge to perform calculations for solutions to the problems related to various topics that they would be taught during the course of this programme.
- To prepare the students with the mathematical tools they would require while studying and analysing problems in electronics networks, electronic and optical communications, semiconductor devices such as transistors, diodes, transient circuits in power devices, and problem solving in Electromagnetic theory, waveguides, and antennas.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use mathematical tools to solve/model the problems related to Electronics
- Solve linear differential equations using a variety of techniques, power series method and special functions
- Understand to solve N coupled equations using matrices, concept of Eigen values and Eigen vectors
- Familiarize with the concept of sequences and series, convergence and divergence
- Appreciate the complex variables and perform operations with complex numbers

SYLLABUS OF ELDSC-7 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Ordinary Differential Equations(ODE): Introduction to First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations.

Series Solutions of ODE: Power Series method, Legendre Polynomials, Bessel's equations and Frobenius method.

Special functions: Beta and gamma functions, error functions

UNIT – II (11 Hours)

Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Solution of a system of Linear equations by LU decomposition, Gauss Jordan and Gauss-Seidel Method. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices. Real and Complex Matrices.

Matrix Eigen Value Problems: Linear transformation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors.

UNIT – III (11 Hours)

Sequences and Series: Sequences and its kind, Limits of a sequence, Convergent, Divergent and oscillatory sequences.

Convergence of Infinite series, Tests of Convergence: Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series Test.

UNIT – IV (11 Hours)

Complex Variables Analysis: Complex Variables, Complex functions, Continuity, Differentiability, Analyticity, Cauchy-Riemann (C-R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Functions, Trigonometric Functions, Hyperbolic Functions.

Complex Integration: Line integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula. Taylor series-exponential, logarithmic and trigonometric functions.

Practical component (if any) – Engineering Mathematics

(Scilab/MATLAB/ any other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Perform operations with various forms of complex numbers to solve equations
- Use mathematics as a tool for solving/modeling systems in electronics
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Solution of First Order Differential Equations
2. To test convergence of a given series.
3. To test divergence of a given series.
4. Solution of linear system of equations using Gauss Elimination method.
5. Solution of linear system of equations using Gauss – Seidel method.
6. Solution of linear system of equations using L-U decomposition method.
7. Plots of the exponential, logarithmic and trigonometric functions and comparison with the plots of their Taylor series expansion till first 10 terms

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

Essential/recommended readings

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2010), 10th Edition
2. Murray Spiegel, Seymour Lipschutz, John Schiller, Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill (2009), 2nd Edition
3. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
4. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill (2006)

Suggestive readings

1. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007).

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

DISCIPLINE SPECIFIC CORE COURSE – 8: Analog Electronics-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analog Electronics-II ELDSC-8	4	3	0	1	Course Admission Eligibility	Basic knowledge of BJT based circuits

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop understanding of Analog Devices starting with ideal Op Amp model and assessing the practical device limitations and learning importance of the Data Sheets.
- Design linear applications but also design of non-linear application without feedback (voltage comparators), with positive feedback (Schmitt Trigger), and the negative feedback but using non- linear elements such as diodes and switches (sample and hold circuits)
- Study of Oscillators and other Signal Generators
- Study Multivibrators and its applications using IC 555 Timer

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basic building blocks of an op-amp and its parameters for various applications design.
- Elucidate and design the linear and non-linear applications of an op-amp.
- Understanding and Designing of various Signal Generators
- Understand the working of multivibrators using IC 555 timer

SYLLABUS OF ELDSC-8 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Basic Operational Amplifier: Concept of differential amplifiers (Dual Input Balanced and Unbalanced Output), Block Diagram of an Operational Amplifier, Characteristics of an Ideal Op-Amp.

Open and Closed Loop Configurations: Inverting, Non-Inverting and Differential Amplifier

Op-Amp Parameters (IC741): Differential Input Resistance, Output Resistance, Input Capacitance, Input Voltage Range, Large Signal Voltage Gain, Offset Voltage Adjustment Range, Input Offset Voltage, Input Offset Current, Input Bias Current,

Common Mode Rejection Ratio, Supply Voltage Rejection Ratio, Bandwidth, Gain Bandwidth Product, Slew Rate.

UNIT – II (11 Hours)

Frequency Response of an Op-Amp.: High Frequency Op-Amp Equivalent Circuit, Open Loop Voltage Gain as a function of Frequency, Closed Loop Frequency Response, Effect of Slew Rate in Applications.

Linear Applications of an Op-Amp: Summing, Scaling and Averaging Amplifiers, Subtractor, Integrator, Differentiator, Current to voltage converter.

UNIT – III (11 Hours)

Active Filters: First Order Low Pass and High Pass Butterworth Filter, Concept of Higher Order Butterworth Filters, Band Pass Filter, Band Reject Filter, All Pass Filter.

Non-Linear Applications of an Op-Amp: Basic Comparator, Level Detectors, Schmitt Trigger, Characteristics of Comparator, Voltage Limiters, Sample and Hold circuit.

UNIT – IV (11 Hours)

Signal Generators: Phase Shift Oscillator, Wien Bridge Oscillator, Square Wave Generator, Triangle Wave Generator, Saw Tooth Wave Generator

IC 555 Timer: Block Diagram, Astable and Monostable Multivibrator Circuit, Applications of Monostable and Astable Multivibrator.

Practical component (if any) – Analog Electronics- II
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the non-ideal behaviour by parameter measurement of Op-amp.
- Design application oriented circuits using Op-amp ICs.
- Generate square wave using different modes of 555 timer IC.
- Prepare the technical report on the experiments carried.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an Op-Amp.
3. Designing of an Integrator using op-amp for a given specification.
4. Designing of a Differentiator using op-amp for a given specification.
5. Designing of analog adder/subtractor circuit.
6. Designing of a First Order Low-pass / High Pass Filter using op-amp and study its frequency response.
7. Designing of a RC Phase Shift Oscillator using Op-Amp.
8. Study of IC 555 as an astable multivibrator.

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

Essential/recommended readings

1. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits , Pearson Education
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education
3. Nutan Kala Joshi and Swati Nagpal, Basic Electronics, Khanna Publishers

Suggestive readings

1. D.Roy Choudhary and Shail B. Jain, Linear Integrated Circuits, New Age International Publishers
2. A.P.Malvino, Electronic Principals, Tata McGraw-Hill

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

DISCIPLINE SPECIFIC CORE COURSE – 9: Signals and Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Signals and Systems ELDSC-9	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand mathematical description and representation of continuous and discrete time signals and systems.
- Develop input-output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
- Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in *s*- domain.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Represent various types of continuous-time and discrete-time signals and their convolution.
- Understand concept of convolution, LTI systems and classify them based on their properties and determine the response of LTI system.
- Determine Fourier series of periodic signals.
- Analyze various systems using Fourier and Laplace transformations.

SYLLABUS OF ELDSC-9 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Signals and Systems: Continuous and discrete time signals, time domain operations (shifting, scaling, reflection, *etc.*) with precedence rules. Exponential and sinusoidal signals, impulse and unit step functions, continuous-time and discrete-time systems and their basic properties.

UNIT – II (11 Hours)

Linear Time -Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative. LTI systems with and without

memory, invariability, causality, stability, unit step response. Differential and Difference equation formulation. Block diagram representation of first order systems.

UNIT – III (12 Hours)

Fourier series Representation of Periodic Signals: Fourier series representation of periodic continuous and discrete signals. Convergence of the Fourier series (Dirichlet conditions).

Fourier Transform: Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and multiplication Properties, Properties of Fourier transform and basic Fourier transform Pairs.

UNIT – IV (11 Hours)

Laplace Transforms: Unilateral Laplace transform, inverse Laplace transform, properties of the Laplace transform, Laplace transform pairs, Laplace transform for signals. Solutions of first and second order differential equations with initial conditions.

Practical component (if any) – Signals and Systems
(Scilab/MATLAB/ OCTAVE/Other Mathematical Simulation software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Generate/plot various signals, there transformation and compute convolution
- Generate/plot Fourier series of periodic signals.
- Compute Fourier transform
- Learn the use of simulation tools and design skills.

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Plotting/generation of signals: continuous time
2. Plotting/generation of signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of signals
5. Fourier series representation of continuous time signals.
6. Fourier series representation of discrete time signals.
7. Computation of Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.

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

Essential/recommended readings

1. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
2. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007).

Suggestive readings

1. S. Haykin and B. V. Veen, Signals and Systems, John Wiley & Sons (2004).

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

DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Artificial Intelligence and Machine Learning ELDSE-1A	**4**	**3**	**-0**	**1**	**Course Admission Eligibility**	**Basic knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:
Artificial Intelligence and Machine Learning has emerged as one of the most rapidly growing technology sector in today's time. This fascinating technology area which deals with designing 'machines which can think' is finding widespread application in almost every industrial and domestic sector. Advancement in the field of AI and ML has also led to complete revolution in the other technology areas including Robotics, embedded systems and Internet of Things. AI and ML is considered to be one of the major contributor to the paradigm shift in technology which has taken place over the past few decades, which is very similar in scale to past events such as the industrial revolution, the computer age, and the smart phone revolution.
This course will give an opportunity to gain expertise in one of the most fascinating areas of science and technology through a well-structured classroom program that covers almost all the topics related to designing machines which can replicate human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence and Machine Learning.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Build intelligent agents for search and games
- Solve AI problems through programming with Python
- Learning optimization and inference algorithms for model learning

- Design and develop programs for an agent to learn and act in a structured environment
- To study different supervised and unsupervised learning algorithms.
- To understand the application development process using ML

.

SYLLABUS OF ELDSE-1A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Introduction: Concept of AI, history, current status, scope, Modeling Techniques: Turing Test Approach, Cognitive Modeling Approach, Rational Agent Approach and Laws of Thought Approach, AI System Architecture: Concept of Agent & Environment, Types of Agents: Reactive Agent, Model based Reflex Agent, Omniscient Agent, Goal Based Agent, Utility based Agent and Learning Agent, Knowledge based Agents and Knowledge Representation Techniques. Types of Environment, PEAS representation of Intelligent Agents, Problem Solving Agents, AI Problem Formulation, State space representation

UNIT – II (11 Hours)

Search Algorithms: Uninformed Search Algorithms: Breadth first search, Depth First Search, Depth Limited Search, Uniform Cost Search and Bidirectional Search, Heuristic Search Algorithms: concept of Heuristic Function, Greedy Best First Search, A* search algorithm, Game Search Algorithms: Minimax Search Algorithm and Alpha-Beta Pruning.

Simple AI problems (such as Water Jug Problem, Maze Problem, 8-Tile Puzzle problem, Traveling Salesman Problem).

UNIT – III (11 Hours)

Probabilistic Reasoning Model: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability, Markov Model and Hidden Markov model.

Markov Decision Process Model: MDP formulation, Elements of MDP Model, concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world

UNIT – IV (12 Hours)

Machine Learning: Types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning. Supervised Learning Vs. Unsupervised Learning **Supervised Learning Techniques:** Regression Analysis, Linear Regression, Classification Algorithm, Logistic Regression, K-NN Algorithm, Classification Vs. Regression, Linear Regression Vs. Logistic Regression, Decision Tree Classification Algorithm, Random Forest Algorithm, Clustering in Machine Learning, Hierarchical Clustering in Machine Learning, K-Means Clustering Algorithm

Practical component (if any) – Artificial Intelligence and Machine Learning
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement various search algorithms
- Implement Bayesian network
- Demonstrate classification and clustering
- Make a small project

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Write a program to solve the given search tree using Breadth First Search
2. Write a program to solve the given search tree using Depth First Search and Depth Limited Search
3. Write a program to solve the given search tree using Uniform Cost Search
4. Write a program to solve the given search tree using Greedy Best First Search
5. Write a program to solve the given game search tree using Minimax Search
6. Program for construction and inference of a Bayesian network
7. Write a Program to perform Regression on given data sets
8. Write a Program to demonstrate Classification
9. Write a Program to demonstrate Clustering
10. Mini Project work

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

Essential/recommended readings

1. Stuart Russell and Peter Norvig, —Artificial Intelligence: A Modern Approach‖ , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, —Artificial Intelligence‖, Tata McGraw Hill
3. Trivedi, M.C., —A Classical Approach to Artificial Intelligence‖, Khanna Publishing House, Delhi.
4. Saroj Kaushik, —Artificial Intelligence , Cengage Learning India, 2011
5. Introduction to Machine Learning with Python, by Andreas C. Müller, Sarah Guido, O'Reilly Media, Inc., 2016

Suggestive readings

1. David Poole and Alan Mackworth, —Artificial Intelligence: Foundations for Computational Agents, Cambridge University Press 2010
2. Machine Learning by Tom. M. Mitchell, Tata McGraw Hill
3. Introduction to Machine Learning by Nils. J. Nillson

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algorithm Design and Analysis ELDSE-1B	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Basic Knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the understanding of usage of basic data structures like stack, queue, linked list, trees
- To introduce the students to design and analyse algorithms
- To highlight the differences between various problem-solving techniques for an efficient algorithm design
- To provide an understanding of algorithm design through a survey of the common algorithm design paradigms of Iterative techniques, Divide and Conquer, Dynamic Programming, Greedy Optimization
- To develop proficiency in Problem Solving and Programming
- To provide an understanding of time and space complexities of algorithms designed to solve computational problems
- To familiarize with various Searching and Sorting techniques

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement data structures like Stacks, Queues. Linked List, trees
- Use an appropriate algorithm using the algorithm design techniques, namely,
- Iterative, Divide and Conquer, Greedy, Dynamic Programming for a series of
- computational problems
- Apply various Searching and Sorting techniques
- Solve computational problems with an understanding of time and space complexities of algorithms

SYLLABUS OF ELDSE-1B Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Data Structures: Stacks, array implementation of stack, operation on stacks, application of stacks-conversion of infix expression to prefix and postfix, evaluation

of expression; Queues, array implementation of queues, operation on queues, Linked List and its implementation of stack and queue.

UNIT – II (11 Hours)

Trees: Introduction to trees, Binary search tree, preorder, postorder and inorder traversal (recursive)

Searching Techniques: Linear and Binary Search, Hashing techniques

UNIT – III (12 Hours)

Algorithm Design Techniques: Iterative techniques-Insertion Sort, Divide and Conquer-Merge Sort, Dynamic Programming-Weighted Interval Scheduling, 0-1 Knapsack Problem

UNIT – IV (11 Hours)

Greedy Algorithm- Interval Scheduling, Fractional Knapsack problem, Dijkstra's shortest path problem. Comparison between Dynamic programming and Greedy algorithm

Sorting Techniques: Quick Sort, Heap sort, Sorting in Linear Time - Bucket Sort, Radix Sort and Count Sort, Time and Space complexity

Practical component (if any) – Algorithm Design and Analysis
(Python/MATLAB software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement Data Structures
- Develop algorithms and write programs in Python language
- Write programs based on Algorithm design techniques
- Implement various Sorting techniques
- Prepare a Technical Report on the experiments carried

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Program to create a stack and perform Pop, Push, traverse operations on the stack using Linear Linked List
2. Program to create a linear queue using Linked List and implement insertion, deletion and display of the queue elements
3. Program to create a Binary Tree to perform traversals (Preorder, Postorder, Inorder) using the concept of recursion.
4. Program to solve the Interval Scheduling problem
5. Program to solve the Weighted Interval Scheduling problem
6. Program to solve the 0-1 Knapsack problem
7. Program to implement Insertion Sort
8. Program to implement Merge Sort
9. Program to implement Heap Sort
10. Program to implement Quick Sort

11. Program to implement Bucket Sort
12. Program to implement Radix Sort
13. Program to implement Binary Search

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

Essential/recommended readings

1. M.T.Goodrich, R.Tamassia, M.H.Goldwasser, Data Structures & Algorithms, Wiley
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Prentice Hall India. Third edition (2015).
3. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education India, First Edition (2013).
4. S. Lipschutz, Data Structures with C, Schaum's Outlines Series, Tata McGraw Hill
5. A.M.Tenenbaum, Y.Langsam, M.J. Augenstein, Data Structures using C, Pearson/PHI

Suggestive readings

1. Sarabasse and A.V. Gleder, Computer Algorithm-Introduction to Design and Analysis, Pearson Education, Third Edition (1999).

