UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/
Dated: 13.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 38-1/ (38-1-3) dated 08.12.2022]

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

Add the following:

Syllabi of Semester-II of the following departments under Faculty of Science based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

FACULTY OF SCIENCE

DEPARTMENT OF BOTANY

Category-I

B.Sc. (H) Botany

DISCIPLINE SPECIFIC CORE COURSE – 4: Microbiology and Plant-Microbe 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		
Microbiology and Plant-Microbe Interactions	**04**	**2**	0	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

To impart basic understanding about microbial world and their interactions with plants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understanding microbes and their roles and applications.
- Understanding about modes of reproduction of Viruses, Archaebacteria, Eubacteria.
- Understand plant-microbe interaction

SYLLABUS OF DSC-4

Unit 1: Introduction 02 Hours

Microbial world, Growth and nutrition of microbes with reference to nutritional media.

Unit 2: Viruses 07 Hours

Discovery; Physicochemical and biological characteristics; Classification (Baltimore); General structure with special reference to viroids and prions, DNA and RNA viruses; General account and mechanism of replication, lytic and lysogenic cycle; General account of viral diseases of plants (mosaic and vein clearing disease).

Unit 3: Bacteria 09 Hours

Discovery, General characteristics; Types - Archaebacteria, Eubacteria, Wall less forms (Mycoplasma, Phytoplasma and Spheroplasts); Cell structure; Nutritional types; Reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction); General account of bacterial diseases of plants (Citrus canker, Angular leaf spots of cotton).

Unit 4: Applied Microbiology 04 Hours

Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics and agriculture. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit 5: Plant-Microbe interactions 08 Hours

General account of Plant-microbe interactions; Plant growth promoting rhizobacteria (PGPR); Mechanism of nitrogen fixation by Cyanobacteria and Rhizobia; Types of mycorrhizal association with plants; Ectomycorrhiza and Endomycorrhiza and their effects on plant growth.

Practicals:

1. Study of Viruses: Electron micrographs / Model - T-Bacteriophage and TMV; specimens/digital resources/ Line drawings of Lytic and Lysogenic Cycle. 08 Hours
2. Study of Bacteria: Electron micrographs of bacteria; Types of Bacteria from temporary/permanent slides. Endospore, Binary fission, Conjugation, Root nodule through specimens/digital resources. 08 Hours
3. Study of Plant Growth Promoting Rhizobacteria (PGPR) through specimens/digital resources (at least three). 04 Hours
4. Gram staining to differentiate between Gram-positive and Gram-negative bacteria. 08 Hours
5. Study of *Rhizobium* from root nodules of a leguminous plant. 08 Hours
6. Isolation of *Anabaena* from *Azolla* leaves. 08 Hours
7. Histochemical staining to observe Arbuscular Mycorrhizal Fungi (AMF) colonization in roots. 08 Hours
8. Study of Bacterial diseases (Citrus canker, Angular leaf spots of cotton) and viral diseases

of plants (mosaic and vein clearing disease) through specimens/digital resources.

08 Hours

Suggested Readings:

1. Pelczar, M.J. (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata Mc-Graw- Hill Co.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2016) Microbiology: An Introduction, Indian edition, Pearson India Education Services Pvt. Limited, Noida, India
3. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, 6th edition: McGraw Hill, New Delhi.
4. Gupta, R., Chugh, G. (2022) Plants, Microbes and Diseases 1st Edition, I.K. International Pvt. Ltd., Delhi.
5. Subba Rao, N.S. (2000) Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Additional Resources:

1. Talaro, K.P., Talaro, A. (2006). Foundations in Microbiology. Mc-Graw Hill, New Delhi

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

DISCIPLINE SPECIFIC CORE COURSE – 5: Plant Resources and Economic Botany

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Resources and Economic Botany	**04**	**2**	0	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with the economic importance of diverse plant species and train them in identifying plants of economic importance through field visit/s, live plant specimens, herbarium specimens and digital resources.
- To make students understand the importance of various plant parts and derived products used as food, fibers, medicines, oils and other economically important products.
- To acquaint students with the processing of various economically important plant resources and train them to identify and analyses nutrients using simple microchemical tests.

Learning outcomes

The Learning Outcomes of this course are as follows:

- This course would provide students with information about the economic importance and products derived from plants and their roles in our daily lives.
- Students will learn to perform micro-chemical tests to study presence of various components.
- Students will explore the regional diversity in food crops and other plants and their ethnobotanical importance.

SYLLABUS OF DSC-5

Unit 1: Introduction and Origin of Cultivated Plants **02 Hours**
Importance of Plant Resources; Vavilov's concept for the Origin of cultivated plants; Centres of Origin (Primary and Secondary); Centres of diversity, Harlan's concept of gene pools. Plant Genetic Resources and their conservation.

Unit 2: Cereals **04 Hours**
Wheats (Origin, Evolution of Wheats (tetra- & hexaploid), Morphology, Production, and Economic Importance of Hexaploid Wheat); Rice (Origin-Monophyletic and Polyphyletic, Production, Morphology, Comparison between *indica* and *japonica* Rice, Parboiling,

Economic Importance); Other cereals: Maize, Barley, Oats, Millets (jowar, bajra, ragi) and Pseudocereals.

Unit 3: Legumes **03 Hours**

General account (Nutritive Value of Pulses, Protein Malnutrition, Lathyrism,
Favism, Ecological Importance); chick pea and pigeon pea (Production, Morphology and Economic Importance). Other Legumes: Lentil, Cluster Bean, Lathyrus, Beans, Pea, Cowpea, Fodder legumes and Green manure crops.

Unit 4: Sugars and Starches **03 Hours**

Sugarcane (Morphology, Ratooning, Nobilization, Products and By- products); Potato (Morphology, Tuber Anatomy, Seed Tubers vs True Potato Seeds and Economic uses).

Unit 5: Spices, Condiments & Flavourings **03 Hours**

General Account (Spices, Condiments, Culinary Herbs and Essences, with examples), Importance of Spices, Clove (Morphology, Anatomy of part used and Economic Importance) and Black Pepper (Morphology, Anatomy of part used and Economic Importance). Other examples: Ginger, Turmeric, Cinnamon, Saffron, Cardamom, Chillies & Pepper, Fennel, Coriander, Cumin, Vanilla, Nutmeg.

Unit 6: Beverages **02 Hours**

Types of Beverages (Alcoholic and Non-Alcoholic) with examples, Tea and coffee (Morphology, Chemistry, Processing and Economic Importance)

Unit 7: Fibres and Fibre-yielding plants **03 Hours**

Classification of Fibres based upon their Origin (surface fibres, bast fibres, and leaf fibres, with examples); Jute (morphology, extraction and economic importance), Cotton (*Gossypium* species, morphology, processing and economic importance) Comparison between Jute and Cotton fibers. Other examples: Flax, Hemp and Coconut.

Unit 8: Oil-Yielding Plants **03 Hours**

Fatty Oils and Essential Oils, Comparison between Fatty Oils and Essential Oils; Fatty Oils (Classification with examples, keeping quality), Groundnut (Morphology and Economic Importance); Essential Oils (General characteristics, Methods of Extraction and Economic Importance, with examples). Other examples: Rapeseed & Mustard (canola), Coconut, Olive, Castor, Cottonseed, Sesame, Soybean, Linseed.

Unit 9: Medicinal and Drug-Yielding Plants **02 Hours**

Brief Account of Therapeutic Drugs with Examples; Morphology, Chemical Constituents, Economic Importance of *Cinchona, Rauwolfia, Digitalis.*

Unit 10: Fumigatory & Masticatory **02 Hours**

Tobacco **(**Morphology, species - *Nicotiana tabacum* & *N. rustica*), Processing, Products, Economic Importance and Health Hazards), *Cannabis*, *Papaver* (Morphology, Chemical Constituents, Economic Importance)

Unit 11: Rubber **01 Hour**

Para Rubber - *Hevea brasiliensis* (Morphology, Tapping of latex, Processing, Products and Economic Importance)

Unit 12: Fruits & Nuts **01 Hour**

Tropical & Temperate; *Citrus*, Mango, Banana, Apple, Pineapple, Papaya; Nuts: Cashew, Walnut, Almond & Pistachio.

Unit 13: Vegetables **01 Hour**

Common examples of root crops, leafy vegetables (herbag), fruit seed vegetables;

Practicals:

1. **Cereals**: Wheat (Habit Sketch, L.S/T.S. grain, W.M. starch grains, Micro-chemical tests), Rice (Habit Sketch, study of paddy and grain, W.M. starch grains, Micro- chemical tests). Millets - Pearl Millet, Finger Millet and Pseudocereals - Amaranth Grain, Quinoa (specimens/digital resources and grains) **08 Hours**
2. **Legumes**: Chickpea, pigeonpea (Habit, fruit, seed structure, Micro-chemical tests). **04 Hours**
3. **Sugars and Starches**: Sugarcane (Habit Sketch, Products and By-products, Cane Juice-Micro - chemical tests); Potato (Habit Sketch, Tuber morphology, T.S. tuber to show localization of starch grains, W.M. starch grains, Micro-chemical tests). **08 Hours**
4. **Spices**: Clove, Blackpepper (Habit and sections L.S./T.S.), Saffron, fennel (specimen/digital resources) **04 Hours**
5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans) **04 Hours**
6. **Fibres**: Jute (specimens/digital resources of *Corchorus capsularis* and *C. olitorious*, T.S. stem, test for cellulose and lignin on section of stem and fibre). Cotton (specimen, W.M. seed to show lint and fuzz; W.M. fibre and test for cellulose) **08 Hours**
7. **Oil-Yielding Plants**: Fatty Oils: Groundnut (Habit-specimen, Fruit, seeds, Microchemical Tests) Coconut-Habit (photograph), Fruit, T.S. nut, Mustard - (Habit- specimen, Fruit, seeds); Essential Oils: Habit Sketch of Rose, Jasmine, Vetiver, Sandalwood and *Eucalyptus* (specimens/photographs) **08 Hours**
8. **Drug-Yielding plants:** Habit - Fever Bark Tree, Poppy, Foxglove and Cannabis (Specimens/ Photographs) **08 Hours**
9. **Tobacco:** *Nicotiana tabacum* and *N. rustica* (specimens/photographs), Tobacco Products
10. **Rubber:** Para Rubber-Habit, Tapping of latex (Specimen/photograph), Rubber Products **04 Hours**
11. **Petro-crops:** *Saccharum officinarum* , *Jatropha* sp. **04 Hours**

Suggested Readings:

1. Kochhar,S.L. (2012). Economic Botany in Tropics. New Delhi, India: MacMillan & Co.
2. Kochhar, S.L. (2016). Economic Botany – A Comprehensive Study, 5th Edition. New Delhi, India: Cambridge University Press.
3. Wickens, G.E. (2001). Economic Botany: Principles & Practices. The Netherlands: Kluwer Academic Publishers.
4. Chrispeels, M.J., Sadava, D.E. (1994). Plants. Genes and Agriculture. Jones & Bartlett-Publishers.
5. Berg L, (2008). Introductory Botany: Plants, People, And The Environment, Thomson Brooks/Cole.
6. Cook F.E.M. (1995). Economic Botany: Data Collection Standard Royal Botanic Garden, Kew, Richmond.