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

DISCIPLINE SPECIFIC ELECTIVES (DSE-3)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematics Foundation for Computing ELDSE-1C	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Basic Knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:

- The aims is to introduce to students of electronics new mathematics such as Boolean algebra, relations, and graph theory which though look abstract concepts can be used effectively to design and analyze electronic circuits.
- To apply mathematical techniques for real world and engineering problems and expose students to some front-line techniques used in industry and academics.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Formulate recurrence relations to solve problems involving an unknown sequence. Student should see the significance in light of the Forbenius method they learn.
- Use Boolean algebra to design and analyze digital switching circuitry, such as found in personal computers, pocket calculators, CD players, cellular telephones, and a host of other electronic products.
- Appreciate circuit analysis in terms of topology.

SYLLABUS OF ELDSE-1C Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (12 Hours)

Elementary Combinatorics: Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formula.

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

UNIT – II (10 Hours)

Recurrence Relations: Recurrence Relations, generating functions, iteration and induction, Linear Recurrence Relations with constant coefficients and their solution, Substitution Method, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

UNIT – III (11 Hours)

Boolean Algebras and Switching Circuits: Axioms of Boolean Algebra, De Morgan's law, Simplification of Boolean Expressions, Representation theorem, Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial,3, 4 and 5 variable Karnaugh diagrams, Quine-McCluskey method, Switching circuits and applications of switching circuits.

UNIT – IV (12 Hours)

Graph Theory: Introduction to Graph Theory with emphasis on DC circuit analysis, Representing circuital network as a graph, identification of branches, nodes, Tree branch/ twig. Formulation of incidence matrix. Usage of incidence matrix to solve for node voltage in two loop DC circuits with voltage and/ or current sources.

Practical component (if any) – Mathematics Foundation for Computing
(Python software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Implement python programs to calculate permutation and combinations.
- Write python programs based on Boolean Algebra and Minimize Karnaugh diagrams
- Should be able to do node analysis using incidence matrix/ Graph Theory.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Write a program that generates all the permutations of a given set of digits (with or without repetitions).
2. Write a program to generate Fibonacci Series using recursion.
3. Write a program to implement binary search using recursion.
4. Write a Program to accept the truth values of variables x and y, and print the truth table of the following logical operations:
    a. Conjunction
    b. Disjunction
    c. NAND
    d. NOR
    e. Exclusive OR
    f. Exclusive NOR
    g. Negation

5. Determine node voltages of given two loop circuits using given incidence matrix.

Essential/recommended readings

1. V. Krishnamurthy, Combinatorics, Theory and Application, Affiliated East-West Press 1985.
2. C.L. Liu & Mahopatra, Elements of Discrete mathematics, 2nd Sub Edition 1985, Tata McGraw Hill
3. G. Langholz, A. Kandel and J. Mott, Foundations of Digital Logic Design, World Scientific, Singapore, 1998.
4. Kenneth H. Rosen. Discrete Mathematics and Its Application. McGraw-Hill Education, Pennsylvania, U.S.A, 2011.
5. M.O. Albertson and J.P. Hutchinson, Discrete Mathematics with Algorithms, John Wiley and Sons (USA, 1988).

Suggestive readings

1. T.H. Coremen, C.E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice Hall India (3rd edition 2009)

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT

GENERIC ELECTIVES (GE-1)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Circuits and Interfacing ELGE-3A	**4**	**3**	**0**	**1**	**-**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the basics of operational amplifier and it's linear and nonlinear applications.
- To familiarize IC 555 Timer and its application
- Understand the working of multivibrators
- To understand working of various types of transducers.
- To introduce concept of embedded systems using Arduino.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Familiarize with design of the linear and non-linear applications of an op-amp.
- Understand the working of multivibrators
- Understand working of various types of transducers.
- Understand working of Arduino

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

UNIT – I (12 Hours)

Basic Operational amplifiers: Block diagram, symbol, op- amp parameters (IC 741).

Op -Amp Circuits: Closed loop Inverting, Non-inverting, Summing and difference amplifier, Integrator, differentiator, Instrumentation Amplifier, Audio Amplifier (LM386) Voltage to current converter.

Comparators: Basic comparator, Schmitt Trigger.

UNIT – II (11 Hours)

Signal Conditioning Circuits: Active filters: First order Butterworth low pass and high pass filter, Wide Band -Pass filter, Wide Band-Reject filter, All-Pass filter (Designing with Circuit diagrams and formulas only for all filter)

Signal Generators: Phase shift oscillator, Wein Bridge oscillator (Designing with Circuit diagrams and formulas)

Multivibrators (IC 555): Block diagram, Astable and Monostable circuit. Applications of Astable and Monostable multivibrators.

UNIT – III (11 Hours)

Transducers (Basic Working): Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge),Capacitive (diaphragm), Hall effect sensors, Microphone, Touch Switch, Piezoelectric sensors, light (photoconductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), Pressure sensor.

UNIT – IV (11 Hours)

A-D and D-A Conversion: D-A conversion: 4-bit binary weighted resistor type, circuit and working. Circuit of R-2R ladder- Basic concept. A-D conversion characteristics (Number of channels, resolution), successive approximation ADC. (Mention the relevant ICs for all).

Data Acquisition using Arduino: Arduino: Birth, Open-Source community, Functional Block Diagram, Functions of each Pin, Applications of Arduino, IDE, Basic Interfacing and I/O Concept, Interfacing LED, Switch,7seg LED.

Practical component (if any) – Electronic Circuits and Interfacing
(Hardware and Circuit Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Design application-oriented circuits using Op-amp.
- Design application-oriented circuits using timer IC
- Familiarization with different specifications of arduino boards.
- Interfacing of various sensors with arduino.

LIST OF PRACTICALS (Total Practical Hours – 30 Hours)

1. Study of inverting and non-inverting amplifier.
2. Study of analog adder/ subtractor circuit.
3. Study of basic integrator circuit/ basic differentiator circuit.
4. Design of first order LPF / first order HPF.
5. Study of basic astable multivibrator / monostable multivibrator.
6. 555 Timer-Rain alarm /Motor control by PWM /LED flasher circuit.

7. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement Strain using half and full bridge.)/ To determine the Characteristics of LVDT.
8. To determine the Characteristics of Thermistors and RTD.
9. Test the different Arduino Boards, Open-Source and Arduino Shields and install Arduino IDE and its development tool.
10. Develop a program to Blink LED for 1second when switch is pressed.

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

Essential/recommended readings

1. Measurement Systems, 4/e, Doeblin McGraw Hill, New York, 1992.
2. Electrical Measurements & Electronic Measurements by A.K. Sawhney
3. Electronic Instrumentation by H.S Kalsi, McGraw Hill
4. R. A. Gayakwad, Op-Amps and Linear IC_s, Pearson Education (2003)
5. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.
6. Beginning Arduino Programming, Brian Evans, Technology in Action

Suggestive readings

1. Instrumentation- Devices and Systems by Rangan, Sarma, and Mani, Tata-McGraw Hill
2. Instrumentation measurements and analysis by Nakra & Choudhary
3. Measurement & Instrumentation- DVS Murthy
4. Timer, Op Amp, and Optoelectronic Circuits & Projects, Forrest M Mims, Master Publishing Inc.
5. Exploring Arduino, Jeremy Blum, Wiley
6. Beginning Arduino, Michael McRobetrs, Technology in Action
7. Practical Arduino Engineering, Harold Timmis, Technology in Action
8. Practical Arduino: Cool Projects for open-source hardware, Jonathan Oxer, Hugh Blemings, Technology in Action

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

GENERIC ELECTIVES (GE-2)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Modelling and Simulation ELGE-3B	**4**	**3**	**0**	**1**	**12th Pass**	**Basic Knowledge of Python language**

Learning Objectives

The Learning Objectives of this course are as follows:
It covers modeling and simulation principles as applied to engineering and social sciences. It discusses the techniques for modeling a simple to slightly complex system and perform statistical analysis. It covers about the steps involved in developing models for static, continuous and discrete systems. It also offers the introduction to number of latest models and simulation tools being used in industry with a set of examples. Examples may include modeling and analysis of manufacturing systems, computer-communication networks, operating system and various utilities and logistic systems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Enable to perform simulations for developing models in order to solve problems in static and dynamic systems.
- Evaluate simulation models and do the analysis of a number of systems existing in real life.
- Synthesize queuing theory, random numbers generators and their application to modeling and simulation.

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

UNIT – I (12 Hours)

Introduction to Modeling and Simulation: Introduction and historical development in Modeling and Simulation. System, Model and Simulation. Real system vs. Model of the system. Analytical solution vs. Simulation. Static vs. Dynamic Simulation Models. Continuous time vs. Discrete time modeling system. Hybrid systems, Feedback systems, Iterative systems Modeling. Random numbers in Simulation, random variables with discrete and continuous probability distribution. Deterministic and Stochastic Modeling System. Mathematical Modeling & Mathematical Tools.

UNIT – II (11 Hours)

Modeling Techniques and Design Steps: Discrete Event Simulation Models. System Models and Events. State variables, Entities and Attributes. Steps of Model Designs, Verification, validation and calibration of the Model.
Single server Queuing system, Database server as Queuing System.
Monte Carlo Method for static System.
Discrete and continuous Markov Models.

UNIT – III (11 Hours)
Simulation Techniques and Specifications: Advantages and disadvantages, Limitations, Steps in Simulation Study.
Differential Equation System Specification DESS, Discrete Event System Specification DEVS, Discrete Time System Specification DTSS.
Random numbers in Simulation. Random numbers generation and testing, Random variables with Discrete and continuous probability distribution. Simulation with Mathematical Models, Stochastic Models

UNIT – IV (11 Hours)
Modeling and Simulation Tools with Applications: System development, Project planning, System definition, Model formulation, input data collection and analysis, Model translation, verification and validation, experimentation and Analysis.
Different Applications domain of Modeling and Simulation.
Case Studies: Simulation of DEVS in a Bank, School, Hospital, or any such system. Modeling and analysis of a manufacturing systems, grocery store, computer-communication network or CPU scheduling.

Importance of different Modeling and Simulation softwares and their selection.
Brief overview and usefulness of Modeling and Simulation softwares- Scilab, SPICE, VHDL, Freemat, IMODELER, platform JModelica.org, Statistical Analysis Software SAS, MS- Excel.

Practical component (if any) – Modelling and Simulation
(Python or any Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Program for implementation, testing of random numbers
- Simulation of gaming dice
- Different Models implementation- GPSS, DEVS
- Implementation of DESS, Monte Carlo Method, Markov Chain
- Simulation of real time problems

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. Implement different methods of random number generation
2. Simulating games of dice that generate discrete random variate, using random number generation

3. GPSS models - queue, storage, facility, multi-server queue, decision making problems
4. Perform an experiment on Testing of random numbers.
5. Write a simulator for any DEVS model that has scalar real values for its inputs, states and outputs.
6. Define a DEVS counter that counts the number of non-zero input events received since initialization and outputs this number when queried by a zero valued input.
7. Formulate a causal simulator for multi-component DESS.
8. Implementing an application of Monte Carlo methods.
9. Implement an application of Markov's chain.
10. Simulation of single queue server system.
11. Study of an implemented goal programming system and on decision making tools.
12. Study of a Game theory problem and solution.

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

Essential/recommended readings

1. Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman, 3ed, Theory of Modeling and Simulation, Academic Press : Elsevier 1985.
2. Narsingh Deo, System Simulation with Digital Computers, Prentice Hall of India, 1979.
3. Geoffrey Gordon, System Simulation, 2ndEd., PHI, 1987
4. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, 3rdEd., Tata McGraw Hill, 2003

Suggestive readings

1. Raj Jain, Art of Computer Systems Performance Analysis, John Wiley and Sons, Inc,1991
2. Sheldon M. Ross, Simulation, 4thEd., Elsevier 2008
3. Jerry Banks and John S. Carson, Barry L Nelson, Discrete-Event System Simulation, 5thEd., Prentice Hall, 2010

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

DISCIPLINE SPECIFIC CORE COURSE – 7: Analytical Instrumentation I (INDSC3A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analytical Instrumentation I (INDSC3A)	**04**	**02**	**0**	**02**	**Course admission eligibility**	**Basic knowledge of chemistry**

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize with the classification of analytical methods
- To understand the fundamentals of qualitative and quantitative analysis concepts.
- To categorize and understand the principle behind various separation techniques (planar and columns) and their instrumentation.
- To understand the principle, instrumentation and applications of visible and ultraviolet molecular spectroscopy

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the classification of analytical methods
- Comprehend fundamentals of qualitative and quantitative analysis
- Differentiate between principle, instrumentation and operation of PaperChromatography and Thin layer chromatography
- Identify various Column Chromatographic techniques and their instrumentation
- Understand the concept of UV-Visible spectroscopy

SYLLABUS OF DSC-7

UNIT – I **(8 hours)**

Introduction to Analytical methods: Classification of Analytical Methods: Classical and Instrumental, Types of Instrumental Methods, Various sample extraction techniques. Instruments for analysis, Calibration of instrumental methods, Selecting an analytical method

UNIT – II **(7 hours)**

Chromatographic Separation methods: Planar Chromatographic methods: Principle and applications of Paper Chromatography, Thin layer chromatography (TLC) and High-Performance Thin Layer Chromatography (HPTLC).

UNIT – III **(8 hours)**

Column Chromatography: General Description of column chromatography, Classification of Chromatographic Methods, Elution in Column Chromatography, Migration rate of solutes, Band Broadening and column efficiency, Optimization of Column Performance.
Gel Permeation Chromatography (GPC): Principle, Instrumentation and Applications.

UNIT – IV **(7 hours)**

Molecular Spectro-analytical Methods of Analysis: Colorimetry and Spectrophotometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and limitations, Instrumentation of single beam and double beam instrument.

Practical component: **(60 hours)**

1. Preparation of solutions and buffers.
2. Introduction to the use of Analytical Equipment (Analytical Balance, Volumetric Glassware, pH meter).
3. To extract the spinach pigments using liquid-liquid extraction.
4. Separation of plant pigments by paper chromatography.
5. Separation of food colours by paper chromatography.
6. Separation of pharmaceutical sample mixture using thin layer chromatography.
7. Separation of amino acids/sugar/carbohydrates by Thin Layer Chromatography.
8. Separation of cobalt chloride and Blue Dextran mixture by Gel Permeation Chromatography.
9. To study the effect of various solvents on membrane permeability of beetroot using visible spectroscopy
10. Determination of pKa value for a dye using visible spectroscopy.
11. Spectrometric determination of iron in water samples using double beam spectrophotometer.
12. To identify the given unknown colourless samples using UV spectrophotometer.

Essential/recommended readings

1. H.H. Willard, L.L Merrit, J.A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 2004.
2. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 7th edition, 2016.
3. James W. Robinson, Eileen Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, CRC Press, 7th edition, 2014
4. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 6th edition 2009.

Suggestive readings

1. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 2019.
2. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2015.
3. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition, 2011

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

DISCIPLINE SPECIFIC CORE COURSE – 8: Operational Amplifiers and Applications (INDSC3B)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Operational Amplifiers and Applications (INDSC3B)	04	03	0	01	Course admission eligibility	Basics of Analog Electronics- BJT circuits

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide understanding of DC and AC characteristics of operational amplifiers (op-amp)
- Design various filters and oscillators circuits using op-amps
- Study linear and non-linear applications of op-amp
- Design multivibrators and other circuits using op-amp.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the DC and AC characteristics of operational amplifiers (op-amp) and its effect on output, significance of op-amp parameters, and compensation techniques
- Elucidate and design circuits to study linear and non-linear applications of op-amps and special application ICs
- Explain the working of signal generators using op-amp
- Explain and compare the working of multivibrators using general purpose op-amp

SYLLABUS OF DSC- 8

UNIT – I **(11 hours)**

Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output, Single input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741).

UNIT – II **(12 hours)**

Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

Op-Amp Circuits: Open and closed loop configuration, Limitations of open loop, characteristics of ideal op-amp, frequency response of op-amp in open loop and closed loop. Non-Inverting & Inverting amplifiers, Summing & Difference amplifiers, Log & antilog amplifiers, Instrumentation Amplifier, Integrator & Differentiator circuit, Voltage to current converter, Current to voltage converter.

UNIT – III **(11 hours)**

Comparators: Basic comparator, Level detector, Schmitt Trigger. Voltage limiters, Signal **Generators:** Phase shift oscillator, Wein bridge oscillator, square wave generator, triangle wave generator, saw tooth wave generator, and Multivibrators using opamp.

UNIT – IV **(11 hours)**

Signal conditioning circuits: Sample and hold systems, Active filters: Low pass and high pass Butterworth filter (first and second order), Band pass filter, Band reject filter, and All pass filter.

Practical component: **(30 hours)**

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a first order low-pass filter using op-amp and study its frequency response.
7. Designing of a first order high-pass filter using op-amp and study its frequency response.
8. Designing of a RC phase shift oscillator using op-amp.
9. Design an astable multivibrator using opamp.
10. Design a schmitt trigger circuit using op-amp and study its hysteresis loop.

Essential/recommended readings

1. R. A. Gayakwad, Op-Amps and Linear Integrated circuits, Pearson Education, 4th Edition, May 2015.
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, 6th Edition, Aug 2000, Pearson,
3. Pearson Education (2001).J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).

Suggestive readings

1. A.P.Malvino, David J Bates, Electronic Principals, 7th Edition, Tata McGraw-Hil Education, (July 2017).

DISCIPLINE SPECIFIC CORE COURSE – 9: Mathematical Techniques for Instrumentation (INDSC3C)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Techniques for Instrumentation (INDSC3C)	**04**	**03**	**0**	**01**	**Course admission eligibility**	**Basic knowledge of mathematics**

Learning Objectives

The Learning Objectives of this course are as follows:

- To give an ability to apply knowledge of mathematics to engineering problems.
- To introduce the basic concepts required to understand, construct, solve and interpret
- differential equations.
- To teach methods to solve differential equations of various types.
- To teach students to understand the Laplace transform method to solve ordinary differential equations.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Recognize ODEs of varying order and use these to solve engineering problems.
- Derive mathematical models of physical systems.
- Solve the most common PDEs, recurrent in engineering using standard techniques.
- Demonstrate the utility of Laplace transform in solving the ordinary differential equations

SYLLABUS OF DSC-8

UNIT – I **(12 hours)**

Ordinary Differential Equations: First Order Ordinary Differential Equations, Separable Ordinary Differential Equations, Exact and Non-Exact Differential Equations, Linear Ordinary Differential Equations. Linear Independence and Dependence, Linear Differential Equations of Second Order with Constant Coefficients and Variable Coefficients: Homogeneous and non-homogeneous.

Method of Variation of Parameters, Electric Circuits (RL, RC and RLC circuits).

UNIT – II **(11 hours)**

Partial Differential Equations: Formation of Partial Differential Equation, Partial Differential Equation of First Order: Linear and Non-linear. Method of Separation of Variables. Classification of Partial Differential Equations of Second Order, One-dimensional Heat equation, Modeling a Vibrating string and the Wave Equation.

UNIT – III **(11 hours)**

Laplace Transform: Laplace Transform and its properties, Convolution theorem, Laplace Transform of Periodic function, Inverse Laplace transforms and its properties. Application of Laplace Transform to Differential Equations with Constant Coefficients, Solution to System of Simultaneous Differential Equations.

UNIT – IV **(11 hours)**

Fourier series and Transforms: Fourier Series: Even and Odd functions, Half range expansions, Fourier Integral, Fourier Transforms: Fourier Sine and Cosine Transforms, Forced Oscillations.

Practical component: **(30 hours)**

1. Plot the trigonometric functions like sin (x), cos(x), tan(x).
2. Plot the following algebraic expressions log(x), exp(x), x^2, x^3, $x+x^2+\exp(x)$.
3. Plot the following unit step functions u(t), u(t-4) and u(t+2).
4. Solve the first-order ordinary differential equations.
5. Solve the linear differential equation of second order with constant coefficients.
6. Solve the linear differential equation of second order with variable coefficients.
7. Evaluate the Laplace Transform of a given function.
8. Evaluate the inverse Laplace transform of a given function.
9. Evaluate the Fourier series coefficients of a given function.
10. Computing the Fourier Transform of a given signals.

Essential/recommended readings

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition (2020).
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing ,7th Edition.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 43rd Edition (2017).
4. HK Dass, Higher Engineering Mathematics, S.Chand Publishing,22nd Edition.

Suggestive readings

1. Dennis G.Zill,Advanced Engineering Mathematics, Jones & Bartlett Publishers,6th Edition (2016).
2. John Bird**,** Higher Engineering Mathematics,2017

DISCIPLINE SPECIFIC ELECTIVE COURSE – 1: Signal and Systems (INDSE3A)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Signal and Systems (INDSE3A)	04	03	0-	01	Course admission eligibility	Basic knowledge of mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To give information about signals and systems mathematically and perform mathematical operations on signals.
- To teach the properties and the response of the LTI system using convolution.
- To give knowledge about Laplace transform, Fourier Transform and Z-transform for analysing continuous-time and discrete-time signals and systems.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concept and types of signals and systems and their properties which is useful to learn digital tele-communication
- Classify systems based on their properties and determine the response of LTI system using convolution
- Understand how to apply the Laplace transform, Fourier Transform and Z-transform for analyzing continuous-time and discrete-time signals and systems

SYLLABUS OF DSE-1

UNIT – I **(12 hours)**

Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and Unit step functions, Continuous-Time and Discrete-Time Systems.

UNIT – II **(11 hours)**

Linear Time-Invariant Systems (LTI): Continuous & discrete time LTI systems, Convolution Sum, Convolution integral, Properties of LTI Systems: Commutative, Distributive and Associative. LTI systems with and without memory, Invariability, Causality, Stability.Unit Step response of System, Differential and Difference equation formulation, Block diagram representation of first order systems.

UNIT – III **(11 hours)**

Sampling: The Sampling Theorem and its implications. Spectra of sampled signals.
Laplace Transform: Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

UNIT – IV **(11 hours)**

Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms and their inverses.
Z-transform: properties, transfer function representation, inverse Z transform of rational functions- transform of input/output difference equation, stability of discrete time systems- frequency response of discrete time systems.

Practical component: **(30 hours)**

Learning Scilab/MATLAB (Experiments based on available systems).
Exploration of Signals and Systems using Scilab/MATLAB.

1. Generation of Signals: continuous time
2. Generation of Signals: discrete time
3. Addition, multiplication, folding and reversal of signals.
4. Convolution of Signals.
5. Solution of Difference equations.
6. Introduction to SIMULINK and calculation of output of systems represented by block diagrams.
7. Determination of Fourier Series coefficients of the given signals.
8. Determination of Fourier transform of the given signals.
9. Determination of Z transform of the given signals

Essential/recommended readings

1. H. P. Hsu, Signals and Systems, 4th Edition Tata McGraw Hill (2019).
2. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, 4th EditionOrchard Publications (2008).
3. W. Y. Young, Signals and Systems with MATLAB, Springer (2014).
4. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2010).

Suggestive readings

1. Alan V. Oppenheim, Alan S. Willsky with S. Hamid, Signals and Systems, 2nd edition, Pearson, Inc. (2022).

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 2: VHDL Programming(INDSE3B)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
VHDL Programming (INDSE3B)	04	02	0	02	Course admission eligibility	Understanding of Digital Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop the basic understanding of VHDL Modules, entity and architectures.
- To familiarize with different VHDL elements, Keywords and Identifiers
- To describe hardware in VHDL using different Modeling styles.
- To understand concurrent and sequential assignments.
- To introduce built in primitive gates and understand Gate level Modelling

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn about HDL Modules and simulation tools.
- Apply the knowledge of entity, architectures, VHDL Modules to describe hardware.
- Write and analyze various VHDL codes for combinational and sequential logic circuits
- describe hardware using multiple modeling styles.

SYLLABUS OF DSE-2

UNIT – I **(8 hours)**

Introduction to VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, VHDL requirements, VHDL basic language elements, Keywords, Identifiers, White Space Characters, Comments, format, VHDL operators.

VHDL Modeling: Describing hardware in VHDL, entity, architectures, VHDL Modules, Delays, data flow style, behavioural style, structural style, mixed design style, simulating design.

UNIT – II **(8 hours)**

BehavioralModeling: Introduction to behavioural modelling, Signal assignment,

Concurrent and sequential assignments., Entity Declaration, Architecture Body, BehavioralModeling, Process statement, Loop control statements, Multiple Processes, Delay Models, inertial delay model, transport delay model, transport vs inertial delay, Signal Drivers.

UNIT – III **(7 hours)**

Dataflow and Structural Modeling: Data flow Modeling, Concurrent Assignment statements, Block statements, Structural Modeling, Component declaration and Instantiation, generate statements, Process, IF, CASE, LOOP, NEXT, EXIT and ASSERT statements.

UNIT – IV **(7 hours)**

Gate level modeling: Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

Practical component: **(60 hours)**

Learning Scilab/MATLAB (Experiments based on available systems).
Exploration of Signals and Systems using Scilab/MATLAB.

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4-bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 3-bit Ripple counter.

Essential/recommended readings

1. J. Bhasker, VHDL Primer, Pearson, 3rd edition ,2015.
2. Volnei. A.Pedroni, Circuit Design with VHDL, MIT Press; Third edition, 2020
3. Sudhakar Yalamanchili, Introductory VHDL-From Simulation to Synthesis, Pearson Education India. First Edition, 2000

Suggestive readings

1. Douglas Perry, VHDL, McGraw-Hill Education; 4th edition, 2002
2. Charles.H.Roth, Digital system Design using VHDL, Cengage; 2nd edition, 2012

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

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3: Programming using MATLAB(INDSE3C)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Programming Using MATLAB (INDSE3C)	04	02	0	02	Course admission eligibility	Basic knowledge of mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize the student with MATLAB software.
- The objective of this lab is to introduce students to the basic operations of MATLAB.
- To enable the student on how to approach solving Engineering problems using simulation tools.
- To prepare the students to use MATLAB in their project works.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Use MATLAB for interactive computations
- Generate plots and exports them for use in reports
- Familiar with inbuilt MATLAB functions and will be able to generate user defined functions for various applications
- Understands fundamental of digital image and signal processing

SYLLABUS OF DSE-3

UNIT – I **(8 hours)**

Introduction to MATLAB: MATLAB Features, MATLAB Windows, defining variables, variable naming, checking existence, different Operations on variables, clear Operations, data type, precedence, scalar, vectors and Arrays.

UNIT – II **(7 hours)**

Data and Data Flow in MATLAB: Operators in MATLAB, Matrix operations, Reshaping Matrices, Importing & Exporting of Data, Arrays, Data types, File Input-Output, Communication with External Devices.

Character and Strings: Defining character and string, accessing character or substring

from string, string concatenation and comparing, conversion between strings and number. Defining and working with Multidimensional Array and Cell arrays.

UNIT – III **(7 hours)**

Programming: Writing Script Files and Functions files, Error Correction, M-Lint Automatic Code Analyzer, Saving Files. Flow control statement: Conditional or selection, error handling, loop control, program termination. Solution of simultaneous linear equations.

UNIT – IV **(8 hours)**

MATLAB Graphics: Simple Graphics, Graphic Types, Plotting Functions, Creating Plot & Editing Plot, multiple plots, labeling graph, line colors, style and Marker. Introduction of Graphical User Interface (GUI), Generation and implementation of various functions on image.

Practical component: **(60 hours)**

1. Define variables, create a matrix of any size with all possible methods and perform various mathematical operations.
2. Create a multidimensional array and delete any Row/Column from it and create a new array.
3. Plot and label trigonometric functions using subplot command.
4. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.
5. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
6. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
7. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
8. Write a script to test whether a user defined no. is Prime or not.
9. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by the user.
10. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
11. Write a function to generate the AP series.
12. Write a function to generate the GP series.
13. Write a function to generate the Fibonacci series.
14. Write a function to generate the amplitude and frequency modulated signal.

Essential/recommended readings

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, (2019) PHI Learning, New Delhi.
2. Fausett, L. V., Applied Numerical Analysis Using MATLAB, (2005) Prentice Hall, Upper Saddle River, New Jersey.
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, (2019) Ellis-Horwood.

Suggestive readings

1. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENTS

GENERIC ELECTIVES (GE-3):

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Virtual Instrumentation (INGE3A)	04	02	0	02	Course admission eligibility	Basic knowledge Electronics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study the basic structure of virtual instrumentation
- To learn the basic programming concepts in LabVIEW
- To understand the basics of data acquisition for designing a Virtual Instrument

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the importance and applications of Virtual Instrumentation
- Learn the basic programming concepts in LabVIEW
- Recognize the components of Virtual instrumentation and use them for PC Based measurement

SYLLABUS OF GE-3

UNIT – I **(8 hours)**

Graphical System Design: Graphical system design model, Design flow with GSD,

Virtual Instrumentation, Virtual instrument, and traditional instrument, Hardware and software in virtual instrumentation, Virtual instrumentation for Test, control & design, Graphical system design using LABVIEW, Graphical programming & textual programming.