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

DISCIPLINE SPECIFIC CORE COURSE – 6: Plant Systematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Systematics	**04**	**2**	**0**	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The course will help students gain knowledge about:

- The basics of plant systematics and its inter-relationships with allied subject areas

Learning outcomes

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

- understand technical terminology used in plant taxonomy
- apply the terminologies to describe, identify and classify flowering plants
- search and analyse taxonomic information from internet-based scientific databases and other resources
- interpret and evaluate the concept of species and evolutionary processes in angiosperms
- comprehend and compare various systems of classifications
- recognise diversity in local/regional flora
- appreciate the significance and application of systematics in science and welfare of society

SYLLABUS OF DSC-6

Unit 1: Introduction **02 Hours**

Identification, Classification (types) and Nomenclature, Phylogeny; Major contributions - Parasara, Charaka, Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Bremer, MW Chase

Unit 2: Resources in Plant Identification **02 Hours**

Literature (Floras, Manuals, *Icones*, Monographs, Revisions, Journals, e-resources); Herbaria and Botanical gardens (in brief)

Unit 3: Systematics - An Interdisciplinary Science **04 Hours**

Relevance of palynology, cytology, phytochemistry and molecular data (cite at least (streak, spread & pour), replica plating, serial dilution.

three examples from each with emphasis on application in resolving taxonomic problems - details of techniques to be excluded)

Unit 4: Botanical Nomenclature **05 Hours**
Principles and rules (ICN); Ranks and names; Principle of priority and its limitations; Concept of 'Type', Author citation, Valid publication, Rejection of names; Nomenclature of hybrids

Unit 5: Systems of Classification **06 Hours**
Taxonomic hierarchy; Concept of species (morphological, biological and evolutionary); Classifications - Bentham and Hooker's (up to series), Engler and Prantl's (upto sub-class) and Angiosperm Phylogeny Group (APG) classification (major clades).

Unit 6: Approaches in Systematics **06 Hours**
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades and grades).
Phenetics - Principles, Methodology, Characters; Selection of OTUs, Character weighing and Coding; Cluster analysis; Phenogram.
Cladistics - Principles, Methodology, Characters; Selection of EUs, Character weighing and Coding; Cluster analysis; Cladogram

Unit 7: Evolution of Angiosperms **05 Hours**
Concept of a primitive flower (Euanthial theory and Pseudanthial theory); Basal Living Angiosperms; Herbaceous origin; Co-evolution of angiosperms with animals.

Practicals:
1. Field trip/ Visit to any herbaria/ Botanical Garden. **04 Hours**
2. To prepare at least five herbarium specimens and identify them using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's classification and comapare it with APG IV System in the field note book). **08 Hours**
3. Description of taxa using semi-technical terms and identification of the families according to Bentham and Hooker's classification and compare the placement of family with APG IV System (Only placement of family according to APG IV system to be mentioned) **48 Hours**

Note: Any **twelve** families from the following list to be studied with **at least two** specimens (**or one** where limitations exist).

List of Suggested Families (*mandatory)
Acanthaceae, Amaranthaceae, *Apiaceae, Apocynaceae, *Asteraceae, *Brassicaceae, *Euphorbiaceae, *Fabaceae, *Lamiaceae, Liliaceae, *Malvaceae, Moraceae, *Poaceae, *Ranunculaceae, *Solanaceae

Suggested Readings:
1. Simpson, M. G. (2019). Plant systematics. 3rd Edition, Academic press.
2. Singh, G. (2019). Plant Systematics- An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.
3. Stuessy, T.F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, 2nd edition, Columbia University Press.
4. Taylor, D.V., Hickey, L.J. (1997) Flowering Plants: Origin, Evolution and Phylogeny.

CBS Publishers & Distributers, New Delhi.
5. Pandey, A. K., Kasana, S. (2021). *Plant Systematics*. 2nd Edition. CRC Press Taylor and Francis Group
6. http://www.mobot.org/MOBOT/research/APweb/
7. Maheshwari, J. K. (1963). The flora of Delhi. Council of Scientific & Industrial Research.
8. Maheshwari, J. K. (1966). Illustrations to the Flora of Delhi. Council of Scientific & Industrial Research.
9. Harris, J. G., Harris, M. W. (2001). Plant Identification Terminology: An Illustrated Glossary. Spring Lake, Utah: Spring Lake Pub. Spring Lake, Utah.
10. Radford, A. E. (1974). Vascular plant systematics. Harper & Row Publishers, New York, London.
11. Judd, W.S., Campbell, L.S., Kellogg, E.A., Stevens, P.F., Donoghue, M.J. (2016) Plant Systematics: A Phylogenetic Approach. 4th edition. Sunderland, MA: Sinauer Associates

Additional Resources:

1. The Angiosperm Phylogeny Group, Chase, M. W., Christenhusz, M. J.M., Fay, M. F., Byng, J. W., Judd, W. S., Soltis, D.E. Mabberley, D. J., Sennikov, A. N., Soltis, P. S., Stevens, P. F. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants*:* APG IV. Botanical journal of the Linnean Society 181 (1): 1–20.
2. Soltis, D. E., Bell, C. D., Kim, S., Soltis, P. S. (2008). Origin and early evolution of angiosperms. Annals of the New York Academy of Sciences 1133: 3-25.
3. Scutt, C. P. (2021). The origin of angiosperms*.* In Evolutionary developmental biology: a reference guide. Cham: Springer International Publishing.
4. https://www.mobot.org/MOBOT/research/APweb/treeapweb2s.gif
5. https://www.digitalatlasofancientlife.org
6. http://apps.kew.org/herbcat/navigator.do
7. https://efloraofindia.com/
8. https://powo.science.kew.org/
9. Page, R.D.M., Holmes, E.C. (1998). Molecular Evolution: A phylogenetic approach. Blackwell Publishing Ltd.

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

Category II
B.Sc. Life Science with Botany as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE – 2: Genetics and Molecular Biology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology	**04**	**2**	**0**	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objective
To apprise students with the basic principles of Genetics and Molecular Biology and its applications in living systems

Learning Outcome:
Students would be able to

- understand the fundamentals of Mendelian inheritance and non-Mendelian inheritance.
- describe the concepts of linkage and crossing over and their usage in constructing genetic maps.
- gain knowledge about chromosomal aberrations and mutations.
- become familiar with structure and function of nucleic acids with reference to replication, transcription and translation.
- understand the mechanisms of gene regulation

SYLLABUS OF DSC-02

Unit 1: Mendelian genetics and extrachromosomal inheritance **06 Hours**
Mendel's principles of inheritance; chromosomal theory of inheritance; incomplete dominance and co-dominance; multiple allelism; lethal alleles (dominant and recessive lethals); deviations of Mendelian dihybrid ratio (Epistatic interactions-Dominant, Recessive, Duplicate Dominant, Duplicate Recessive, Duplicate Gene Interaction, Dominant - Recessive); polygenic inheritance; numericals based on above; extrachromosomal inheritance (Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance: petite mutants in yeast); Maternal effect (shell coiling in snails).

Unit 2: Structure & Function of the gene **02 Hours**
Classical and molecular concept of gene - Benzer's cis-trans complementation analyses & fine map of rII locus in phage. Central Dogma.

Unit 3: Linkage, crossing over and chromosome mapping **03 Hours**
Discovery; linkage and crossing over; recombination frequency: two factor crosses; sex linkage (eye color in *Drosophila*; colour blindness and haemophilia in humans).

Unit 4: Variation in chromosome number and structure **03 Hours**
Haploidy, polyploidy, autopolyploidy (examples: banana, watermelon), allopolyploidy (ancestry of wheat) and aneuploidy (Down's, Turner's and Klinefelter's syndromes); Deletion; Duplication (Bar eye in *Drosophila*); Inversion (paracentric and pericentric); Translocation (*Rhoeo, Oenothera;* Robertsonian translocation, Familial Down Syndrome and cancer).

Unit 5: DNA structure and replication **03 Hours**
Discovery of DNA; Watson and Crick model of DNA structure; semiconservative replication (Meselson & Stahl's experiment); DNA replication mechanism in *E. coli* (semi-discontinuous mode and Y-fork).

Unit 6: Mutations **03 Hours**
History; mutation types with examples [spontaneous and induced; somatic and germinal; biochemical mutations; point mutations (base substitutions): transition and transversion; deletion and frameshift mutations), missense and nonsense mutations]; Molecular basis of mutation; Mutagens - physical (UV and X-rays), chemical mutagens [Base analogues, deaminating, alkylating and intercalating agents] and Transposons.

Unit 7: Gene expression **06 Hours**
Genetic code; Structure and types of RNA; Transcription and Translation in Prokaryotes; Transcription, RNA processing and Translation in Eukaryotes.

Unit 8: Regulation of gene expression: Prokaryotes **04 Hours**
Inducible and repressible systems, negative and positive control of lactose operon and tryptophan operon. **Eukaryotes -** Transcriptional gene silencing - Role of chromatin, DNA methylation, histone modifications; cis-acting elements (promoters & enhancers/silencers), trans-acting factors; Post-transcriptional gene regulation (RNA interference/ PTGS), role of small RNAs, Epigenetics.