UNIT – II **(7 hours)**

LabVIEW Basics: Introduction, advantages of LABVIEW software environment, palettes, front panel controls & indicators, Block diagram, Data flow program. Repetition and Loops: For loops, while loops, structure tunnels, terminals inside or outside loops, shift registers, feed-back nodes, control timing, case structure.

UNIT – III **(8 hours)**

Arrays and Clusters: Arrays, Introduction, arrays in LABVIEW, creating one – dimensional array controls, indicators, and constants, creating two-dimensional arrays, creating multidimensional arrays, initializing array, deleting, inserting, and replacing elements, rows, columns, and pages within arrays, arrays functions. Clusters: Cluster controls and indicator, order of cluster elements, Cluster operations.

Plotting Data: Types of waveforms, waveform graphs, waveform charts, XY graphs, Intensity graphs & charts, Digital waveform graphs, 3D graphs, customizing graphs & charts, configuring a graph or chart, Displaying special planners on the XY graph.

UNIT – IV **(7 hours)**

File Input/ Output: File formats, file write &read, generating filenames automatically, String handling,string functions, LABVIEW string formats, parsing of strings. Instrument Control: Introduction, GPIB communication, Hardware specification, software architecture, Instrument I/O assistant, VISA, Instrument drivers, serial port communications, using other interfaces.

Practical component: **(60 hours)**

1. Build a VI to compute the expressions Y = (A*B*C) + (D*E) and Y = mx + c.
2. Split an input string into two outputs with reference to a separating character. Find the length of the input string and reverse the string.
3. Build a VI to perform various Boolean Operations (AND, OR, NAND, NOR, XOR).
4. Write a program in LabVIEW to find whether the given number is odd or even.
5. Create a VI to find the sum of first n natural numbers using a While Loop with a feedback node.
6. Create a VI to compute full adder logic using half adder logic as subVI.
7. Write a program in LabVIEW to find the square of the numbers from 1 to 100 using (a) a For Loop and (b) a While Loop.
8. Create a VI to compare the element of two clusters if the value of the corresponding elements are the same switch on LED in the output cluster.
9. Create a VI to compare clusters and Switch ON an LED in the output cluster if the nth element of cluster 1 is greater than the nth element of cluster 2.
10. Create a 2D numeric array (5 x 5) containing random numbers and find its transpose.
11. Create a VI to read a two-dimensional array and find the sum of the elements

in the row-wise and column-wise separately and display the sums of the rows and columns.

12. Create a 1D array and find its reverse.
13. Build a VI to plot a circle in the XY graph using a For Loop.
14. Build a VI that generates a 1D array of random numbers and sort the ascending descending array and also find the max. and min. value array element.
15. Build a cluster control that consists of a seven-segment LED display, a switch, a string control, and numeric control. Split the cluster elements using the Unbundle function and alter the values of some of the cluster controls. Bundle them again and display in a cluster indicator.
16. Using For loop determine the number of odd numbers between a range of numbers entered by the user.
17. Build a VI to plot different colors in an intensity graph using an array.
18. Create a VI to check whether the cluster elements are in range or not. Specify the upper and lower limits. Display the coerced output and a cluster of LEDs to indicate whether a particular cluster element is in the range or not.
19. Write a program to solve x2+bx+c=0.
20. Build a VI to generate two waveforms of different amplitude and frequencies add the signal to find the resultant and plot it on a separate waveform graph.
21. Create a VI to read a two-dimensional array and find the sum of the elements in the row-wise and column-wise separately and display the sums of the rows and columns.

Essential/recommended readings

1. Jovitha Jerome,Virtual Instrumentation Using Labview,PHI Learning Pvt. Ltd. (2010)
2. John Essick, Hands-on Introduction to LabVIEW for Scientists and Engineers, 3rd Edition, 2015.
3. Gupta, Virtual Instrumentation Using Labview 2E, McGraw Hill. (2010)

Suggestive readings

1. Jeffrey Travis, LabVIEW for everyone, Prentice-Hall PTR,2007.

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GENERIC ELECTIVES (GE-3): Industrial and environmental techniques (INGE3B)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/		

				Practice		
Industrial and environmental techniques (INGE3B)	**04**	**02**	**0**	**02**	**Course admission eligibility**	**Basic knowledge of chemistry or analytical chemistry**

Learning Objectives

The Learning Objectives of this course are as follows:

- Demonstration of a clear and exhaustive understanding of the basic concepts of Industrial analysis of different industrial products.
- Impart theoretical and practical knowledge of Analysis of food and food products
- Learn analysis of various pharmaceutical drugs as per the standard pharmacopeia
  To expose to different types of Environmental pollutants and their analysis:

Learning outcomes

The Learning Outcomes of this course are as follows:

- Identify the key environmental factors shaping an industry
- Demonstrate ability to use tools and methodologies for performing analysis for various types of industries
- Develop a detailed professional report of Industry Analysis conducted.

SYLLABUS OF GE-3

UNIT – I **(8 hours)**

Industrial analysis

Paints: Definition, constituents and their functions, flash point of paints, separation of pigments, binder and thinner. Analysis of vehicle and thinner.

Pigments: General outline of identification and analysis of pigments -organic and inorganic pigments, their qualitative chemical test, analysis of white and tinted pigments.

Pesticides: Definition and classification of pesticides, analysis of the following in outline – DDT, Malathion, Diagionon.

Alloys: Composition and estimation of main constituents in in the following – Stainless steel, Brass, Solder and Gun metal

Rubber and Polymers: Mechanical, Thermal, Electrical and Optical properties, Analysis and Characterization.

UNIT – II **(8 hours)**

Analysis of food and food products

Composition and analysis of the following: Milk- Specific gravity, total solid, fat, proteins, lactose, contaminants in milk (QAS, artificial color and antibiotic), Wheat flour- Moisture, ash, oil, fat, protein, fiber, acidity, starch and maltose. Beverages-

Alcohol contents. Tea- Moisture, ash, tannin and caffeine. cyclamate. Honey- Moisture, HMF, Free acid, pH and carbohydrate.

UNIT – III **(7 hours)**

Pharmaceutical analysis

Drug, classification of drugs, introduction to Indian pharmacopoeia. Analysis of following drugs as per IP and BP (monograms) - Amoxycillin, Analgin, Proponolol, Pilocarbine nitrate, Rifampicin, Paracetamol, Nimuselide, Ranitidine.

UNIT – IV **(7 hours)**

Environmental analysis

Analysis of water- color, Odor, pH, taste, conductivity, dissolved solid, hardness, DO, COD, BOD, chlorides, sulphates, nitrites and phosphates.

Analysis of air- Sampling, particulate matter, gaseous pollutants-SOX, NOX, COX and organic pollutant

Practical component: **(60 hours)**

1. Determination of physical parameters of wastewater: pH, color, conductivity and Oxidation reduction potential.
2. Determination of dissolved oxygen in given water sample.
3. Estimation of phosphorous in fertilizer
4. Determination of calcium in cement sample (Titrimetry)
5. Estimation of calcium and Magnesium in dolomite ore.
6. Analysis of water for COD.
7. Colorimetric estimation of trace of nitrogen in the given water sample using Nessler's reagent.
8. Analysis of tea and coffee.
9. Determination of refractive index of given edible oil/solvents and determine its percentage purity.
10. Determination of Ascorbic acid.
11. Colorimetric estimation of Rifampicin (IP 1996)
12. Assay of Aspirin.
13. Estimation of specific gravity and total solids present in milk samples.
14. Estimation of lactose content of milk.
15. Determination of glucose in honey.
16. Quality assessment of Rubber/polypropylene/polyethylene samples

Essential/recommended readings

1. Analytical chemistry: an introduction: D. A. Skoog, D. M. West and F. J. Holler, Saunders the College publishers, 6th edition.
2. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 6th edition 2009.
3. Indian Pharmacopeia (2018)
4. A.B. Mathur and I.S. Bhardwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt Limited, 2003
5. Rao, E. S. (2013). Food Quality Evaluation (I ed.). New Delhi: Variety Book Publishers.
6. DeMan. (2007). Principles of Food Chemistry. Springer, 3rdedition.

Suggestive readings

1. Rao, E. S. (2013). Food Quality Evaluation (I ed.). New Delhi: Variety Book Publishers.
2. DeMan. (2007). Principles of Food Chemistry. Springer, 3rd edition.
1.

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Semester-III

Department of Physical Education & Sports Sciences

BSc. (Hons.) Physical Education, Health Education and Sports

B.Sc.-PE- DSC-7 (4) Kinesiology

Sl. No.	Course Title &Code	Credits	Credit Distribution of the Course			Eligibility Criteria	pre- Requisite ofthe Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Kinesiology	04	3	0	1	XII Passed	NIL

Objective: To impart the knowledge, practices, Applications and analyses related to Kinesiology.

Learning Outcome: Students will learn the science of movement for better sports performance and the basic knowledge practices, Applications and skills of Kinesiology will help to create a strong foundation for Physical Education and Sports to engage human subjects of all ages, sex, and ability.

The student will learn the concepts and applications meaning, aim & objectives, importance of kinesiology for physical education and sports, Fundamental concepts and Applications Centre of gravity, line of gravity, axis and planes of motion, fundamental starting positions, terminology of fundamental movements, and classification of muscles.

The student will develop the understanding skill and practices about Location & Action of Muscles at Various Joints:- a) Upper extremity – shoulder girdle, shoulder joints, elbow joint, b) Neck, trunk (Lumboth oracic region and c) Lower extremity – Hip joint, knee joint, ankle joint and Muscular analysis of fundamental movements:- Walking, running, jumping, throwing, catching, pulling, pushing, striking, hanging.

The student will gain knowledge and Applications of Structure of Motor Actions: - Structure of cyclic and acyclic motoraction and movement combination, functional relationship of different phases of motor action.

The student will gain knowledge and applications of Qualities & Physiological Principles of Movements such as movement rhythm, movement coupling movement flow, movement precision and movement amplitude.

The Student will be able to analyze (Muscular) the Fundamental, Sports Skills, as their innovative applications.

THEORY SYLLABUS (45 hours/Lectures)

UNIT-I **(11 Hours/lectures)**

Meaning, aim & objectives, importance of kinesiology for physical education and sports
Fundamental concepts: Centre of gravity, line of gravity, axis and planes of motion, fundamental starting positions, terminology of fundamental movements, and classification of muscles

UNIT-II **(11 Hours/lectures)**

Location & Action of Muscles at Various Joints:-
a) Upper extremity – shoulder girdle, shoulder joints, elbow joint
b) Neck, trunk (Lumboth oracic region)
c) Lower extremity – Hip joint, knee joint, ankle joint Muscular analysis of fundamental movements:- Walking, running, jumping, throwing, catching, pulling, pushing,striking, hanging

UNIT-III **(12 hours/lectures)**

Structure of Motor Actions: - Structure of cyclic and acyclic motor action and movement combination, functional relationship of different phases of motor action.

UNIT-IV **(11 hours/lectures)**

Qualities & Physiological Principles Of Movements:- Movement rhythm, movement coupling movement flow, movement precision and movement amplitude.

Practical **(30 hours/lectures)**

1. Demonstration of planes & axes of a given movement.
2. Determination of the location of muscles at various joints:
   - i. Shoulder girdle
   - ii. Shoulder joints
   - iii. Elbow joint
   - iv. Hip joint
   - v. Knee joint
   - vi. Ankle joint
3. Muscular analysis of the techniques of game of your specialization
4. Measurement Demonstration of qualities of movement.

SUGGESTED READINGS

1. Bartlett, R. (2007). Introduction to Sports Biomechanics. Routledge Publishers, USA.
2. Blazevich, A. (2007). Sports Biomechanics. A & C Black Publishers, USA.
3. Breer & Zarnicks (1979). Efficiency of human movement. WIB Sounders Co. USA.
4. Hamill, J. and Knutzen, K.M. (2003). Biomechanical Basis of Human Movement. Lippincott Williams and Wilkins, USA.
5. Hay (1993). The biomechanics of sports techniques. Prentice Hall Inc. New Jersey.
6. McGinnis, P. (2004). Biomechanics of Sports & Exercise. Human Kinetics, USA.
7. Oatis, C.A. (2008). Kinesiology.2nd Ed. Lippincott, Williams & Wilkins, USA.
8. Lakshmi, V. (2005), Biomechanics of Body Movement in Sports. Khel Sahitya Kendra: New Delhi
9. Shaw, D. (2014). Mechanical Basis of Biomechanics. Sports Publication: New Delhi
10. Margaria, R. (1979). Biomechanics and Energetics of Muscular Exercise. University Press, Oxford: Great Britain
11. Rai, R. (2003). Biomechanics Mechanics Aspects of Human Motion. Agrim Publication: Mohali
12. Uppal, A.K., Kumar, V.L.G. & Panda, M.M. (2004). Biomechanics in Physical Education and Exercise Science. Friends Publication: New Delhi
13. Shaw, D (2018). Pedagogic Kinesiology. Sports Publication: Delhi
14. Wells, K.F. & Luttgens, K. (1976). Kinesiology: Scientific Basic of Human Motion (6th Ed.) Saunders College Publishing. Philadelphia
15. Robertson, D.G.E. Caldwell, G.E., Hamil, J. Kamen G., & Whittlesey, S.N. (2014). Research Methods in Biomechanics. (2nd ed.) Edwards Brothers Malloy: USA
16. Shaw , D (2003). Sports Biomechanics. Khel Sahitya Kendra: New Delhi.
17. Shaw, D (1998). Biomechanics and Kinesiology of human motion. Khel Sahitya Kendra: New Delhi.

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Semester III

DSC-8 (4) EXERCISE & SPORTS PSYCHOLOGY

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Exercise & Sports Psychology	4	3	0	1	XII Pass	NIL

Objective: - The student is provided with the knowledge Practices Applications and Innovative of psychological aspects of sports performance.

Learning Outcome: - The student learns the psychological aspects to apply to improve the performance in sports. Such core knowledge and skills helps to create a strong foundation to engage human subject of all ages, sex, and ability

The student will learn about Sports and Exercise Psychology and understanding Practices and Applications, motivation, arousal and anxiety and personality.

The student will gain knowledge applications and practices of about the Group, Dynamic, aggression, psychological preparation and performance enhancement.

The learner will able to create data and its interpretation

THEORY SYLLABUS (45 Hours/Lectures)

Unit-I (i) Sports and Exercise Psychology (ii) Concept, Scope, role of sports and exercise psychologist (iii) Importance of Sports and exercise psychology. (iv) Historical development and future of Sports and Exercise Psychology, **(12 Hours/Lectures)**

Unit-II (i) Motivation: guidelines for building motivation, achievement motivation.
(ii) Arousal and Anxiety: Types, phenomena of Anxiety in relation to performance – Drive Theory, Inverted U Theory and IZOF. **(11 Hours/Lectures)**

Unit-III (i) Personality: approaches to personality – Trait, types and psychodynamic theories, determinants of personality, assessment of personality.
(ii) Team Cohesion: a conceptual model of Cohesion, assessment of Cohesion, relationship of Cohesion with performance. **(11 Hours/Lectures)**

Unit-IV (i) Aggression in sports: types, phenomena of Aggression – Instinct Theory and Social Learning Theory, Assessment of Aggression and Leadership in Sports
(ii) Psychological preparation – Long term and short term psychological preparation, Goal setting and self-confidence **(11 Hours/Lectures)**

Practical Syllabus (30 Hours/ Lectures)

1. Measurement of Motivation
2. Measurement of Anxiety
3. Measurement of Personality
4. Measurement of Team Cohesion
5. Measurement of Aggression

SUGGESTED READINGS:

1. Coaklay, J.J. (2009). Sporting Sociology, Issues and controversies, Mcgraw Hill International (Uint-1,3,4&5) Dixit S (2006). Khel- Manovigyan. Sports Publications. Delhi
2. Cohen RJ and Swerdlik ME (2002). .Psychological testing and Assessment: An Introduction to Tests and Measurement. McGraw Hill. New York. U.S.A.
3. Cox RH (2002). Sport Psychology. McGraw Hill. London.
4. Liukkonen JED (2007). Psychology for Physical Educators. Human Kinetics. U.S.A. Mortin GL (2003). Sports Psychology, Sports Science. Press. USA.
5. Sahni SP (2005). Psychology and Its Application in Sports. D.V.S. Delhi. Shaw D and Other (2005). Sport & Exercise Psychology. Bios. U.K.
6. Verma V (1999). Sport Psychology & All Round Development. Sport Pub. New Delhi.
7. Wann DL (1997). Sport Psychology. Prentice Hall. New Jerey.

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Semester-III
BSc-PE-DSC-9(4)-101: ATHLETICS

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Athletics	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency in a game of one's choice.

After the Completion of First Month:

The student will be able to gain knowledge with respect to Historical Development, Organizational Structure and Playfield Technology of the respective sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of psychological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports, gain knowledge about different tests of fitness andskill evaluation as well as the evaluation of player's performance. The technical practice of sprint races, middle and long distance races, hurdles races, jumping event- long jump, throwing events- shot put, hammer throw.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components. Track marking and marking of different arenas for selected events in unit-III.

THEORY SYLLABUS (60 hrs lectures)

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation of the sport.
- Warming up and psychological basis of Warming up.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match competition Coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game- – sprint races, middle and long distance races, hurdles races, jumping event- long jump, throwing events- shot put, hammer throw.
- Motor Fitness Components Testing
- Skill/Technique Evaluation
- Evaluation of Player's Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components related to sport: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.

- Track marking and marking of different arenas for selected events in unit-III.

Practical - **(60 hrs.)**

1. Learning and demonstrating various skills/techniques of sports- sprint races, middle and long distanceraces, hurdles races, jumping event- long jump, throwing events- shot put.
2. Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.
3. Track marking and marking of different arenas for selected events in unit-III.

SUGGESTED READINGS:

- Chauhan VS (1999). Khel Jagat Mein Athletics. A.P. Pub, Jalandhar.
- Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
- Evans DA (1984). Teaching Athletics. Hodder, London.
- Fox EL (1998). Physiological Basis of Physical Education and Athletics Brown Pub.
- Gothi E (2004). Teaching & Coaching Athletics. Sport Pub., New Delhi.
- Gupta R. (2004). Layout & Marking of Track & Field. Friends Publications. India. New Delhi.
- Handbook-Rules and Regulation. International Athletic Federation (2010).
- Herb Amato, DA ATC et al (2002). Practical Exam Preparation Guide of Clinical Skills of Athletic Training. Slack Incorporated. 1st ed., USA.
- Kumar, Pardeep. (2008). Historical Development of Track & Field. Friends Publication. New Delhi
- Maughan, R. and Gluson, M. (2004). The Biomechanical Basics of Athletic Performance. Oxford University Press, U.K.
- Prentice, W. and Arnheim, D. (2005). Arnheim"s Principles of Athletic Training 12th Ed. McGraw Hill. in place of Knight (1988).
- Renwick GR (2001). Play Better Athletics. Sports Pub, Delhi.
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III

BSc-PE-DSC-9 (4)-102: BADMINTON

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Badminton	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player's performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and its testing.

THEORY SYLLABUS **(30 hrs lectures)**

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- organizational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player's Performance.

Unit-IV

(07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS:

1. Bloss, M.V. et al (2000). Badminton. McGraw Hill,USA.
2. Bompa O Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology ofTraining" Human kinetics. NY.
3. Brahms Bernd-Voler. (2010). Badmnton Handbook. Mayer & Mayer Sports: UK. Unt-II, III &IV-p-9-14.
4. Daris Pal. (1988). Badminton-The complete practical guide. Dairs & Charles Inc.: USA. Unit-IIp-1-28 III- p-29-88, 109-152 & IV-p-97-108
5. Downey J (1990). How to Coach Badminton. Collins Pub.London.
6. Golds, M. (2002). Badminton: Skills of the Game. Growood Press,USA.
7. Grice, T. (2007). Badminton: Steps to Success. 2nd Ed. Human Kinetics,USA.
8. GuptaR.KumarP.andTyagiS.(2008).TextbookonTeachingSkillandProwess(Part-I&II). FriendsPublication. New Delhi.
9. Hoeger, W.W. Kand & Hoeger, S.A. (1997). Principles and Labs for physical fitness. (2nd Edi.).Morton Publishing Company. USA. Unit- II- p-127, 178-187, Unit- p-10-194.
10. Singh, Hardayal. (1991). Science of Sport Training. D.V.S Pub. Delhi.
11. Singh, MK. (2007). Comprehensive Badminton. Friends Pub. New Delhi.
12. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi.
13. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III
BSc-PE-DSC-9 (4)-103: BASKETBALL

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Basketball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS **(30 hrs lectures)**

Unit-I **(07 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(08 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

- Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
- Drewett, J. (2007). How to Improve at Basketball. Crabtree Publishing Co., USA.
- Goldstein, S. (1998). Basketball Fundamentals. 2nd Ed. Golden Aura Publishing,USA.
- Jain Naveen (2003). Play and Learn Basket Ball. Khel Sahitya Kendra. NewDelhi.
- Nat BB (1997). Conditioning Coaches Association. NBA Power Conditioning. Human Kinetics.
- Sharma OP (2003). Basket Ball Skills and Rules. Khel Sahitya Kendra, Delhi.
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Wilmore & Costill (2004).Physiology of Sports &Exercise. Human Kinetics, US

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

Semester III

BSc-PE-DSC-9 (4)-104: CRICKET

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Cricket	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(07 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(08 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Amarnath M. (1996). Learn to Play Good Cricket. UBS Publishers. New Delhi.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. Boycott, G. (2010). Play Cricket the Right Way. Great Northern Books Limited, U.K.
4. Cricket (2008). Sports Skills: Cricket Fielding (Know the Game). A & C Black Publishers.
5. Gupta, K. (2006). How to Play Cricket. Goodwill Publishing House, New Delhi.
6. Hobls, J. (2008). The Game of Cricket As it should be played. Jepson Press, USA.
7. Jain R. (2003). Fielding Drills in Cricket. Khel Sahitya Kendra. New Delhi.
8. Rachna (2002). Coaching Successfully: Cricket. Khel Sahitya Kendra. New Delhi.
9. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
10. Sharma P. (2003). Cricket.Shyam Parkashan.Jaipur.
11. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9(4)-105: FOOTBALL

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Football	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in agame of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical – **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. American Football Coaches Association (2002). The Football Coaching Bible. 1st Ed., Human Kinetics, USA.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. Carling, C., Williams, M. and Reilling, T. (2006). Handbook of Soccer Match Analysis: A Systematic Approach to Improving Performance. Routledge Publishers, USA.
4. Long, H. and Czarnecki, J. (2007). Football for Dummies. For Dummies Publisher, USA.
5. N Kumar (2003). Play and Learn Football. K.S.K. New Delhi.
6. Reilly, T. (2006). The Science Training Soccer: A Scientific Approach to Developing Strength, Speed and Endurance. Routledge Publisher, USA.
7. Reilly, T. and J.C.D. Arau (2008). Science and Football V: The Proceedings of the 5th World Congress on Sports Science and Football, Volume5.
8. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
9. Sharma OP (2001). Teaching and Coaching –Football. Khel S.K.Delhi.
10. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-106: GYMNASTICS

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Gymnastics	04	2	0	2	XII Pass	NIL

Objective:-The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of Gymnastics.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of Gymnastics, gain knowledge about different tests of fitness and skill evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components.

THEORY SYLLABUS

Unit-I **(07 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation of the sport.
- Warming up and psychological basis of Warming up.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III **(08 hrs lectures)**

- Basic skills and techniques of the Artistic Gymnastics, trampoline, parko and rhythmic
- Motor Fitness Components Testing
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components related to sport: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.

- Practical - (60 hrs.)
  - Learning and demonstrating various skills/techniques of Artistic Gymnastics, trampoline, parko and rhythmic.
  - Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Brown (2009). How to Improve at Gymnastics. Crabtree Publishing Co., USA.
3. Chakraborty S and Sharma L (1995). Fundamental of Gymnastics. D.V.S. Pub. New Delhi.
4. Chakraborty S (1995). Fundamental of Gymnastics. DVS Pub. New Delhi.
5. Chakraborty S (1998). Women's Gymnastics. Friends Pub.Delhi.
6. Code of Points Trampoline Gymnastics (2005). Federation Int. DE Gymnastics
7. Federation International Gymnastics (2006). Federation Int. DE Gymnastics
8. Harvey FJ (1998). Physical Exercises & Gymnastics. Khel Sahitya. New Delhi.
9. Jain R (2005). Play and Learn Gymnastics. Khel SahitayaKendra
10. Mitchell, D., Davis, B. and Lopez, R. (2002). Teaching Fundamental Gymnastics Skills. Human Kinetics, USA.
11. Price, R.G. (2006). The Ultimate Guide to Weight Training for Gymnastics. 2nd Ed. Sportsworkout.com.
12. Schlegel, E. and Dunn, CR. (2001). The Gymnastics Book: The Young Performer"s Guide to Gymnastics. Firefly Books, USA.
13. Smither Graham (1980). Behing the Science of Gymnastics. London.
14. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
15. Stickland, L.R. (2008). Gender Gymnastics. Trans Pacific Press, Japan.
16. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-107: HANDBALL

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Handball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and its effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Jain D (2003). Play & Learn Handball. Khel Sahitya Kendra. New Delhi.
3. Kleinman, I. (2009). Complete Physical Education Plans. 2nd Ed. Human Kinetics, USA.
4. Page, J. (2000). Ball Games. Lerner Sports Publisher, USA.
5. Phillips, B.E. (2009). Fundamental Handball. Kessinger Publishers, USA.
6. Schmottlach N Mcmanama J (1997). Physical Education Handbook. 9th Edition. Allyn & Bacon.London.
7. Schmottlach, N. and McManama (2005). Physical Education Activity Handbook. Benjamin Cummings, USA.
8. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
9. Surhone, L.M. et al (2010). Team Handball. Betascript Publishing,USA
10. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
11. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-108: HOCKEY

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Hockey	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.
Learning Outcome:-The student attains knowledge, understanding, interpreting and analyzing proficiency in a game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will be able to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

(08 hrs lectures)

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, during and Post match coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs)

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. International Hockey Federation, Rules of the Game of Hockey with Guidance for Players and Umpires. International Hockey Federation.
3. Jain D (2003). Hockey Skills & Rules. khel Sahitya Kendra . New Delhi.
4. Narang P (2003). Play & Learn Hockey. Khel Sahitya Kendra. New Delhi.
5. Pecknold, R. and Foeste, A. (2009). Hockey : Essential Skills. McGraw Hills,USA.
6. Rossiter, S. (2003). Hockey the NHL Way : Goaltending Illustrated Edition. Sterling Publishers,USA.
7. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
8. Walter, R. and Johnson, M. (2009). Hockey Plays and Strategies. Human Kinetics,USA.
9. Weekes, D. (2003). The Biggest Book of Hockey Trivia. Greystone Books,USA.
10. Wukovits, J.F. (2000). History of Hockey 1st Ed. Lucent Books,USA.
11. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
12. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9(4)-109: JUDO

Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Judo	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individual wishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I **(08 hrs lectures)**

- Historical Development and Modern Trends (National and International Level)
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II **(08 hrs lectures)**

- Rules and their interpretation.
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III **(07 hrs lectures)**

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV **(07 hrs lectures)**

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Diago, T. (2005). Kodokan Judo Throwing Techniques. Kodansha International Publishers,Japan.
3. Harrison EJ (2002). Coaching Successfully Judo. Sports.Delhi.
4. Jain D (2003). Play and Learn Judo. Khel Sahitaya Kendra. New Delhi.
5. Law, M. (2009). Falling Hard : A Journey into the World of Judo. Trumpeter Publisher,Japan.
6. Putin, V., Shestakov, V. ad Levitsky, A. (2004). Judo : History, Theory and Practice. Blue Snake Books, Moscow.
7. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
8. Takahashi, M. (2005). Mastering Judo. Human Kinetics,USA.

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

SemesterIII

BSc-PE-DSC-9 (4)-110: KABADDI

Credit = 4(2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Kabaddi	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one"s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player"s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it"s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it"s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III

- Basic skills and techniques of the Sports/Game. **(07 hrs lectures)**
- Skill/Technique Evaluation
- Evaluation of Player"s Performance.

Unit-IV (07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - **(60 hrs.)**

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

- Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
- Kumar, Dharmander. (2018). Kabaddi and It"s Playing Techniques. Writers Choice, New Delhi.
- Mishra , S.C. (2007). Teach Yourself Kabaddi. Sports Publications, New Delhi.
- Rao CV (1983). Kabaddi. Native Indian Sports. NSNIS. Patiala Publisher
- Rao EP (1994). Modern Coaching in Kabaddi.D.V.S.Pub
- Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
- Syal, M. (2004). Kabaddi Teaching. Prerna Parkashan, New Delhi.
- Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi.

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

Semester III

BSc-PE-DSC-9(4)-111: KHO-KHO

Credit = 4(2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Kho-Kho	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.

Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III

- Basic skills and techniques of the Sports/Game. **(07 hrs lectures)**
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV (07 **hrs** lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.
Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Chakrabarty G (2002). Kho - Kho Aveloken. Khel Sahitya Kendra.Delhi.
3. Panday L (1982). Kho - Kho Sarvaswa. Metropolitan. New Delhi
4. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
5. Vanaik A. (2005). Playfield Manual, Friends Publication. New Delhi
6. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-112: VOLLEYBALL

Credit = 4(2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Volleyball	04	2	0	2	XII Pass	NIL

Objective: - The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one‟s choice.

After the Completion of First Month:

A student will be able to gain knowledge with respect to Historical Development, Organisational Structure and Playfield Technology of a sport/game.

After the Completion of Second Month:

A student will be able to understand and interpret the rules of game as well as game knowledge in the areas of physiological basis of Warming up and technical aspects of coaching.

After the Completion of Third Month:

A student will be able to learn and acquire various skills of sports/game, gain knowledge about different techniques evaluation as well as the evaluation of player‟s performance.

After the Completion of Fourth Month:

A student will be learning about various fitness components and its forms. Further, the student will beable to practice and improve performance on the basis of knowledge gained in understanding various fitness components and it‟s testing.

THEORY SYLLABUS

Unit-I

- Historical Development and Modern Trends (National and International Level) **(08 hrs lectures)**
- Organisational Structure (State, National and International Level)
- Playfield Technology – Marking and Construction of the playfields.