Practicals:

1. To study mitosis in *Allium cepa* through squash preparation of root tips. **04 Hours**
2. To study meiosis in *Allium cepa* through smear preparation of anthers. **08 Hours**
3. To study incomplete dominance and deviations of Mendelian dihybrid ratio (12:3:1, 9:3:4, 9:7, 15:1, 13:3) through seed samples. **08 Hours**

a) Human Genetics b) Study of autosomal & sex-linked dominant & recessive inheritance through pedigree analyses. c) n ABO blood group testing using kits, d) To study the syndromes (Down's, Klinefelter's, and Turner's) through karyotypes **08 Hours**

4. To study chromosomal aberrations: reciprocal translocation through squash preparations of *Rhoeo* anthers. Complex translocation ring, quadrivalents, lagging chromosomes, dicentric/inversion bridge through permanent slides. **08 Hours**
5. To prepare LB medium, inoculate and maintain (spread plate, streak plate, pour plate & serial dilution methods) *E. coli* cultures. **08 Hours**
6. To isolate genomic DNA from cauliflower and *E.coli*. Visualise using agarose gel electrophoresis. **08 Hours**
7. To estimate DNA by diphenylamine method. **04 Hours**

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.

Additional Resources:

1. Russell, P. J. (2010). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings
2. Snustad, D.P., Simmons, M.J. (2016). Principles of Genetics, 7th Edition. New Delhi, Delhi: John Wiley & sons
3. Pierce, B. A. (2020). Genetics: A Conceptual Approach Seventh Edition, Macmillan

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

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

Credit 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		
Ethnobotany	04	2	0	2	12th Pass	NIL

Learning Objectives

- To have the knowledge of the plants used by the local communities, tribals, ethenic groups, their nutritive and medicinal value.

Learning outcomes

After studying this course the student will gain knowledge about:

- Students would have an understanding of the treasure, value and usefulness of the natural products and their efficient use by the local communities as food and medicine and their conservation practices.

SYLLABUS OF GE-6

Unit 1: Introduction to Ethnobotany and Basic Taxonomy **06 Hours**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science, databases and knowledge resource (Traditional Knowledge Digital Library), The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles, Plants used by the indigenous societies: a) Food plants b) Medicinal plants c) intoxicants and beverages d) Resins and oils and miscellaneous uses.

Unit 2: Applied Ethnobotany **07 Weeks**

Role of ethnobotany in modern Medicine, Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology): a) *Azadiractha indica,* b) Ocimum sanctum, c) *Vitex negundo,* d) *Gloriosa superba,* e) *Tribulus terrestris,* f) *Pongamia pinnata,* g) *Cassia auriculata,* h) *Indigofera tinctoria*.

Unit 3: The Ecology of Ethnobotany **07 Hours**

Ethnobotany—Spirits, Lore, Material Cultures, Folk Magic, Narcotics, Stimulants; Nutritional Ethnobotany – Agriculture, foraging and wild foods; Linguistic

Ethnobotany—Botanical Classification and Ethics; Medicinal Ethnobotany and Ethnopharmacology; Ethnoveterinary knowledge

Unit 4: Research Methods in Ethnobotany **06 Hours**

Etic and Emic Perspectives: a) Field work; b) Herbarium; c) Ancient Literature and oral traditions; d) Archaeological finding inferences; e) Religious and sacred places.

Unit 5: Protecting Knowledge **04 Hours**

Ethnobotany and legal aspects, Ethnobotany as a tool to protect interests of ethnic groups, Sharing of wealth concept with few examples from India, Biopiracy, Intellectual Property Rights and Traditional Knowledge; Case studies of traditional medicines leading to development of modern pharmaceutical products (use of *Trichopus zeylanicus* by kanhi tribe and Artemesia sp. for malaria cure)

Practicals: **60 Hours**

- Collection, identification and preparation of herbarium of three ethno-botanically important plants with appropriate references
- Preparation of crude extract of ethno-botanically important plants with appropriate references (any method to be used)
- Project work-documentation, literature survey, and collection of information on ethno-botanically useful plants from traditional healers)

Suggested Readings:

- Jain, S.K. (2010). Manual of Ethnobotany. Rajasthan: Scientific Publishers.
- Martin, G.J. (1995). Ethnobotany: A Methods Manual. Chapman Hall
- Cunningham, A.B. (2001). Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan, London.
- Young, K.J. (2007). Ethnobotany. Infobase Publishing, New York.
- Schmidt, B.M., Cheng, D.M.K. (Eds.) (2017). Ethnobotany: A Phytochemical Perspective. John Wiley & Sons Ltd. Chichester, UK.
- Research papers from various Scientific Journals for case studies**.**

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

14

GENERIC ELECTIVES (GE-7)

Credit 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		
Viewing and Capturing Diversity in Nature	**4**	**2**	0	2	12^{th} Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide students a comprehensive introduction to photography, including both aesthetic and technique.
- To get students to rethink the environment in which they live through the medium of pictures.
- To become thoroughly familiar with digital camera and smartphone photography technology.
- To develop a working knowledge of digital image modification,
- To understand the importance and use Nature photography in your business and career prospects.
- To enhance appreciation for the tremendous beauty inherent in plants and gardens.

Learning outcomes

On successful completion of this course, a student will be able to:

- understand the digital camera or smartphone camera functions.
- use different photographic equipment to enhance their photographic skills.
- know about the photographic variables with weather and season.
- exploit their photographic work in various professions and for entrepreneurship development.

SYLLABUS OF GE-7

Unit 1: Basics of Photography and Videography **10 Hours**

History and development of digital photography, Introduction to lenses and camera, Definitions (Megapixel, Magnification, Resolving Power, Zoom feature, contrast and brightness of image), Types of lenses, analog camera, Digital camera, SLR camera, imaging system in camera. Role of lighting, depth of field, focal length, colour and contrast in photography, types of photography and techniques, working of camera: exposure, shutter speed and aperture.

Understanding Image: Types of shots: distance, angle and movement; digital image basics: image format, resolution, aspect ratio, Pixels, DPI and PPI, composition and aesthetics: rules and guidelines.

Unit 2: Diversity of Nature: Colours and Landscape 10 Hours

Importance of plants as natural products, General characteristic features of various plant life forms (Single celled, colonial forms, filamentous forms and multicellular and complex forms). General account of diverse landscaping patterns based on different geographical locations, plant adaptations and ecological interactions, role of plant pigments (diverse forms of alga, leaf coloration, floral pigments) in aesthetic appeal.

Unit 3: Diversity around us - A magnified view 05 Hours

Principles of Microscopy: Dissection and compound microscope, scanning electron microscope. importance of sample preparation for microscopy, staining techniques.

Unit 4: Photographic visualisation of Nature 05 Hours

Sensitization of Biodiversity conservation; Thematic depiction of nature in Art galleries; Eco-tourism: a general account; role of photography in Eco-tourism and ecological discourse.

Practicals: 60 Hours

1. To study the parts of a digital camera.
2. To study the principle and working of digital camera/ smartphone camera.
3. Working and handling of light microscopes (Dissection and Compound).
4. Study of plant forms through microscopic lens (Single celled, colonial forms, filamentous forms, multicellular and complex forms).
5. To study techniques of capturing shots (using light and lenses effectively, macro and micro photography, wide angle and close-ups).
6. Study of plant adaptations through photographs (Aquatic and desert plants).
7. To capture and understand the Ecological Interactions.
8. Identification of different plant life forms through online available tools/ search engines.
9. Outdoor/ Campus Photography: Plants, Environment, Landscapes and cityscape, Mushrooms.
10. Project Work: To make a portfolio of diverse landscaping patterns/ selected theme through outdoor visits.

Suggested Readings:

1. Ang., T. (2008). Fundamentals of modern Photography. London, Mitchell.
2. Patterson, F. (1999). The Art of Seeing. Key Porter Books.
3. Fitzharris, T. (2011). Landscape Photography. Firefly Books.
4. Kelby, S. (2012). The digital photography book. Peachpit Press.
5. Langford, M., Fox, A., Smith, R.S. (2013). Langford basic photography: the guide for serious photographers. Amsterdam: Focal Press/Elsevier.
6. Peterson, B. (2016). Understanding exposure: how to shoot great photographs with any camera. AmPhoto Books.
7. Karp, G. (2010). Cell Biology, 6th edition. New Jersey, U.S.A.: John Wiley & Sons.

Additional Resources:

1. Sharma, P.D. (2010.) Ecology and Environment. Meerut, UP. Rastogi Publications.

2. Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press

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

GENERIC ELECTIVES (GE-8)

Credit 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		
Agricultural Botany and Weed Science	**4**	**2**	**0**	2	12^{th} Pass	**Nil**

Objectives: To gain the knowledge on
- Requirement of the conditions for seed germination
- Growth hormones, plant development and flowering conditions
- Weeds and the methods to control weeds

Learning Outcomes:
After completion of this course the students would be able to understand:
- how is the quality of seeds judged and how are the suitable conditions for the seed germination created?
- how are the growth, flowering and fruiting in plants managed through the applications of hormones?
- how are weeds managed in commercial crops?

Unit 1: Seed Physiology **04 Hours**

Seed dormancy types, factors, mechanism and methods for breaking dormancy, seed viability, seed vigour and seed germination.

Unit 2: Physiology of Crop Growth and Yield **05 Hours**

Growth, methods of growth analysis, factors affecting growth, concept of phytotronics and Fertilizers (Nitrogen, Phosphorus, biofertilizers).

Unit 3: Regulation of Growth and Development **04 Hours**

Role of hormones in plant growth and development, growth retardant.

Unit 4: Reproductive Physiology and Senescence **06 Hours**

Physiology of flowering, Photoperiodism, vernalization, physiology of fruit ripening, senescence and regulation of senescence.

Unit 5: Biology of Weeds **04 Hours**

Ecology of weeds, competition, reproduction of weeds. Allelopathy and Invasive Plants.

Unit 6: Crop Management Practices **07 Hours**

Mechanical, Cultural, Biological and Chemical Weed control. Some abnoxious weeds and their management, Integrated pest management (IPM).