Unit-II

- Rules and their interpretation. **(08 hrs lectures)**
- Warming up and physiological basis of Warming up and it‟s effect on performance.
- Cooling down and its effect.
- Techniques of Coaching – Pep talk, Pre, During and Post match Coaching.

Unit-III (07 hrs lectures)

- Basic skills and techniques of the Sports/Game.
- Skill/Technique Evaluation
- Evaluation of Player‟s Performance.

Unit-IV (07 hrs lectures)

- Introduction to Physical and Motor Fitness components: Strength, Speed, Endurance, Coordinative Abilities and Flexibility.
- Motor Fitness Components Testing of above components.

Practical - (60 hrs.)

Learning and demonstrating various skills/techniques of sports.

Learning to demonstrate various tests to evaluate motor components as listed in unit IV above.

SUGGESTED READINGS

1. American Volleyball Coaches Association (2005). Volleyball : Skills & Drills. Human Kinetics,USA.
2. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
3. FIVB (1996). Backcourt Spiking in Modern Volley Ball. FIVB.Chennai.
4. Kenny, B. and Gregory, C. (2006). Volleyball : Steps to Success. Human Kinetics,USA.
5. Saggar SK (1994). Cosco Skills Statics - Volley Ball. Sport Publication. Delhi.
6. Scates AE (1993). Winning Volley Ball. WC Brown.USA.
7. Scates, A. and Linn, M. (2002). Complete Conditioning for Volleyball. Human Kinetics,USA.
8. Shondell, D. and Reynaud, C. (2002). The Volleyball Coaching Bible. Human Kinetics,USA.
9. Singh, Hardayal. (1919). Science of Sports Training. DVS Publication, N. Delhi.
10. The National Alliance for Youth Sports (2009). Coaching Volleyball. For Dummies Publishers,USA.
11. Volleyball, USA (2009). Volleyball : Systems and Strategies. Human Kinetics,USA.
12. Vanaik A. (2017). Officiating and Coaching, Friends Publication. New Delhi

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

Semester III

BSc-PE-DSC-9 (4)-113: YOGA Credit = 4 (2 THz + 2 P)

Max. Marks=100 30 hrs Theory + 60 hrs Practical

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Yoga	04	2	0	2	XII Pass	NIL

Objective:-The Students will acquire knowledge and understanding of a specific sport in which an individualwishes to excel.
Learning Outcome:-The student will attain knowledge, understanding, interpreting and analyzing proficiency ina game of one"s choice.

After the Completion of First Month:

The Students will develop the understanding and knowledge of Origin of yoga, definition and scope of yoga, limitations and misconceptions, importance of yoga in physical education and other fields, Yoga asana completion at:- State, National, International, SGFI, AIU etc. Philosophical aspects of Yog. Pre-Vedic, Vedic period; Buddhism, Upanishad period, Jainism & tantra, qualifications, qualities and responsibilities of a coach, Duties/responsibilities of technical official, Scoring system and judgment criteria, Protocols for referees, judges and officials.

The student will learn about the prayer.

After the Completion of Second Month:

The Students will develop the understanding and knowledge of Meaning, techniques, precautions & effects of the following:-Asanas : padmasana, vajrasana, sidhasana, paschimottanasa, halasana, sarvangasana, shalabhasana, ardh-matsyendrasana, bhujangasana, tadasana, vrikshasana, matsyasana, gomukhasana, ushtrasana, shavasana, makarasana, vrishchikasana, dhanurasana, purna matsyendrasana, chakrasana, ek pad sikandasana, bakasana, mayurasana, shirshasanaPranayama : anulom-vilom, bhastrika, suryabhedhen pranayama, sheetali, sheetkari, bhramari, ujjayiShatkarma : neti, dhauti, nauli, basti, kunjal, kapal bhati, shankh prakshalanaBandhas : jalandhar, uddyana, mool bandha.

The student will be able to perform Asanas, pranayama, shatkarma, bandha.

After the Completion of Third Month:

The Students will gain knowledge of Disease wise treatment through yoga therapy- Asthma, high & lowB.P, diabetes, obesity, heart disease, insomania, arthritis, backache & female disease.

The student will learn Yoga-nidra/relaxation techniques

After the Completion of Fourth Month:

The Students will gain knowledge of Diet & constitution, components of nutrition, water, natural diet,balanced diet, fasting-its benefits, types & preparation. Importance of vegetarianism in yogic diet.

The student will learn Visit to yoga centers/institutes

THEORY SYLLABUS

UNIT-I **(07 hrs lectures)**

- Origin of yoga, definition and scope of yoga, limitations and misconceptions of Yoga
- Importance of yoga in physical education and other fields
- Yoga asana competition at:- State, National, International, SGFI, AIU etc.

UNIT-II **(07 hrs lectures)**

- Philosophical aspects of yoga-Pre-Vedic, Vedic period; Buddhism, Upanishad period, Jainism & tantra
- Qualifications, qualities and responsibilities of a coach,
- Duties/responsibilities of technical official, Scoring system and judgment criteria,

- Protocols for referees, judges and officials.

UNIT-III **(09 hrs lectures)**

- Meaning, techniques, precautions & effects of the following:-
- Asanas : padmasana, vajrasana, sidhasana, paschimottanasa, halasana, sarvangasana, shalabhasana, ardh-matsyendrasana, bhujangasana, tadasana, vrikshasana, matsyasana, gomukhasana, ushtrasana, shavasana, makarasana, vrishchikasana, dhanurasana, purna matsyendrasana, chakrasana, ek pad sikandasana, bakasana, mayurasana, shirshasana
- Pranayama : anulom-vilom, bhastrika, suryabhedhen pranayama, sheetali, sheetkari, bhramari, ujjayi
- Shatkarma : neti, dhauti, nauli, basti, kunjal, kapal bhati, shankh prakshalana
- Bandhas : jalandhar, uddyana, mool bandha

UNIT-IV **(07 hrs lectures)**

- Disease wise treatment through yoga therapy- Asthma, high & low B.P, diabetes, obesity, heart disease, insomania, arthritis, backache & female disease
- Diet & Nutrition, components of nutrition, water, natural diet, balanced diet, fasting-its benefits, types & preparation, importance of vegetarianism in yogic diet.

PRACTICALS (60 hrs.)

1. Prayer
2. Asanas, pranayama, shatkarma, bandha (as mentioned in theory)
3. Yoga-nidra/relaxation techniques
4. Visit to yoga centers/institutes

SUGGESTED READINGS

- Anand Omprarkash (2001). Yog Dawra Kaya Kalp, Kanpur. Sewasth Sahitya Perkashan
- Iyengar, B.K.S. (1995). Light on Yoga : The Bible of Modern Yoga. Schocken Publishers, USA.
- Kaminoff, L. et al (2007). Yoga Anatomy. Human Kinetics, USA.
- Kirk, M. (2005). The Hatha Yoga Illustrated. Human Kinetics, USA.
- Sharma JP and Ganesh S(2007). Yog Kala Ek Prichya. Friends Publication. New Delhi
- Sharma J. P. (2007). Manav jeevan evam yoga. Friends Publication. New Delhi.
- Sharma Jai Prakash And Sehgal Madhu(2006). Yog-Shiksha. Friends Publication. Delhi.
- Sharma Jai Prakash and Rathore Bhupender Singh (2007). Yoga Ke Tatva. Friends Publication. Delhi
- Mukerji, A.P. (2010). The Doctorine and Practice of Yoga. General Books, LLC, New Delhi.
- Norton, W.W. (2010). Yoga for Osteoporosis : The Complete Guide. W.W. Norton & Company, USA.
- Sarin N (2003). Yoga Dawara Rogoon Ka Upchhar. Khel Sahitya Kendra
- Sri Swami Rama, (2001). Breathing. Rishikesh Sadhana Mandir Trust.
- Swami Ram (2000). Yoga & Married Life. Rishikesh Sadhana Mandir Trust
- Swami Swatma Ram: Patanjali Yoga Sutra
- Swami Veda Bharti (2000). Yoga Polity. Economy and Family. Rishikesh Sadhana Mandir Trust
- Text Book Hath Yoga Pradipika
- Text Book Patanjali Yoga Sutra

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

Pool of Generic Electives

Semester III

GE-3(4)-301 Olympic Education

GE-3(4)-301
4 Credits (3 THz+1Tutorial)

Sr. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1	Olympic Education	4	3	1	0	XII	---

Objective: To impart the knowledge, practices and applications about the Olympism its functions through the various International sportsfederation, National committees and IOC commissions.

Learning Outcome: Students will learn the deep knowledge about ancient and modern Olympics, administration,organisation of Olympics Games and functions of IOC.

After the Completion of First Month:

The students will develop the understanding practices, applications and knowledge of Concept of Olympics movement, the ancient Olympic Games and the Modern Olympic Games and its movement. It also helps to know about the aims and symbols of the Olympic movement and International Olympic Committee (IOC).

After the Completion of Second Month:

The students will develop the understanding practices, applications and knowledge of The National Olympic Committee (NOC), International Sports Federations (IFs), National Sports Federations (NFs), Volunteerism and Olympics games.

After the Completion of Third Month:

The students will gain understanding practices, applications and knowledge of the Organization of Olympics games, international bid process for selecting sites / city for the games, Participation in Olympic Games and about Women & sports.

After the Completion of Fourth Month:

The students will gain knowledge, practices, applications and understanding of the Olympic museum, Olympic academy and Olympic solidarity programme, Paralympics games and concept of Sports for all. It also helps to know about Culture, Olympism, winning, participation and universality of the games, drug abuse and doping in sports and games.

THEORY SYLLABUS: (60 Hours/Lectures)

UNIT-I THE OLYMPIC MOVEMENT (15 Hours/Lectures)

1 Concept of Olympics movement, the ancient Olympic games and the Modern Olympic games and itsmovement.
2 Aims and symbols of the Olympic movement.
3 The International Olympic Committee (IOC).

UNIT-II STRUCTURE OF THE OLYMPIC MOVEMENT (15 Hours/Lectures)

1. The National Olympic Committee (NOC).
2 The International Sports Federations (IFs).
3 The National Sports Federations (NFs).
4 Volunteerism and Olympics games.

UNIT-III THE OLYMPIC GAME (15 Hours/Lectures)

1 Organization of Olympics games.
2. The international bid process for selecting sites / city for the games.
3. Participation in Olympic Games.
4. Women and sports.

UNIT-IV IOC PROGRAMMES (15 Hours/Lectures)

1. Olympic museum, Olympic academy and Olympic solidarity program.
2. Paralympics games and concept of Sports for all.
3. Culture, Olympism, winning, participation and universality of the games.
4 Drug abuse and doping.

SUGGESTED READING:

- Carto, J.E.L. And Calif, S.D. (1984). Medicine & Sport Science: Physical Structure of OlympicAthletes. London: Karger.
- Cliw, Gifford, (2004). Summer Olympic.
- Daw, Anderson. (2008). The Story of the Olympics.
- Kumar, Pardeep. (2008). Historical Development of Track & Field. Friends Publication. New Delhi.
- Maranirs David, Rome 1960: The Olympics that changed the world, 2008.
- Osbome, Manpope, Ancient Greece and the Olympic, 2004.
- Oxlade, chris., Olympic, 1999.
- Perrottet, tony, The Naked Olympics: the true story of the Ancient Games, 2004.
- Toropove, Brandon., The Olympic for Beginners, 2008.
- Wallechineley, Davi, The Complete Book of the Olympic, 1992.

BA(PROG.) WITH PHYSICAL EDUCATION & SPORTS AS NON-MAJOR
SEMESTER-3
B.A.-PE-DSC-3 (MINOR)
HEALTH EDUCATION

DSC

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Health Education	04	3	0	1	XII	--

Objective: To acquaint the students with basic aspects and practices with application to health, health education and various health agencies.

Learning Outcomes of the Paper:

1. The learners will learn the basic concepts of developing the practices of health along with the dimensions, spectrum and determinant of health.
2. The learners will develop the ability to apply the scope and principles of health education in life.
3. The learners will be able to comprehend the role of personal and occupational hygiene for better health practices.
4. The learners will be able to understand and apply the causes and preventive measures of various communicable and non-communicable diseases.
5. The learners will gain knowledge and practices about the role and schemes of various health promoting agencies like WHO, UNICEF, UNDP, MHFW, Red Cross etc.
6. The learners will be able to change their behavioural aspects related to personal health.
7. The learners will be able to create the databases related to health and hygiene.

SYLLABUS

M.M.: 100
No. of Credits: 04 (Lecture-03, Practical-1)
Theory: 45 hours, Practical: 30 hours

Unit-1: Introduction to Health

1. Meaning, Definition & Importance of Health
2. Dimensions of Health
3. Spectrum of Health
4. Determinants of Health

Unit-2: Introduction to Health Education

1. Meaning and Definition of Health Education
2. Aim and Objectives of Health Education
3. Importance and Scope of Health Education
4. Principles of Health Education

Unit-3: Hygiene and Health Issues

1. Personal Hygiene
2. Occupational Hygiene
3. Communicable Diseases : Meaning, Spread and Prevention
4. Non-Communicable Diseases: Meaning, Spread and Prevention

Unit-4: Health Agencies

1. Introduction to International Health Agencies: WHO (World Health Organization), UNICEF (United Nations International Children's Fund), UNDP (United Nations Development Programme)
2. Introduction to National Health Agencies: Ministry of Health and Family Welfare; Indian Red Cross Society, Hind Kushth Nivaran Sangh, Indian Council for Child Welfare, Tuberculosis Association of India, Bharat Sevak Samaj, Central Social Welfare Board

PRACTICAL

1. Conduct a survey on personal hygiene Habits of your college students.
2. Visit to any one national health agency and preparation of a report.
3. Conduct a Survey on anyone of the following:
    a. Communicable Disease
    b. Non-Communicable Disease

SUGGESTED READINGS

1. Anspaugh, D.J.; Ezell, G. andGoodman, K.N. (2006).Teaching Today's Health.Mosby Publishers. Chicago, USA.
2. Balayan, D. (2007). Swasthya Shiksha Evam Prathmik Chikitsa. Khel Sahitya. Delhi.
3. Chopra,D. and Simon, D. (2001). Grow Younger, Live Longer: 10 Steps to Reverse Aging. Three Rivers Press. New York. USA.
4. Dewan, A.P. (1996). School Health Manual. Nature Cure and Yoga Health Centre. New Delhi.
5. Dixit, S. (2006). Swasthya Shiksha. Sports Publication. Delhi.
6. Donatelle, R.J. (2005). Health the Basics. Sixth Edition. Oregon State University.
7. Floyd, P. M. and Yeilding, C. (2003). Personal Health: Perspectives and Lifestyles. Thomson Wads Worth. Belmont. California. USA.
8. Hales, D. (2005). An Invitation to Health. Thomson-Wadsworth, Belmont. California.USA.
9. Park, K. (2007). Park‟s Text Book of Preventive & Social Medicine. Banarsi Das Bhanot & Company. Delhi.
10. Snehlata (2006). Shareer,Vigyan Evam Swasthya Raksha. Discovery Pub. Houses. New Delhi.
11. Uppal, A.K. & Gautam, G.P. (2008). Health & Physical Education. Friends Publication. New Delhi.