Practicals: (60 hours)

1. To study the effect of ethylene on shelf life of cut flowers./ To study the effect of cytokinin on leaf senescence.
2. To test the viability of weed seeds.
3. To study the allelopathic effects of weeds on germination of crop seeds.
4. To study the effect of herbicides on seed germination and seedling growth of weeds.
5. Determination of pH and analysis of a soil sample for carbonates, chlorides, sulphates, organic matter and base deficiency by rapid field tests.
6. To perform the qualitative test for Nitrogen (NH^{4+}, NO^{3-}, urea) in a fertilizer and the soil sample.
7. Demonstration / photographs for the mechanisms used in herbicide application.
8. Field trip to a crop land to study weeds.
9. Submission of any two properly dried and mounted weed specimens with the herbarium label.

Suggested Readings:

1. Ashton, F. M., Monaco, T. J. (2002). Weed Science: Principles and Practices. New Jersey, U.S.: John Wiley and Sons. Inc.
2. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
3. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development International 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
4. Mandal, R.C. (1990). Weeds, weedicides and weed control: Principle and Practice. New Delhi, Delhi: Agro Botanical Publishers.
5. Rao, V. S. (1999). Principles of Weed Science. Oxford and IBH Publishers, New Delhi.
6. Subramanian, S. (2017). All about weed control. New Delhi, Delhi: Kalayani publishers.

GENERIC ELECTIVES (GE-9)

Credit 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		
Intelligent Systems in Plants	04	2	**0**	2	12th Pass	**Nil**

Learning Objectives

- The course aims to lay the foundations on plant intelligence and develops understanding of the intelligent adaptively variable behaviour of plants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The students will be learning the concepts of intelligence, distinction between development and intelligent behaviour and morphological /adaptive strategies employed by plants to survive.

SYLLABUS OF GE-09

Unit 1: Introduction **04 Hours**
An Introduction to Plant Structure (Morphological and Anatomical details), compartmentalization

Unit 2: Plants and Intelligence **03 Hours**
Introduction to Plant Intelligence and Memory - Historical Perspective

Unit 3: Sensory Biology **04 Hours**
Cell to cell communication, Self-recognition, Recognition of Neighbours and Relatives.

Unit 4: Learning in Plants **06 Hours**
Habituation learning, Learning by association (Rhizosphere and Mycorrhizae), Adaptive Intelligence (Hydrophytes, Xerophytes, Parasites, Carnivorous plants, Thermogenic plants), Response to water, heat, salt, cold stress. Mechanical and chemical defence against predators with special reference to secondary metabolites.

Unit 5: Intelligent Behaviour of Plants **13 Hours**
A Guided tour to Plant Movements (Tropic Movements, Movement towards gravity, light, tracking sun movements, prey driven movements, liberation movements), Intelligent response to minerals and light (Seed germination, root cap, response of shoot, leaf morphology and anatomy), Unique pollination and seed dispersal mechanisms, Osmosis, Short and long-distance transport of water and food, Metabolic redundancy, Life Cycle Signaling in response to external stimuli (Reactive Oxygen Species, peptides, receptors, hormones).

Practicals:(60 hours)

1. Study the structure of plant cell using temporary mount
2. Study of the cell as an osmotic system (Plasmolysis and Deplasmolysis).
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Extraction and qualitative analysis of alkaloids, flavonoids, tannins and phenols.
5. To study the phenomenon of seed germination (effect of light).
6. To study light sensitivity and etiolation vs. de-etiolation.
7. Morphology and orientation of chloroplasts in leaves growing in light and dark, plasmodesmata connections and plasma membrane receptors. (through photographs or other digital resources)
8. Estimation of total photosynthetic pigments.
9. Study of (a) Root cap (b) Trichomes: non-glandular and glandular (c) Leaf Morphology and Anatomy. (d) pulvinus anatomy in *Mimosa pudica.* (e) Specialised motor tissue at the base of monocot leaves
10. (a) Study of morphological and anatomical adaptations of hydrophytes, xerophytes. (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
11. Pollination types (selected) and associated seed dispersal mechanisms

Suggested Readings:

1. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
2. Evert, RF., Eichhorn, S.E. (2012). Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
3. Koller, D. (2011). The Restless Plant. Edited by Elizabeth Van Volkenburgh, Haward University Press, Cambridge, Massachusetts, and London, England.
4. Crang, R., Lyons-Sobaski, S., Wise, R. (2018) Plant Anatomy- A Concept based approach to the structure of seed plants, Springer Nature, Switzerland.

Additional Resources:

Trewavas A. (2017). The foundations of plant intelligence. Interface Focus 7: 20160098. http://dx.doi.org/10.1098/rsfs.2016.0098

GENERIC ELECTIVES (GE-10)

Credit 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		
Informatics and Statistics for Biology and Allied Sciences	**4**	2	0	2	**12th Pass**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To build an understanding in silico/computational approaches in various aspects of understanding biology and biological research.

- To build analytical skills and integrate the principles of statistical analyses for robust interpretation of biological observations.

Learning outcomes

The student will understand
- the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field.
- learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools.
- understand the basic concept of sampling methods, data classification, presentation and statistical analysis.

SYLLABUS OF GE-10

Unit 1: Introduction to Bioinformatics **03 Hours**

Historical background, Aims and scope, bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology and drug discovery, Applications and Limitations in bioinformatics.

Unit 2: Biological databases **04 Hours**

Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (BLAST)), introduction to EMBL, DDBJ, UniProt, PDB and KEGG.

Unit 3: Basic concepts of Sequence alignment **04 Hours**

Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments

Unit 4: Molecular Phylogeny **04 Hours**

Introduction to Molecular Phylogeny, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbor-joining) methods.

Unit 5: Biostatistics **02 Hours**

Biostatistics – definition, Basics of descriptive and inferential statistics; Limitations and applications of biostatistics.

Unit 6: Data types and presentation **03 Hours**

Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data;

Unit 7: Descriptive Statistics **04 Hours**

Measures of central tendency - mean, median, and mode; Measures of dispersion - range, standard deviation, and standard error.

Unit 8: Correlation and Regression **03 Hours**

Types and methods of correlation, Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

Unit 9: Statistical inference **03 Hours**

Hypothesis – (simple hypothesis), student's t test, chi-square test.

(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)

Practicals: 60 Hours

1. Biological databases (NCBI, EMBL, UniProt, PDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Making of Bar diagrams, Pie chart, Histogram, Frequency polygon, Cumulative frequency curve (any four) in the given data set using Microsoft Excel
8. Calculation of mean, mode, median, standard deviation and standard error (through manual calculation and using Microsoft Excel) (use only ungrouped data)
9. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
10. Student's t-test (using Microsoft Excel only), chi square test (Manual and using Microsoft Excel)

Suggested readings:

1. Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). *Bioinformatics*, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). *Bioinformatics: A practical guide to the analysis of genes and proteins*, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
5. Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications.
6. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

Additional Resources:

1. Pevsner, J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong, J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
5. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.

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

DEPARTMENT OF ZOOLOGY

Category-I
BSc. (H) Zoology

DISCIPLINE SPECIFIC CORE COURSE– 4 (DSC-4): Non-Chordata: Coelomates

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to impart in-depth knowledge about the diverse life forms from the taxonomic positions of Annelida to Echinodermata.
- It will help the students to identify the body plan types of complex non-chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.
- The course will help the students to understand the characteristic morphological, adaptive and anatomical features of diverse animals
- The course will help students to understand the economic and ecological significance of various animals in human life.
- The course will create interest among them to explore and appreciate the animal diversity in nature.

Learning Outcomes

By studying this course, students will be able to

- learn about the importance of systematics, taxonomy, and structural organization ofnon-chordate coelomates.
- recognize the diversity of non-chordates living in varied ecological habitats.
- critically analyse the organization, complexity and characteristic features of non-chordates.
- comprehend the economic importance of non-chordates, their interaction with the environment and their role in the ecosystem.
- enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

SYLLABUS OF DSC-4

UNIT – I Annelida **07 Hours**

General characteristics and classification; Excretion in Annelida; Evolution of coelom and metamerism.

UNIT – II Arthropoda and Onychophora **12 Hours**

General characteristics and classification (Special reference to Insecta up to orders); Vision and Respiration in Arthropoda; Metamorphosis in insects; Social life of bees and termite, Evolutionary significance of Onychopora.

UNIT – III Mollusca **06 Hours**

General characteristics and classification; Respiration in Mollusca; Torsion and Detorsion in Gastropoda; Pearl formation in bivalves.

UNIT – IV Echinodermata **05 Hours**

General characteristics and classification; Water-vascular System in Asteroidea.

Note: Outline classification up to classes to be followed from "Ruppert, Fox and Barnes (2004). Invertebrate Zoology: A Functional Evolutionary Approach". VII Edition, Cengage Learning, India.

Practical component -60 Hours

1. Study of *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria,* Trochophore larva.
2. Study of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. Study of *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta,* termite, *Apis, Musca.*
4. Study of *Peripatus.*
5. Study of *Chiton, Dentalium, Pila, Doris, Helix, Unio, Patella, Ostrea, Pinctada, Sepia, Octopus, Nautilus.*
6. Study of *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria, Antedon*; Any two larval forms.
7. Study of mouth parts, digestive system and nervous system of *Periplaneta.**
8. Study of the digestive system of *Pheretima*. *
9. Submit a Project Report on the larval forms in different phyla OR field study of the insect diversity.

   *Subject to UGC approval and guidelines

Essential/recommended readings

1. Ruppert, Fox and Barnes (2004). Invertebrate Zoology. VII Edition,Cengage Learning, India.
2. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition,McGraw-Hill Education.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis. III Edition, Blackwell Science

Suggestive readings

1. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
2. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers

DISCIPLINE SPECIFIC CORE COURSE– 5 (DSC-5): Fundamentals of Biomolecules

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

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

Learning Objectives

The learning objectives of this course are as follows:

- To provide fundamental and precise knowledge of biomolecules that play a crucial role in all processes of life and the development of diseases.
- To make the students understand the fundamental building blocks of living organisms that include carbohydrates, proteins, lipids, nucleic acids
- To apprise the students of the various functions of the molecules like providing structural integrity to the tissue-engineered constructs.
- Through this course, the students would be able to understand the physiological importance of these biomolecules.
- The enzymatic study would enable them to understand the various metabolic pathways and physiological reactions.