BA(PROG.) WITH PHYSICAL EDUCATION & SPORTS AS MAJOR
SEMESTER-3
B.A.-PE-DSC-3 (MAJOR)
SPORTS NUTRITION AND ERGOGENIC AIDS

DSC

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical/Practice		
1.	Sports Nutrition and Ergogenic Aids	04	3	0	1	XII	--

Objective: To acquaint the students with basic concepts, application and creativity related to sports nutrition and ergogenic aids.

Learning Outcomes of the Paper:

1. The learners will understand the basic concept and practices of Nutrition and its importance in the field of Sports.
2. The learners will be able to describe the functions of different types of Nutrients and their sources.
3. The learners will gain knowledge of application of nutrient-supplementation and nutrition guidelines.
4. The learners will understand the concept of Ergogenic Aids and their role in sports.
5. The learners will identify the list of prohibited substances to control doping.
6. The learners will be able to create / construct the diet chart/ plan as per individual needs.
7. The learners will be acquainted to the role of World Anti -Doping Agency (WADA) and National Anti-Doping Agency.

SYLLABUS

M.M.: 100
No. of Credits: 04 (Lecture-03, Practical-1)
Theory: 45 hours, Practical: 30 hours

Unit-1: Nutrition

1. Meaning, Definition & Importance of Nutrition
2. Nutrients: Classification, Function, Source
3. Balanced Diet, Dietary Aids, Dietary Gimmicks
4. Achieving a Healthy and Balanced Diet

Unit-2: Sports Nutrition

1. Role of Nutrition in Sports
2. Basic Nutrition Guidelines
3. Energy Balance Equations
4. Pre- and Post-performance Nutrition to athletes

Unit-3: Ergogenic Aids

1. Meaning and Definition of Ergogenic Aids
2. Types of Ergogenic Aids
3. Role of Ergogenic Aids in Sports
4. Nutrition and Ergogenic Aids

Unit-4: Doping and Sports

1. Meaning and Definition of Doping
2. Disadvantages of Doping in Sports
3. Introduction to WADA (World Anti-Doping Agency) and NADA (National Anti-Doping Agency)
4. List of prohibited substances by WADA (World Anti-Doping Agency)

PRACTICAL

1. Preparation of a regular Diet Chart/ Plan for Sportspersons.
2. Preparation of Diet Schedule for Competitive performance (before and after the competition)
3. Visit to Nutritional/ Medical institution and preparation of report.
4. Conduct survey on nutritional practices of sportspersons.

SUGGESTED READINGS

1. Anspaugh, D.J.; Ezell, G. and Goodman, K.N. (2006). Teaching Today's Health. Mosby Publishers. Chicago, USA.
2. Balayan, D. (2007). Swasthya Shiksha Evam Prathmik Chikitsa. Khel Sahitya. Delhi.
3. Chopra, D. and Simon, D. (2001). Grow Younger, Live Longer: 10 Steps to Reverse Aging. Three Rivers Press. New York. USA.
4. Dewan, A.P. (1996). School Health Manual. Nature Cure and Yoga Health Centre. New Delhi.
5. Dixit, S. (2006). Swasthya Shiksha. Sports Publication. Delhi.
6. Donatelle, R.J. (2005). Health the Basics. Sixth Edition. Oregon State University.
7. Floyd, P. M. and Yeilding, C. (2003). Personal Health: Perspectives and Lifestyles. Thomson Wads Worth. Belmont. California. USA.
8. Hales, D. (2005). An Invitation to Health. Thomson- Wadsworth, Belmont. California. USA.
9. Park, K. (2007). Park‟s Text Book of Preventive & Social Medicine. Banarsi Das Bhanot & Company. Delhi.
10. Snehlata (2006). Shareer, Vigyan Evam Swasthya Raksha. Discovery Pub. Houses. New Delhi.
11. Uppal, A.K. &. Gautam, G.P. (2008). Health & Physical Education. Friends Publication. New Delhi.

SEMESTER- III
BSc-PE-DSE-1(4)-101: (DSE)
ADAPTED PHYSICAL EDUCATION
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
ADAPTED PHYSICAL EDUCATION	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding and practices to the learners about adapted physical education in order to let them realize that Divyang student also are the part of active education system as well.

Learning Outcomes:

At the end of the course the student will be able to-

1. Acquire the knowledge of meaning definition and components of adapted physical educational in suitable modern aspects.
2. Understand the General educational styles, strategies, teaching style and adapted physical education.
3. Recognize suitable general and specific activities for early childhood adapted physical education.
4. Apply the knowledge of measuring & assessing students, Criteria for eligibility for adapted physical education.

PART – A Theory Syllabus

UNIT I - **(09 Hours)**

1.1 Definition of Adapted Physical Education and components of Individualized education Programme (IEP)
1.2 Measuring & Assessing students, Criteria for eligibility for adapted physical education, Alternative instructions in physical education and teaching in inclusive setting

UNIT II **(09 Hours)**

2.1 General educational styles and strategies,

2.2 Teaching style and adapted physical education
2.3 Ways of facilitating skill acquisition and behaviour management approaches emphasized in adapted physical education

UNIT III **(09 Hours)**

3.1 Children and youth with unique needs:-Intellectual disabilities
3.2 Learning disabilities and attention defects
3.3 behavior disorder
3.4 Visual impairment, Deafness, Cerebral palsy, shock
3.5 spinal cord disabilities and amputation
3.6 Students without disabilities with unique needs

UNIT IV **(09 Hours)**

4.1 Development Areas: -
- 4.1.1 Physical fitness
- 4.1.2 Motor Development
- 4.1.3 Perceptual- motor development

4.2 Early childhood adapted physical education

UNIT V **(09 Hours)**

5.1 Activity Areas and adapted physical education:
- 5.1.1 Team sports
- 5.1.2 Individual sports
- 5.1.3 Dual sports
- 5.1.4 Gymnastics
- 5.1.5 Aquatics

5.3 Adventure Sport, Dance, Rhythmic movements

PART – B Practical Syllabus **(30 Hours)**

To prepare Individual Education Programme of different challenged population.
1. To measure and Assess the degree of Help/Need
2. To facilitate special skill acquisitions
3. To prepare programme for: Visual impairment and Deafness
4. To prepare programme for: Spinal cord disability and Amputation
5. Development Areas: Physical Fitness & Motor Development

Note: Evaluation will be done on the basis of practical examination of the activities taught.

References:

1. Bhandani, R.K., An Overview of Natural and Man Made Disaster their Reduction CSIR New Delhi
2. Gupta, H.K. Disaster Management University Press India 2003
3. Gupta, MC Manuals on Natural Disaster Management in India, National Centre for Disaster Management IIPA, New Delhi 2001.
4. Singh, M.K., 'A to Z Badminton', Friends Publication, New Delhi

5. Arora S., Agarwal M Gupta B. (2018), “Fitness; Wellness And Nutrition”, Vivechan Publications (INDIA) ISBN: 978-93-83914-89-0.
6. Morris L R, Schulz L, (1989) “Creative play activities for children with disabilities” Human Kinetics books, campaign Illinois.
7. Davis RW, (2002) “Teaching Disability Sports.” Human Kinetics.
8. Mishra, S.C, (2007) “Viklang aur Khel”, Sports Publications.
9. Shaw D. (2018) “Fundamental Statistics in Physical Education and Sports Sciences” Sports Publication, ISBN: 81-86190-57-0.
10. Shaw D. (2020) “Physical Education Practical Manual for Class XI” Prachi Publication, ISBN : 978-8193-7698-0-5.
11. Shaw D. (2020) “Physical Education for Class XII” Prachi Publication, ISBN : 978-81-7730-848-8.
12. Shaw D. (2020) “Physical Education for Class XI” Prachi Publication, ISBN : 978-81-7730-847-1.
13. Shaw D. (2020) “Physical Education Practical Manual for Class XII” Prachi Publication, ISBN : 978-81-937698-1-2.

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

SEMESTER- III
BSc-PE-DSE-1(4)-102 (DSE)
PERSONALITY DEVELOPMENT
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
PERSONALITY DEVELOPMENT	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding and practices to the learners about Personality development.

Learning Outcomes:

At the end of the course the student will be able to-

5. Acquire the knowledge of meaning, definition and importance of Personality Development.
6. Understand the Components of Physical Personality, Physical Fitness, Self- Responsibility for Health & Personality Development.
7. Use the components of personality and its applications of self-evaluation for one's personality
8. Apply the knowledge of nutrition to enhance personality.

Theory Syllabus

UNIT I INTRODUCTION **(09 Hours)**

1.1 Definition, Meaning and Description of Personality, Components of Personality – Physical, Emotional, Cognitive, Social, Mental, Vital and Spiritual; Role of Physical Personality as Foundation of Personality.
1.2 Components of Physical Personality: Growth & Development; Nutrition, Exercise, Physical Fitness, Self- Responsibility for Health & Personality Development.

UNIT II PHYSICAL GROWTH & DEVELOPMENT **(09 Hours)**

2.1 Meaning and Definition – Physical Growth, Development, Differences between Growth and Development; Growth and Development patterns in various body systems. Role in Promoting Personality Development
2.2 Growth Patterns: Magnitude and Rate of Physical Growth, Distance and Velocity Curves, Classification of Human Growth Cycle – Baby, Child, Adolescent, Post-Adolescent, Adult and Old age.

UNIT III NUTRITION & PERSONALITY DEVELOPMENT **(09 Hours)**

3.1 Meaning & Definitions, Nutrients, Balanced diet for Health Needs and Personality Development, Micro & Macronutrients relation to Personality Development.

3.2 Nutritional Requirements: Nutritional requirements for Growing Age, Physical Activities, Sports, Sports Training, Food Groups: Classification of Food into various groups based on their nutrients, daily intake of various food groups, Nutrients of common foods

UNIT IV PHYSICAL FITNESS & PERSONALITY (09 Hours)

4.1 Meaning & Definition of Physical Fitness and its components. PAR-Q, Health Related Physical Fitness & Personality; Physical Performance components of Fitness, Personal needs and Personality Development

4.2 Personal Physical Fitness: Personal strengths and weaknesses in components of Physical Fitness, Development of weak components, Role of Behaviour changes for developing personal fitness strengths.

UNIT V SELF RESPONSIBILITY (09 Hours)

5.1 Meaning & concept of Self Responsibility

5.1.1Daily Schedules (DS) Awareness and Logbooks for practice of DS.

5.2 Physical Education: Role of Physical Education in promoting Self Responsibility

5.2.1 Self-Responsibility and Behaviour change, PE for Personality Development.

5.2.2 Foundations of Personality Development & Personal Strengths through Physical Education as the basis of self-responsibility

5.2.3 Principles of Self-Responsibility & their relation to art & science of health

5.2.4 Fitness & wellness promotion

PART- B Practical (30 Hours)

1. To demonstrate the components of personality with examples.
2. To demonstrate stages of behaviour change.
3. To demonstrate PAR-Q
4. To demonstrate daily physical log and methods its activities.
5. To demonstrate balanced nutrition with food items and quantity required
6. To demonstrate the application of self-evaluation of one's personality
7. To demonstrate different methods of meditation (At least two)

REFERENCES:

1. Allen, B.P. Personality Theories: Development, Growth and Diversity. Allyn & Bacon, New York, USA., 2005.
2. Anspaugh, D.J., M. H. Hamrick and F.D. Rosato, Wellness: Concepts and Applications, McGraw Hill, Boston, USA
3. Deepak. C. and D. Simon. Grow Younger Live Longer: 10 Steps to Reverse Aging. Three Rivess Press, New York, USA, 2001.
4. Hales, D. An Invitation to Health, Thomson Wads worth, Texas, USA, 2005.
5. Herron, W.G. Personality Development and Psychotherapy in our Diverse Society: A Sourcebook. Jason Aronson, Boston, USA, 1998
6. Hogger, W.W.K., and S.R. Hogger, Fitness & Wellness, Wads worth Publishing, Belmont, USA, 2007.
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Oxford University Press, Oxford, U.K. (1990).
8. Kansal, D.K..Applied Measurement, Evaluation & Sports Selection, Sports & Spiritual Science Publications, Delhi (2008).
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10. Robbins, G., D. Powers and S. Burgess. A Wellness Way of Life. McGraw Hill, Boston, USA, 2002.
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12. Shoffer, D.R. Social and Personality Development. Wads worth Publishing, Belmont, USA, 2004.
13. Shukla, A. The Mother on Education: From Reflections to Action, National Council for Teacher Education (NCTE), 2004.
14. Steven, C., The 8th Habit: From Effectiveness Greatness, Franklin Covey Co., New York, USA, 2004.
15. Tortora, G.J. & Grabowski,S.R., Principles of Anatomy and Physiology, John-Wiley & Sons, New York, USA (1996).
16. Vivekananda, S., Personality Development, Advaita Ashrama, Kolkata (2003).
17. Wrightsman, L.S. Jr., Adult Personality Development, Sage Publications Inc.
18. Wuest, D.A. and Bucher, C.A. Foundations of Physical Education, Exercise Science and Sports by McGraw Hill, (2006)

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

SEMESTER- 3
BSc-PE-DSE-1(4)-103 (DSE)
EXERCISE PRESCRIPTION FOR HEALTH AND FITNESS
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
EXERCISE PRESCRIPTION FOR HEALTH AND FITNESS	04	03	0	01	XII	NA

Objective:

The objective of this course is to provide an understanding, skill and practices to the learners about exercise prescription for health and fitness.

Learning Outcomes:

At the end of the course the student will be able to-

9. Acquire the knowledge and practices of exercise prescription on the behalf of health status.
10. Deal with differentiation and relation between exercise & physical activity.
11. Understand and demonstrate the direct and indirect health benefits of the exercise
12. Get understanding and applications of acronyms FITT (Frequency, Intensity, Time (duration), type (Mode of Exercise) (Training principles for batter training)

Theory Syllabus

UNIT I - (09 Hours)

1.1 Background of exercise prescription to non-sports person, basis of exercise prescription and measurement of motivation for physical exercise/activity health status
1.2 Physical personality in relation to physique, attitude, interests.
1.3 Exercise for recreation, health, fitness, wellness and competition.

UNIT II - (09 Hours)

2.1 Meaning and definition of exercise & physical activity
2.1.1Differences between exercise & physical activity (chronic and acute effect for adaptation)
2.1.2 Relation between exercise & physical activity

UNIT III - (09 Hours)

3.1 Health benefits of exercise, exercise as pro-active health care.
3.2 Exercise for prevention of heart disease, osteoporosis, diabetes type-II, hypertension, obesity etc.