Learning Outcomes

By studying this course, students will be able to

- Interpret the structure-functional relationships of carbohydrates, proteins, lipids and nucleic acids.
- Understand the qualitative analysis of functional groups
- understand the properties of various biomolecules.
- appreciate the action of the enzyme and the various factors that affect their action detail.

SYLLABUS OF DSC-5

UNIT – I Carbohydrates **06 Hours**

Structure and biological importance: with emphasis on aldose, ketose, chiral centre, polarised Light, Fischer nomenclature, Haworth projection formula, mutarotation of glucose, anomers, pyranose, furanose, glycosidic linkage; reducing and non-reducing sugars: monosaccharides, disaccharides, polysaccharides and glycoconjugates.

UNIT – II Lipids **04 Hours**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, tri-acylglycerols, phospholipids, glycolipids, steroids.

UNIT – III Proteins **08 Hours**

Amino acids: Structure, classification and general properties of α-amino acids; physiological importance of essential and non-essential amino acids; proteins: bonds stabilizing protein structure; Levels of organization in protein motifs, folds and domains; Denaturation.

UNIT – IV Nucleic Acids **04 Hours**

Structure: purines and pyrimidines, nucleosides, nucleotides, nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA.

UNIT – V Enzymes **08 Hours**

Nomenclature and classification, cofactors; specificity of enzyme action, Isozymes, Mechanism of enzyme action; Enzyme kinetics; factors affecting rate of enzyme-catalysed reactions; derivation of Michaelis-Menten equation, concept of K_m and V_{max}, Lineweaver-Burk plot, multi-substrate reactions, enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme reaction.

Practical component – 60 Hours

1. Understanding the structures of biomolecules through ball and stick models.
2. To understand the preparation and roles of two important biological buffer systems: phosphate and bicarbonate; Preparation of buffers and determination of pH.
3. Identification of the functional groups by qualitative tests:
    a. Carbohydrates
    b. Lipids
    c. Proteins
4. Separation of amino acids by paper chromatography.
5. Study the action of salivary amylase under optimum conditions.
6. Study the effect of pH, temperature and inhibitors on the action of salivary amylase.

Essential/recommended readings

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman Company.
2. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

Suggestive readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd.

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Human Physiology-Control and Coordination 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		
Human Physiology-Control and Coordination Systems	04	02	0	02	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course will provide a thorough understanding of the normal body function and helps to determine the cause of disease.
- It will enable the development of new and more effective treatments and guidelines for maintaining good health.
- It will equip the students with an ability to pursue career in medical and healthcare sector, pharmaceuticals and other related areas.
- It will help in understanding how these systems interact among themselves to maintain stability or homeostasis.

Learning Outcomes

By studying this course, students will be able to:

- appreciate human physiology and have its enhanced knowledge.
- recognize and identify principal tissue structures and functions
- understand the functions of important physiological systems including the nervous system, muscular system, endocrine and reproductive system
- learn an integrative approach to understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanisms.
- synthesize ideas to make the connection between knowledge of physiology and real-world situations, including healthy lifestyle decisions and problems faced due to homeostatic imbalances
- perform, analyze and report on experiments and observations in physiology
- know the fundamentals and understand advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue an advanced degree.

SYLLABUS OF DSC-6

UNIT – I Nervous System and Sense Organs **08 Hours**

Structure of neuron, resting membrane potential, origin and conduction of action potentialacross the myelinated and unmyelinated nerve fibers; Types of synapses, synaptic transmission, Neuromuscular junction.

UNIT – II Muscle Physiology **07 Hours**

Mechanism of muscle contraction; Characteristics of muscle twitch; Motor unit, summation, and tetanus.

UNIT – III Endocrine System **08 Hours**

Hormones secreted by the glands, their physiological action and the disorders related to their secretion; Classification of hormones and their regulation; Mode of hormone action- Signal transduction pathways for peptide and steroid hormones.

UNIT – IV Reproductive System **07 Hours**

Physiology of male and female reproduction– spermatogenesis, oogenesis, follicular development, steroidogenesis, implantation, pregnancy, and mammary gland development.

Practical component – 60 Hours

1. Classification, structure and functions of tissues: epithelial, connective, muscular and nervous tissue.
2. Structure, histology, types and function of bones and cartilage.
3. Classification and histological structure of muscle; ultrastructure of striated muscle.
4. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres, Nerve cells.
5. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
6. Recording of simple muscle twitch with electrical stimulation (Interpretation/ Virtual).
7. Study of permanent slides of Mammalian Skin, Spinal cord, Hypothalamus, Pineal, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovary.
8. Permanent slide preparation from various tissues: Tissue fixation, block preparation, tissue sectioning, H&E staining, microscopy (Minimum three tissues; tissue can be procured from the slaughterhouse).

Essential/recommended readings

1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology. XIII Edition, John Wiley and Sons, Inc.
2. Widmaier E, Raff H and Strang K. (2013) Vander’s Human Physiology: The Mechanism of Body Functions. XIII Edition, McGraw-Hill Education.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Eroschenko, Victor P. (2012) Di Fiore's Atlas of Histology with Functional Correlations; 12th edition, CBS Publishers and Distributors Pvt. Ltd.

Suggestive readings

1. Chatterjee, C.C. (2021) Human Physiology, 14th Edition, Volume 1 & Volume II, CBS Publishers and Distributors Pvt. Ltd.
2. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.

Category-II
BSc Life Science with Zoology as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE -6 (Zoo-LS-DSC-06):– Cell and Developmental Biology of Animals

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell and Developmental Biology of Animals Zoo-LS-DSC-06	04	02	0	02	Class XII pass	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course will help the students to learn and develop an understanding of a cell as a basic unit of life.
- The course will enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.
- The course will provide the students a complete comprehension about the essential vertebrate developmental biology
- The course will help the students to understand the conundrum of **the different levels of biological complexity** by tracing them back to events at the level of genes and genomes**.**

Learning Outcomes

By studying this course, students will be able to

- Explain the structure and functions of cell organelles involved in diverse cellular processes.
- Know the evolution of different concepts in developmental biology.
- Be able to understand the process of gamete formation from stem cell population to mature ova and sperm. The students will know the differences between Spermatogenesis and Oogenesis.
- Be able to comprehend the sequence of steps leading to the fusion of gametes and learn the contribution of sperm and ova to zygote formation
- Be able to understand how polyspermy is avoided in animal kingdom.
- Learn the mechanisms underpinning cellular diversity and specificity in animals.
- Learn the methods and tools related to developmental biology help to understand different processes of embryogenesis.

SYLLABUS OF Zoo-LS-DSC-06

UNIT - I Cell Division and Differentiation 06 Hours

Types of animal cells and tissues, Mitosis, meiosis, Cell cycle regulation, Cell-cell communication, Stem cells, Differential gene expression.

UNIT- II: Scope and History of Developmental Biology 03 Hours

Historical perspective including contributions by eminent scientists and landmark experiments in the field of Developmental Biology, Concepts of Epigenesis, Preformation, Von Baer laws.

UNIT- III: Early Embryonic Development 15 Hours

Gametogenesis: Spermatogenesis and Oogenesis in mammals; Types of Eggs and Egg membranes Fertilization: External (amphibians) and Internal (mammals), Fast and slow blocks to Polyspermy; Types and Patterns of cleavage; Types of morphogenetic movements; Early development of frog and chick up to gastrulation. Fate maps

UNIT- IV: Late Embryonic Development 04 Hours

Fate of Germ Layers; Formation of neural tube, Extra-embryonic membranes in birds

UNIT- V: Post Embryonic Development 02 Hours

Metamorphic events and its hormonal regulation in amphibians.

Practical Component – 60 Hours

1. Study of the various stages of meiosis through permanent slides.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides- cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Chick – Study of Whole Mounts of developmental stages of Chick through permanent slides (HH stages)- 13 hrs, 18hrs, 24hrs, 28hrs, 33hrs, 36hrs, 48hrs, 72hrs and 96hrs.
4. Study of the different types of placenta along with its function- through permanent slides / photomicrograph.
5. Study of various developmental stages in the life Cycle of Drosophila using stock culture/ permanent slides/ photomicrograph.
6. Visit to IVF centre/ Poultry Farm.
7. Project report on IVF Centre/ Poultry farm/ Drosophila culture/ Zebra fish culture.

Essential/recommended readings

1. Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018) The World of the Cell, IX Edition,Benjamin Cummings Publishing, San Francisco.
3. Gilbert, SF (2014) Developmental Biology (10th edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. ISBN : 9780878939787
4. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
5. Freeman and Bracegirdle (1975, 2nd Edition) "An Atlas of Embryology", Published by Heinmann.

Suggestive readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia.
2. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc
3. Kalthoff Klaus (2001) Analysis of Biological Development, 2nd ed. Boston, MA: Mc Graw-Hill, ISBN : 0071180788
4. Wolpert, L & Tickle, C (2011) Principles of Developmental Biology (4th edition). Oxford University Press, ISBN: 9780198792918
5. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc. ISBN : 9780070634275

Category-IV

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

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-3): Economic Zoology

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

Learning Objectives

The learning objectives of this course are as follows:

- It deals with the application of zoological knowledge for the benefit of mankind by understanding the economy, health and welfare of humans.
- It includes culturing organisms for mass production for human use and to control or eradicate harmful ones.
- It will bring to the fore the multidisciplinary nature of Economic Zoology as it includes sericulture, apiculture, aquaculture, pisciculture and insect pests of agriculture.

Learning Outcomes

By studying this course, students will be able to

- develop an understanding of the beneficial higher and lower organisms in terms of economic prospective.
- aquatic organisms and agriculturally important insect pests based on their morphological characteristics/structures.
- develop a critical understanding of the contribution of organisms to the welfare of society.
- examine the diversity of insect pests of different orders in the agro-ecosystem and sustainable pest management strategies.

SYLLABUS OF GE-3

UNIT – I Aquaculture **05 Hours**

Definition, scope, and significance of Aquaculture, Prawn culture, Pearl culture, Edible Oyster culture.

UNIT – II Pisciculture **07 Hours**

Basic concept on mono and composite fish culture (Carp culture); Fish diseases caused by *Ichthyophthirius multifilis, Trichodinia* sp. and *Ichthyobodo* sp., symptoms and control; Maintenance of aquarium.

UNIT – III Sericulture **05 Hours**

Different species and economic importance of silkworm, Mulberry and Non-mulberry Sericulture (Eri, Muga, Tussar), Sericulture techniques.

UNIT – IV Apiculture **05 Hours**

Different species of Honeybee, types of beehives - Newton and Langstroth, Bee Keeping equipment, Methods of extraction of honey (Indigenous and Modern) and its processing, Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses.

UNIT – V Agricultural Crop Pest and Management **08 Hours**

Bionomics of crop pests of rice (*Leptocorisa acuta*); sugarcane (*Pyrilla perpusilla*); vegetable (*Raphidopalpa foveicollis*); and stored grain (*Corcyra cephalonica*); Pest Management Strategies (Physical, Chemical & Biological)

Practical component – 60 Hours

1. Study of aquatic organisms - prawns, oysters and fishes (*any three)* through museum specimens in the laboratory with details on their classification, distribution and specialized features.
2. Study of different species of aquarium fishes (Goldfish, Guppy, Swordtail fish) and maintenance of aquarium in lab/indoor.
3. Study of major crop pests of rice (*Leptocorisa acuta*), sugarcane (*Pyrilla perpusilla*), vegetable (*Raphidopalpa foveicollis*) and stored grain (*Corcyra cephalonica*) belonging to different orders.
4. Study of *Bombyx mori*, its life cycle and economic importance.
5. Study of the life history of honeybee, *Apis cerana indica* and *Apis mellifera* from specimen/ photographs - egg, larva, pupa, adult (queen, drone, worker)
6. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
7. Project report on life cycle of any one crop pest or on a product obtained from apiculture industry.
8. Field study/lab visit to an apiary/honey processing unit/sericulture institute/aquarium shop/fish farm/pisciculture unit.

Essential/recommended readings

1. Atwal, A.S. (1993) Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi.
2. Shukla, G.S. and Upadhyay, V.B.: Economic Zoology, 4e, 2002, Rastogi.
3. D. B. Tembhare. (2017) Modern Entomology. Published by Himalaya Publishing House (ISO 9001: 2008 Certified).
4. Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royee Ltd. London.

Suggestive readings

1. S.S. Khanna and H.R. Singh. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House.3rdEdition. (ISBN13: 9789384337124)
2. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.

GENERIC ELECTIVES (GE-4): Lifestyle Disorders

CREDIT 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		
Lifestyle Disorders	**04**	**02**	**0**	**02**	**Class XII pass**	**NIL**

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to introduce the students to the concept of health, nutrition, and the factors affecting it.
- It will apprise students of the prevalence of emerging health issues affecting the quality of life.
- The course will facilitate the understanding of different physical and psychological associated disorders and their management for a healthy lifestyle.
- It highlights the important lifestyle-related disorders and describes the risks and remedies in relation to adopting a better life.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of lifestyle choices and the diseases associated with them.
- have an in-depth understanding of making better lifestyle decisions.
- learn about various techniques for preliminary diagnosis of lifestyle disorders

SYLLABUS OF GE-4

UNIT – I Introduction to Lifestyle **05 Hours**

Traditional Indian lifestyle vs modern Indian lifestyle, lifestyle diseases – definition, risk factors-erratic sleep patterns, wrong food choices, smoking, alcohol abuse, stress, lack of optimum physical activity, illicit drug use, Obesity, respiratory diseases, diet and exercise.

UNIT – II Diabetes and Obesity **05 Hours**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes-paediatric and adolescent obesity-weight control and BMI (Body Mass Index), Prediabetes, PCOS/PCOD.

UNIT – III Cardiovascular Diseases **06 Hours**

Coronary atherosclerosis-Coronary artery disease, Causes-Fat and lipid, Alcohol Abuse-Diagnosis, Electrocardiograph, Echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

UNIT – IV Cancer **05 Hours**

Introduction to Cancer and general diagnostic methods to detect cancer; Lung Cancer, Mouth Cancer: associated lifestyle choices, symptoms and treatment.

UNIT – V Hypertension **04 Hours**

Risk factors, complications (brain, heart, eye and kidney) and management of hypertension.

UNIT – VI WHO Global action plan and Monitoring **05 Hours**

WHO Global action plan and Monitoring framework for prevention and control of non-communicable diseases, NPHCE (National Programme for the Health Care of Elderly), Fit India movement (Yoga and meditation).

Practical component – 60 Hours

1. Estimation of blood glucose (GOD/POD) by kit.
2. Calculation of BMI, waist to hip ratio, skin fold test.
3. Imaging techniques for cancer diagnosis. CT Scan, MRI, PET-CT scan. Confirmatory Biopsy.
4. Blood pressure measurement using a sphygmomanometer.
5. Study of cardiac rehabilitation- thrombolytic agents and balloon angioplasty.
6. Project Work based on Case studies related to risk factors of any ONE lifestyle disorder studied.

OR

7. To write a review of personal experience of using any of the available health or lifestyle-related applications over a period of time with some data to correlate.

Essential/recommended readings

1. James M.R, Lifestyle Medicine, 2nd Edition, CRC Press,2013,
2. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition. John Wiley & Sons
3. Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates

Suggestive readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd/W.B. Saunders Company.
2. Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. McGraw-Hill Education 13th Edition.

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

ACBR

Category-I

BSc. (HONS.) Biomedical Sciences

DISCIPLINE SPECIFIC CORE COURSE– 4 (DSC-4): 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		
Biochemistry	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES

The objective of this course is to effectively incorporate the fundamentals of metabolism through key biochemical pathways and make learners appreciate the requirement for the stringency of their regulation; introduce various biochemical techniques used in the characterization of the proteins and a detailed account on how enzymes function: their kinetics, regulation and inhibition.

COURSE OUTCOMES

- Students will gain an understanding of fundamental biochemical principles of metabolism of biomolecules (Carbohydrates, Proteins, Lipids and Nucleic acids) and the associated bio- energetics. They will learn the biochemical reactions in metabolic pathways and understand their interrelations, logics and patterns.

- They will also understand the role of enzymes in the biochemical reactions and the connection between biochemical defects and metabolic disorders. Students would additionally gather a firm understanding and relevance of stringent regulation of metabolic pathways.

- Having understood the structural architecture of proteins in earlier semesters, students shall learn how biological molecules (especially proteins) are characterized through various analytical techniques such as types of column chromatography methods, Polyacrylamide Gel Electrophoresis (PAGE) that are used in contemporary biochemistry research laboratories.

- Students will get a grasp on central concepts underlying enzyme catalysis, kinetics and their mechanism of action. Effects of different kinds of enzyme-inhibitors will also be learned.
- Students would learn how coenzymes assist enzymes in catalyzing biochemical reactions and what is the criterion for their classification.

- Having studied the role of enzymes that regulate metabolic pathways in the third unit, students would learn the general properties of regulatory enzymes, their activity and kinetics.

COURSE CONTENT:

Unit I: Metabolic pathways and their allosteric regulation	**(22 hrs)**
Carbohydrates- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle and their regulation, Cori cycle, Hexose monophosphate shunt. **Lipids**- Mobilization of triglycerides, Metabolism of glycerol, Biosynthesis and β-oxidation of saturated fatty acids (palmitic acid) and their regulation. Significance of ketone bodies. **Proteins**- General over view, Transamination, Deamination, Glucose-Alanine cycle, Urea cycle and its regulation. **Nucleic acid**- General overview, an outline of purine and pyrimidine metabolism. Electron transport chain, Oxidative phosphorylation and Substrate-level phosphorylation.	
Unit II: Analytical methods in protein characterization	**(08 Hours)**
Introduction to spectrophotometry & Lambert-Beer's law, Column chromatography: Ion exchange chromatography, Gel filtration and Affinity chromatography, SDS-PAGE	
Unit III: Enzymes	**(07 Hours**
Introduction to enzymes, Concept of Lock & key and 'Induced fit theory, Concept of activation energy and binding energy. Enzyme kinetics: Michaelis-Menten equation and its physiological significance. Concept of enzyme inhibition: types of inhibitors (competitive &non-competitive) and their examples.	
Unit IV: Coenzymes	**(04 Hours)**
Classification: various types and their function.	
Unit V: Regulatory Enzymes	**(04 Hours)**
General properties of allosteric enzymes. Enzyme regulation by covalent modification. Zymogens.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Measurement of absorbance & %transmittance of a solution using spectrophotometer/colorimeter.

2. Preparation of standard plot and estimation of protein concentration by any one method: Biuret/Lowry/Bradford.
3. Estimation of glucose concentration by an enzymatic/non-enzymatic method.
4. Separation of biomolecules (sugar/amino acids) by thin-layer chromatography (TLC).
5. Separation of biomolecules by gel filtration/Calculation of void volume of Sephadex G-25 column, using Blue Dextran.
6. Analysis of SDS-PAGE as a separation technique (gel analysis).
7. To perform an assay of an enzyme under optimal conditions.
8. Determination of Km, Vmax and Kcat value of a given enzyme from the provided experimental data.

SUGGESTED READINGS:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8^{th} ed.). Macmillan. ISBN:9781319322328
- Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018). 8^{th} ed. Hofmann A. and Clokie S.(Eds.) Cambridge University Press, Cambridge, U.K.
- Plummer, D.T. (2012). *An Introduction to Practical Biochemistry.* New Delhi, India: McGraw-Hill College.
- S. K. Sawhney / Randhir Singh. (2009): Introductory Practical Biochemistry, Narosa Publishers, ISBN-13 : 978-8173193026
- Donald Voet, Judith G. Voet (2021) Voet's Biochemistry, Adapted ed 2021, ISBN: 9789354243820.

BOOK FOR BASIC CONCEPTUAL READING

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Devlin, (2011). *Textbook of biochemistry with clinical correlations*. UK: Wiley T & Sons.

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

DISCIPLINE SPECIFIC CORE COURSE– 5 (DSC-5): 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		
Principles of Genetics	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance, Introduction to pedigree analysis for autosomal and X-linked traits, Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics and Understanding of mechanisms of sex determination.

COURSE OUTCOMES:

- The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.
- Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sex-linked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.
- Students would learn the concept of extra-nuclear inheritance.
- Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.
- The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.
- Students wouldgain insights into genetic and environmental sex determination mechanisms.