UNIT IV - (09 Hours)

4.1 Necessity of exercise prescription
4.1.1 Sedentary population
4.1.2 Different-population
4.1.3 Self-responsibilities and behaviour change stages for exercise regularity

UNIT V - (09 Hours)

5.1 Steps for exercise prescription.
5.2 Exercise, stress test, physical fitness test,
5.3 Understanding acronyms FITT (Frequency, Intensity, Time (duration), Type (Mode of Exercise).
5.4 Principles of fitness training

PART- B Practical Syllabus (30 Hours)

1. Assessment of fitness (At least three)
2. Assessment of physical activity readiness of a person
3. Measurement of health status
4. Prescribing exercise / Programme
5. Evaluation of an exercise Programme

References:

1. American College of Sports Medicine (2000). ACSM's Guidelines for Exercise Testing and Prescription. Lippincott Williams & Wilkines. Philadelphia. USA.
2. Corbin C G Welk W Corbin & K Welk (2005). Concepts of Fitness and Wellness. McGraw Hill Company. New York. USA.
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4. Hales D (2006). An Invitation to Health. Thomson Wadsworth. Belmont. California. USA.
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9. Thomas DQ and JE Kotecki (2007). Physical Activity and Health –An Interactive Approach. Jones and Bartlett Publishers. Sndbury. Masschusett. USA.

10. USDHHS (2000) Healthy People 2010: National Health Services (USDHHS). Washingtons D.C. USA.

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SEMESTER- 3
BSc-PE-DSE-1(4)-104.1 (DSE)
FUNDAMENTALS OF BASKETBALL
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF BASKETBALL	04	02	0	02	XII	--

Objective:

The learner will be able to understand and comprehend the fundamentals of Basketball game with its practices and skill for better pedagogy and performance in Basketball.

Learning Outcomes:

1. The learner will attain basic knowledge of Basketball for different applications.
2. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Basketball.
3. The learner will be able to perform the marking/ drawing/ material organizing for Basketball.
4. The learner will be able to understand, analyze and interpret the fundamental methods and score
5. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Basketball).
6. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Court, marking and General Rules **(8 hours)**

1.1 Court Layout (mention each and every specification)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Skills **(7 hours)**

2.1 Dribble
2.2 Passing
2.3 Shooting
2.4 Rebounding
2.5 Faking

Unit-3: Fundamental Defensive Skills **(8 hours)**

3.1 German drill and suicide drill
3.2 Lay-up shot
3.3 Zone-defence
3.4 Man to man technique
3.5 Attacking skills

Unit-4 Different tests in Basketball **(7 hours)**

4.1 Johnson Basketball Test
4.2 Knox Basketball test
4.3 Harrision Basketball test

PART-B: PRACTICAL **(60 hours)**

1. Court marking on paper and on the playfield as well.
2. General rules and their application and implementation in game situations.
3. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
4. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***"Physical education key learning for competitive exams".*** Iterative International Publishers.
2. Bompa O. Tudor and Halff G. Gregory. (2009) **"Periodization Theory and Methodology of Training"** Human kinetics. NY.
3. Drewett, J. (2007). **How to Improve at Basketball.** Crabtree Publishing Co., USA.
4. Goldstein, S. (1998). **Basketball Fundamentals.** 2 nd Ed. Golden Aura Publishing,USA.
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7. Sharma OP (2003). **Basket Ball Skills and Rules.** Khel Sahitya Kendra, Delhi.
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Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER- 3

BSc-PE-DSE-1(4)-104.2 (DSE)

FUNDAMENTALS OF CRICKET

DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF CRICKET	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Cricket game with its practices and skill for better pedagogy and performance in Cricket.

Learning Outcomes:

1. The learner will attain basic knowledge of Cricket for different applications.
2. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Cricket.
3. The learner will be able to perform the marking/ drawing/ material organizing for Cricket.
4. The learner will be able to understand, analyze and interpret the fundamental methods and score
5. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Cricket).
6. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY Syllabus (30 hours)

Unit-1 Ground, marking and General Rules (8 hours)

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Umpire, Referee Signals, soft signals, fouls and misconduct penalty.
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Batting Skills (7 hours)

2.1 Block
2.2 Cut
2.3 Drive

2.4 Hook
2.5 Leg Glance
2.6 Paddle Sweep
2.7 Pull
2.8 Sweep
2.9 Reverse Sweep
2.10 Slog Sweep
2.11 Slog

Unit-3: Demonstrate (By part and whole) Fundamental Bowling Skills (8 hours)

3.1 Fast bowling
3.1.1 Seam Bowling
3.1.2 Swing Bowling
3.1.3 Bouncer, Beamer & Full toss
3.1.4 In dipper
3.1.5 In swinger
3.1.6 Leg Cutter
3.1.7 Off Cutter
3.1.8 Slow Ball
3.1.9 Reverse

3.2 Spin Bowling

3.2.1 Off-Spin
3.2.2 Leg-Spin
3.2.3 Chinaman
3.2.4 Doosra
3.2.5 Googles
3.2.6 Leg Break
3.2.7 Teesra
3.2.8 Arm Ball

Unit-4 Fundamental Wicket keeping & fielding Skills (7 hours)

4.1 Wicket keeping (Stumping, runout & caught behind)
4.2 Fielding skills
4.2.1 Catching grip Indian style and Australian style
4.2.2 High & Low catch
4.2.3 Dive

PART-B: Practical Syllabus (60 hours)

1. Court marking on paper and on the playfield as well.
2. General rules and their application and implementation in game situations.
3. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
4. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***"Physical education key learning for competitive exams".*** Iterative International Publishers.
2. https://www.cricketbio.com/cricket/fundamental-skills-cricket/ [date of access 30-05-2023]
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SEMESTER- 3
BSc-PE-DSE-1(4)-104.3 (DSE)
FUNDAMENTALS OF KABADDI
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF KABADDI	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of kabaddi game with its practices and skill for better pedagogy and performance in kabaddi.

Learning Outcomes:

7. The learner will attain basic knowledge of Kabaddi for different applications.
8. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Kabaddi.
9. The learner will be able to perform the marking/ drawing/ material organizing for Kabaddi.
10. The learner will be able to understand, analyze and interpret the fundamental methods and score
11. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Kabaddi).
12. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Court, marking and General Rules **(8 hours)**

1.1 Court Layout (Mid line, Baulk line, Bonus line, Boundary line, Lobbies)
1.2 Dimensions of court (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet (Scoring- Bonus, Lonna and all out points)

Unit-2: Demonstrate (By part and whole) Fundamental Offensive Skills **(8 hours)**

2.1 Hand Touch
2.2 Toe Touch

2.3 Side Kick
2.4 Back Kick
2.5 Mule Kick
2.6 Leg Thrust

Unit-3: Fundamental Defensive Skills **(7 hours)**

3.1 Ankle Hold
3.2 Thigh Hold
3.3 Knee Hold/Double Knee Hold
3.4 Waist/Back/Trunk Hold
3.5 Block Tackle
3.6 Wrist Hold

Unit-4 Different tests in Kabaddi **(7 hours)**

4.1 Johnson Kabaddi Test
4.2 Knox Kabaddi test
4.3 Harrision Kabaddi test

PART-B: PRACTICAL **(60 hours)**

5. Court marking on paper and on the playfield as well.
6. General rules and their application and implementation in game situations.
7. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
8. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Bompa O. Tudor and Halff G. Gregory. (2009) "Periodization Theory and Methodology of Training" Human kinetics. NY.
2. Kumar, Dharmander. (2018). Kabaddi and It"s Playing Techniques. Writers Choice, New Delhi.
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Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER- 3
BSc-PE-DSE-1(4)-104.5 (DSE)
FUNDAMENTALS OF HANDBALL
DSE

Sl. No.	Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
			Lecture	Tutorial	Practical		
9.	**FUNDAMENTALS OF HANDBALL**	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Handball game with its practices and skill for better pedagogy and performance in Handball.

Learning Outcomes:

13. The learner will attain basic knowledge of Handball for different applications.
14. The learner will be able to gain knowledge and practices with respect to historical development, organizational structure and playfield technology of Handball.
15. The learner will be able to demonstrate the marking/ drawing/ material organizing for Handball.
16. The learner will be able to understand, analyze and interpret the fundamental methods and score.
17. The learner will be able to learn, demonstrate and acquire fundamental skills (offensive and defensive) of game/sports (Handball).
18. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Ground marking and General Rules **(8 hours)**

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Attacking Fundamental Skills **(7 hours)**

2.1 Attacker with the ball
2.1.1 Creating space
2.1.2 Passing & Catching

2.1.3 Faking
2.1.4 Shooting
2.1.5 Dribbling/ bouncing

2.2 Attacker without the ball
2.2.1 Receiving the ball
2.2.2 Available for teammate
2.2.3 Move without ball
2.2.4 Creating space

Unit-3: Demonstrate (By part and whole) Fundamental defensive Skills (7 hours)

3.1 Defending position
3.2 Intercepting the ball
3.3 Blocking

Unit-4 Different Offensive & Defensive skills of goal keeper (8 hours)

4.1 Offensive skills of goal keeper
4.1.1. Movement in the goal
4.1.2 Offensive posture, positioning
4.1.3 Passing to initiate fast break, attack, throws.
4.1.4 Execution of free throw, goalkeeper throw, throw-in.

4.2 Defensive skills of goal keeper
4.2.1. Defensive posture, positioning
4.2.2 Using hands, legs and torso for saves
4.2.3 Catching, deflecting and knocking down shots

PART- B Practical Syllabus (60 hours)

9. Court marking on paper and on the playfield as well.
10. General rules and their application and implementation in game situations.
11. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
12. Evaluation / testing of fundamental skills (performance analysis).

References:

1. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.
2. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
3. Bana, P., Späte, D., Lund, A., Strub, P., & Khalifa, A. (2011). Teaching Handball at school, Introduction to handball for students aged 5 to 11. International Handball Federation.
4. Buchheit, M. The 30-15 Intermittent Fitness Test: accuracy for individualizing interval training of young intermittent sport players. J Strength Cond. Res., 22: 365-374, 2008.
5. Bunker, B. & R. Thorpe. The curriculum model. Rethinking games teaching. R. Thorpe, Bunker, D., & Almond, L. Loughborough, University of Technology, Loughborough: 7-10, 1986.
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8. Hapkova, I. (2009). Handball does not always mean Handball. European Handball Federation. Lund, J., & Tannehill, D. (2010). Standards-based physical education curriculum development. Burlington, MA: Jones and Bartlett Publishers. Marczinka, Z. (2016). Playing Handball: A Comprehensive Study of the Game. Hungarian Handball Federation.

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SEMESTER- 3
BSc-PE-DSE-1(4)-104.6 (DSE)
FUNDAMENTALS OF HOCKEY
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF HOCKEY	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Hockey game with its practices and skill for better pedagogy and performance in Hockey.

Learning Outcomes:

19. The learner will attain basic knowledge of Hockey for different applications.
20. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Hockey.
21. The learner will be able to perform the marking/ drawing/ material organizing for Hockey.
22. The learner will be able to understand, analyze and interpret the fundamental methods and score
23. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Hockey).
24. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Ground marking and General Rules **(8 hours)**

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Fundamental Skills **(7 hours)**

2.1 Holding of stick
2.2 Ball carrying and elimination
    2.2.1 Running / rolling the ball
    2.2.2 Dribbling (Indian dribble)
    2.2.3 Jinking
2.3 Distribution
    2.3.1 Pushing
    2.3.2 Hit & Slap Hit
    2.3.3 Reverse Push and Reverse slide
2.5 Tomahawk and Overhead

Unit-3: Fundamental Receiving & Blocking Skills **(8 hours)**

3.1 Fore stick receive
3.2 Reverse stick receive
3.3 Receive with deception
3.4 Receive Arial balls
3.5 Tackling (Block & reverse block)
3.6 Penalty corner skills (Drag out & Trap)

Unit-4 Different tests in Hockey **(7 hours)**

4.1 SAI Hockey Skill Test
4.2 Harbans Singh Field Hockey Test
4.3 Fridel Field Hockey test

PART-B: PRACTICAL SYLLABUS **(60 hours)**

13. Court marking on paper and on the playfield as well.
14. General rules and their application and implementation in game situations.
15. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
16. Evaluation / testing of fundamental skills (performance analysis).

References:

9. International Hockey Federation (2003). ***Rules of the Game of Hockey with Guidance for Players and Umpires***. International Hockey Federation. India.
10. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
11. Pecknold, R. and Foeste, A. (2009). Hockey: Essential Skills. McGraw Hills,USA.
12. https://www.nios.ac.in/media/documents/Physical_Education_and_Yog_373/practical/15.pdf [access date 30-05-2023].
13. https://www.sportzyogi.com/friedel-field-hockey-test/[access date 30-05-2023].
14. https://fih.wildapricot.org/resources/Documents/Skills_of_hockey_tiers.pdf [access date 30-05-2023].
15. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.

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SEMESTER- 3
BSc-PE-DSE-1(4)-104.4 (DSE)
FUNDAMENTALS OF KHO-KHO
DSE

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Pre-Requisite of the Course (if any)
		Lecture	Tutorial	Practical		
FUNDAMENTALS OF KHO-KHO	04	02	0	02	XII	NIL

Objective:

The learner will be able to understand and comprehend the fundamentals of Kho-Kho game with its practices and skill for better pedagogy and performance in Kho-Kho.

Learning Outcomes:

25. The learner will attain basic knowledge of Kho-Kho for different applications.
26. The learner will be able to gain knowledge with respect to historical development, organizational structure and playfield technology of Handball.
27. The learner will be able to perform the marking/ drawing/ material organizing for Handball.
28. The learner will be able to understand, analyze and interpret the fundamental methods and score
29. The learner will be able to learn and acquire fundamental skills (offensive and defensive) of game/sports (Handball).
30. The students will also be able to demonstrate their knowledge of skills in both part and whole.

SYLLABUS

PART-A: THEORY **(30 hours)**

Unit-1 Ground marking and General Rules **(8 hours)**

1.1 Ground Layout (mention each and every specification)
1.2 Dimensions of ground (male and female)
1.3 Start and Restart of Play, Duration, Time-out, Suspensions
1.4 Referee Signals, fouls and misconduct
1.5 Technical Officials
1.6 Scoresheet

Unit-2: Demonstrate (By part and whole) Chasing Fundamental Skills **(7 hours)**

2.1 Giving Kho
2.2 Sudden change
2.3. Turning round the post
2.4 Diving
2.5 Late Kho
2.6 Taking direction
2.7 Taping
2.8 Trapping
2.9

Unit-3: Demonstrate (By part and whole) Fundamental running Skills **(8 hours)**

3.1 Position on court
3.2 Running
3.3 Avoiding trapping
3.4 Positioning near the post

Unit-4 Tactical fundamental skills **(7 hours)**

4.1 Fake Kho
4.2 Dodging
    4.2.1 Front dodge
    4.2.2 Back dodge
    4.2.3 Round the post dodge

PART-B: PRACTICAL **(60 hours)**

17. Court marking on paper and on the playfield as well.
18. General rules and their application and implementation in game situations.
19. Learning and demonstrating various fundamental skills mention in unit 2 and 3.
20. Evaluation / testing of fundamental skills (performance analysis).

References:

16. Shaw,D. (2020) ***Physical education practical manual.*** Prachi [India] Pvt. L.td Inder Lok Delhi.
17. Pratap, V., Yadav, A., Sing, K. S., Shaw, D. (2023) ***Physical education key learning for competitive exams.*** Iterative International Publishers.
18. https://www.ultimatekhokho.com/static-assets/pdf/rules-season1.pdf [date of access 30-05-2023]
19. Kishore.,N.(2016) *How to Play Kho-Kho* Prerna Prakashan

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REGISTRAR