COURSE CONTENT:

Unit I: Overview of Changing Paradigms in Genetics	**05 Hours**
A brief overview of how genetic principles took shape, leading to the concept of a blueprint of lifewithin the cell to the physical entity of DNA. Basic structure of DNA, salient features of the doublehelix, semi-conservative replication– Meselson and Stahl experiment. Also mention the surprises we have from genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.	
Unit II: Concept of Genetic Inheritance	**15 Hours**
Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over,cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influencedtraits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).	
Unit III: Extra Nuclear Inheritance	**05 Hours**
Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria andchloroplast).	
Unit IV: Genome Organization	**07 Hours**
Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin- constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.	
Unit V: Cytogenetics and Mutations	**08 Hours**

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes.Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.	
Unit VI: Introduction to Mechanisms of Sex Determination	**05 Hours**
Chromosomal theory of sex determination, mechanisms of sex determination, environmentalfactors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can bedemonstrated through any other material or medium including videos/virtual labs etc.)

1. Observation of wild type and mutant phenotypes in *Drosophila.*
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila.*
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sex-linked
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

SUGGESTED READINGS:

- Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019*).* 12th Edition. *Concepts of genetics.* San Francisco, NY:Pearson ISBN-13: 9780134604718.
- Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. *Principles of genetics.* New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
- Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition *Principles of genetics.* USA. Wiley. ISBN-13: 978-8126510436.

BOOK FOR BASIC CONCEPTUAL READING

- Cooper, G. M. and Hausman, R. E. (2019). 8th Edition. *The cell: A molecular approach.* Massachusetts, USA: Sinauer Associates. ISBN-13: 978-1605358635.
- Hardin, J., Bertoni, G. P., Becker, W.M. (2017). 9th Edition. *Becker's world of the cell.*NY:Pearso. ISBN-13: 978- 0805393934.
- Karp, G., Iwasa, J., Marshall W. (2018). 8th Edition. *Karp's Cell Biology.* New Jersey, USA: Wiley. ISBN-13: 978-1119456292.
- Kornberg, A. (2005). 2nd Edition. *DNA replication.* California, USA: University Science Books. ISBN-13: 978-1891389443.
- Griffith A. J. F., Wessler S. R., Carroll S. B. and Doebley J. (2011). 9th edition. *Introduction to Genetic Analysis.* W H Freeman & Co. ISBN-13 : 978-0716768876.
- Elrod, S and Stansfield, W. (2010). 5th edition. *Schaum's Outline of Genetics.* McGraw Hill. ISBN-13: 978-0071625036

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

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Human Physiology and Anatomy 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		
Human Physiology and Anatomy II	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles.

COURSE OUTCOMES:

Having successfully completed this course, students shall be able to learn and appreciate:

- The students will learn appreciate the structure and functioning of heart, pattern and significance of blood flow in the blood vessels, heart sounds, ECG and purpose of lymph and lymphatic circulation.
- The students would correlate how structure and function of lungs are so intricately designed and how they function with its blood flow and help giving vital oxygen to body. They would develop understanding for neural control and other regulators of respiration and understand daily phenomenon like coughing, sneezing, yawning etc.
- Kidneys are vital organs and students would learn the functional anatomy of a nephron and how it contributes in removing the toxic waste from our body in from of urine. The curriculum would outline the process of micturition and abnormalities associated with it. It would also highlight the role of kidney in controlling pH of the body and preventing acidosis/alkalosis
- The students would have insight into the anatomy of the female and male reproductive systems, including their accessory structures. The student would understand the role of hypothalamic and pituitary hormones in reproductive system. Trace the route of a sperm mother cell from its production till it can fertilize an oocyte. Explain the events in the ovary prior to ovulation, development and maturation of the sex organs and the emergence of

secondary sex characteristics during puberty.

- The students would be able to integrate the role of the endocrine system to maintain homeostasis in human body. Understand the chemical composition mechanisms of hormone action, their site of production, regulation, and effects of hormones of the pituitary, thyroid, parathyroid and adrenal, glands. Hormonal regulation of the reproductive system. The role of the pancreatic endocrine cells in the regulation of blood glucose In addition the contributions of hormones released by the heart, kidneys, and other organs with secondary endocrine functions. The student would be aware of several common diseases associated with endocrine system dysfunction.

- Students would be able to understand the organs of the alimentary canal from proximal to distal, and understand their function. Identify the accessory digestive organs and their functions. Describe the histology that is four fundamental tissue layers of the digestive tract. Contrast the contributions of the enteric and autonomic nervous systems to alimentary tract functioning. Gain awareness about common dysfunctions of digestive system like constipation, gastritis, ulcers, diarrhea etc.

COURSE CONTENT:

Unit-I: Cardiovascular System	**09 Hours**
Functional Anatomy of heart, The Cardiac Cycle, Electrocardiogram. Circulatory system: Bloodvessels, hemodynamics and regulatory mechanisms, Lymphatic circulation - hemodynamics and regulation, micro-circulation	
Unit-II: Respiratory system	**09 Hours**
Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolarventilation, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration	
Unit-III: Renal Physiology	**06 Hours**
Body fluid and electrolytes: their balances and imbalances. Functional Anatomy of kidney,Histology of nephron and its physiology, Urine formation, renal regulation of urine volume and osmolarity, acid-base balance. Urinary bladder: structure, micturition and its regulation	
Unit-IV: Reproductive System	**06 Hours**
Structure and function of male and female reproductive organ. Function and regulation of testicularand ovarian hormones. Gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, parturition and lactation, menopause and basic concepts of infertility.	
Unit-V: Endocrine System	**09 Hours**

General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Thyroid, Parathyroid, Adrenal, and Pancreas. Basic concepts about hypo and hyper secretion of hormones.	
Unit-VI: Gastrointestinal system	**06 Hours**
Anatomy and histology of digestive tract, gastrointestinal physiology: General principles of gut motility secretion, digestion, absorption and assimilation. Gastrointestinal hormones: their formation and action. Physiological anatomy and functions of liver and pancreas.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can bedemonstrated through any other material or medium including videos/virtual labs etc.)

1. Physiological data acquisition based experiments (ECG).
2. Physiological data acquisition-based experiments (EMG).
3. Physiological data acquisition-based experiments (PFT).
4. Blood Pressure recordings in humans.
5. Determination of specific gravity of blood.
6. Determination of osmotic fragility of RBC.
7. To study various types of contraceptives (condoms, IUD"s, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent slides. T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, urethra, fallopian tubes, epididymis, prostate glands, lungs, trachea, bronchioles, pituitary, heart. (Minimum 8 slides covering the systems mentioned in theory.)

SUGGESTED READINGS:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-

6 (for print book).

- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.

BOOK FOR BASIC CONCEPTUAL READING

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)

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

Category-IV
Common Pool of Generic Electives offered by Department of Biomedical Sciences

Generic Elective -2 (GE-2): Landmark Discoveries in Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Landmark Discoveries in Science	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

The objective of the course is to ensure students appreciate the convenience and comfort that they have is all because of discoveries and inventions of the past. Meticulous execution of historical experiments in very little resources would also motivate them towards doing valuable research with enormous facilities that they have. The historical accounts of science provide grounds for interpretation and may be useful in arousing appreciation of science. The course would provide: Detailed analysis of classically designed and executed experiments in Life Sciences over the years. It will provide a foundation of biology by uncovering various players in the machinery of biological processes. I will also be helpful in technical, scientific analysis with historical background for a robust understanding of various discoveries. Critical analysis of the history of biology would surely help students comprehend futuristic scientific discoveries.

COURSE OUTCOMES

- Students will be able to learn how was light manipulated during the past to peer into previously invisible world—those too small or too far away to be seen by the naked eye.
- Students will learn about experiments that had fundamental contribution to our present understanding of key molecular elements of life. They will understand how to examine microbial cells and colonies, using various techniques to manipulate color, size, and contrast in ways that helped Scientists to identify species and diagnose disease.
- Studying this unit, students would come to know that there were three group of Naturalists working simultaneously to find answers to inheritance, evolution and basic composition of life.

Students will be divulged with hereditary aspects of life. They will get familiar with genes and their roles in living organisms.

- Having understood the relationship of genes and inheritance, students would find interesting to learn the mystical molecule that make up these genes. Sequential study of these experiments would step by step unravel the mystery of genetic material.
- Students at this point of course would be curious to know the structure of molecule that forms the genetic material. They would learn how the information present on DNA manifests itself as specific characteristic features and help in diversity among organisms.
- Students will be explained how the in depth knowledge about DNA became the most important tool for *in vitro* research, modification and applications thereof.
- Students will be briefed about some landmark discoveries which helped the field of medicine to grow tremendously and played a significant role in improving the overall health of the human population.
- Students can be given small projects to write discoveries done in conventional way.
- They will be required to provide a descriptive view of the topics assigned to them. Students should highlight the research topic with reference to current understanding.

COURSE CONTENT:

Unit I: View of the invisible Biology	**04 Hours**
Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Book of Optics; Scientific use of Microscopes; Importance of Malphigi microscope that used field lens; Compound Microscope; Robert Hooke's observations in Micrographia; Foldscope by Manu Prakash	
Unit-II: Origin of Life – A question	**03 Hours**
Spontaneous generation versus biogenesis; Problem of spores; Microbiology and Medicine - Germ theory of Disease; Recognition of agents of infection – Koch's Postulates.	
Unit-III: Understanding Biology by observations	**04 Hours**

A) Study of evolution of life: Darwins Theory (B) Study of Inheritance of Life: classical era with contributions of Aristotle, Epicurus, and others; Modern genetics: Gregor JohannMendel, his work on pea plants, theory of Mendelian inheritance (C) Study of compositionof Life : Levels of cellular and molecular organization; Cells, tissues and organs in our body; Pioneers of chromosome studies; Discovery of nucleic acids; Nuclein verified as a distinct chemical entity; Early identification of purines and pyrimidines; building blocks of Nucleic acids and proteins; Chemistry of Nucleic acids; Levene's tetranucleotidehypothesis.	
Unit-IV: DNA as the hereditary material – An experimental view	**06 Hours**
Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; *In vitro* Transformation system; Announcement that the transformingPrinciple was DNA; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation;Additional experiments that supported DNA as the transforming principle; Hershey and Chase clinched the role of DNA as the Genetic Material	
Unit-V: Solving the puzzle of DNA structure	**07 Hours**
Early studies of diffraction of X Rays by DNA fibers – contributions of Rosalind Franklin; Use of X – rays in medicines and research; Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Contribution of Linus Pauling; DNA is replicated in Semi-conservative Fashion; Deciphering the Genetic Code; One Gene One Enzyme Edict.	
Unit-VI: Technical advancements in biology	**07 Hours**
Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT-PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning - History and current applications	
Unit-VII: Research as a backbone of modern medicine	**07 Hours**

(A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of BCG and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine.	
Unit VIII: Project Work [On any one topic]	**07 Hours**
Study historical research papers and provide a descriptive view of research that was carriedout by Scientists as Minor Project. (A) Ancient system of medicine (B) Contribution of any one Indian Scientists in Biology (C) Contribution of any Physicists or Chemists in Biology (for topics listed above)	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Comparison of invisible life under the view of microscopes versus foldscope.
2. Cells as a unit of life and observation under the microscopes.
3. How do the cells divide – a view under the microscope: (mount of an onion root tip, onion bud cells or grasshopper testis).
4. Mendel’s laws of inheritance – clues from nature.
5. Extraction of genomic DNA
6. Use of electric field to analyse DNA and other biomolecules.
7. Sneak Peek through the discovery of Polymerase chain reaction (PCR): Demonstration of original method and comparison with today’s sophistication.
8. To test Flemming’s hypothesis that the mold killed the bacteria.
9. Group Discussion on Research Topics assigned to students.

SUGGESTED READINGS:

- Watson, J. D. (2011) *The Double Helix – A personal account of the discovery of the structure of DNA*. Scribner. ISBN 9780743219174.
- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey,USA: Wiley Publishers. ISBN-978-0470483374.
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. *Molecular Biology: Principles and Practice.* London, United Kingdom: W H Freeman & Co Publishers, ISBN-13: 978-0-716- 7998-8.
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th Edition. *Molecular Biology of the Gene.* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.

BOOK FOR BASIC CONCEPTUAL READING

- Alberts, B et al. (2014). 6th edition. *Molecular Biology of the Cell*. W. W. Norton & Company.ISBN-13 : 978-0815345244
- Bryson, B. (2003) *A short history of nearly everything.* Transworld Publishers. London W5 5SA.A Random House Group Company. ISBN: 9780552997041.
- Lodish H et al. (2003). 5th Revised edition. *Molecular Cell Biology*. W.H.Freeman& Co Ltd;ISBN-13 : 978-0716743668
- Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular Cloning: A Laboratory Manual,* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Kornberg, A. (2005). 2nd Edition. *DNA Replication.* California, United States: University ScienceBooks, ISBN-13: 978-1891389443.

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

Note: *The Generic Electives courses offered in Semester-I are also open for Semester-II*

DEPARTMENT OF GEOLOGY

Category-I
BSc (Hons.) Geology

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Structural Geology

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Structural Geology (DSC-4)	4	3	0	1	12th Pass	---

Learning Objectives
Structural geology essentially deals with the geometry, kinematics and dynamics of deformation of rocks. In response to the instability of the lithosphere produced by complex plate tectonic movements, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state, at different scales and at different depths, which manifests in a variety of complex structures in these rocks.

Learning outcomes
On completion of the course, the student should be able to:
i. Identify the different geometric features of deformation, different types of deformation-induced structures,
ii. Understand basic techniques of measurement of different parameters in deformed rocks, and
iii. Understand a glimpse of the underlying deformation processes and mechanisms.

SYLLABUS OF DSC-4

UNIT – I (09 Hours)
Introduction to Structure and Topography: Understanding a topographic map; Effects of topography on structural features: Rule of V; Planar and linear structures; Concept of dip and strike, trend and plunge.

UNIT – II (09 Hours)
Stress and strain in rocks: Concept of rock deformation: Definition of Stress and Strain, Strain ellipses of different types and their geological significance. Mohr circle for stress and its application.

UNIT – III (08 Hours)
Folds: Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding.

UNIT – IV (08 Hours)
Foliation and lineation: Description and origin of foliations: axial plane cleavage and its tectonic significance; different types of foliations: crenulation cleavage, disjunctive cleavage,

salty cleavage, schistosity, gneissosity etc. Description and origin of lineation and relationship with major structures; stretching lineation and its relationship with strain.

UNIT – V (08 Hours)

Fractures and faults: Geometric and genetic classification of fractures and faults; Effects of faulting on the outcrops; Geologic/geomorphic criteria for recognition of faults and Mechanism of faulting: Anderson theory of faulting. Joints – different types of joints and their geological significance – columnar joint, pinnate joint, plumose structure.

UNIT – VI (03 Hours)

Shear Zones: Introduction, Geometry, strain profile, shear zones rocks and shear sense indicators.

Practical component - 30 Hours

Basic idea of topographic contours, Topographic sheets of various scales.
Structural contouring and 3-point problems of dip and strike
Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities.
Exercises of stereographic projections

Essential/recommended readings

Fossen, H. (2010) Structural Geology. Cambridge University Press
Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.

Suggestive readings

Fossen, H. (2010) Structural Geology. Cambridge University Press.
Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.
Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.
Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

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DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Igneous Petrology

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Igneous Petrology (DSC-5)	4	3	0	1	12^{th} Pass	----

Learning Objectives

To develop an understanding of the types of magma as well as types of igneous rocks. Magma generation in relation to different geodynamic settings and its relation with the petrological and geochemical features of the igneous rocks.

Learning outcomes

On completion of the course, the student should be able to:

a) Identify the igneous rocks using petrographical, mineralogical and geochemical indices

b) Determine the evolution of igneous rocks in relation to different geodynamic settings

SYLLABUS OF DSC- 5

UNIT – I (09 Hours)

Introduction to Igneous Petrology: Scope of Igneous petrology, classification of Igneous rocks, igneous textures, igneous structures.

UNIT – II (09 Hours)

Introduction to silicate melts and magmas: Physical properties of magma, the ascent of magmas, magmatic differentiation.

UNIT – III (09 Hours)

Introduction to Igneous Phase diagrams. The phase rule, the lever rule, Two Component systems involving melt: Binary system with a Eutectic, Binary system with a peritectic, Binary system thermal barrier, Binary system with solid solution.

UNIT – IV (09 Hours)

The chemistry of igneous rocks. Modal mineralogy, normative mineralogy, variation diagrams based on major elements, trace elements and their significance, application of radioactive isotopes in igneous petrology.

UNIT – V (09 Hours)

Introduction to igneous environments: Basalts and mantle structure, Magma generation and igneous rocks associated with various plate tectonic settings.

Practical component : 30 Hours

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite.
Classification of Igneous Rocks.
Plotting and interpretation of variation diagrams.
Igneous rock occurrences in Indian context.

Essential/recommended readings

Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.
Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press.

Suggestive readings (if any)

Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press.
Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
Sen, G. (2014) Petrology Principles and Practice, Springer-Verlag Berlin Heidelberg
Bose M.K. (1997). Igneous Petrology.
Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.

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DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Elements of Geochemistry

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elements of Geochemistry DSC-6	**4**	**3**	**0**	**1**	**12^{th} Pass**	**---**

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop an understanding of the chemical nature of the earth and other planetary material and relate mineralogy, geochemistry and bulk chemistry.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will be able to appreciate the field of geochemistry and understand the properties of the elements - Nucleosynthesis; Cosmochemistry; Principles of isotope geochemistry; Solid earth geochemistry: Core, Mantle, Crust. Near-surface geochemical environment, Chemical weathering of minerals and rocks. Examples of instrumentation, data collection and analyses

SYLLABUS OF DSC-6

UNIT – I (09 Hours)

The abundance of elements in the cosmos, solar system and earth. Meteorites, distribution of elements in core, mantle, crust.

UNIT – II (12 Hours)

Introduction to properties of elements: periodic table, chemical bonding, states of matter and atomic environment of elements, geochemical classification of elements, the concept of elemental fractionation.

UNIT – III (12 Hours)

Geochemistry of igneous rocks: geochemical variability of magma and its products. Near-surface geochemical environment: Chemical weathering of minerals and rocks.

UNIT – IV (12 Hours)

Introduction to isotope geology: use of stable and radiogenic isotopes in earth science.

Practical component: - 30 Hours

- Geochemical analysis of geological materials (analytical methods, concept of normalization)
- Geochemical variation diagrams, common geochemical plots, and their interpretations.
- Basic idea about handling and interpretation of isotope data.

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Essential/recommended readings

Mason, B (1986). Principles of Geochemistry. 3rd Edition, Wiley New York.
Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.

Suggestive readings

Mason, B (1986). Principles of Geochemistry. 3rd Edition, Wiley New York.
Rollinson H. (2007). Using geochemical data evaluation. Presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
Walther John, V., 2009 Essentials of geochemistry, student edition. Jones and Bartlett Publishers
Albarede, F, 2003. An introduction to geochemistry. Cambridge University Press.
Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.
Geochemistry by William M White, Wiley-Blackwell (2013).

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

CATEGORY-IV

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

GENERIC ELECTIVES (GE-2): Physics & Chemistry of Earth

Credit 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		
Physics & Chemistry of Earth (GE-2)	4	3	1	0	Class-XII	---

Learning Objectives
To develop an understanding of the surface and internal structure of the Earth and its mineralogy and chemistry; To equip the students about the present and past processes operative in shaping the physical and chemical make-up of the planet Earth

Learning outcomes
After completion of this course students will learn about:

- Physical, mineralogical and chemical structure of the earth
- Major surface features and their evolution through time
- Concept of geological time and its determination
- Earth's magneitc field, its short term and long term variation and its application
- Physical and chemical evolution of earth through time

SYLLABUS OF GE-2 – (Lecture- 45 Hours)
UNIT – I
Earth: surface features: Continents, continental margins, oceans
Earth's materials: Rocks and Minerals

UNIT – II
Earth’s interior - variation of physical parameters and seismic wave velocity inside the earth, major sub divisions and discontinuities. Depth-wise mineralogical variation in the Earth. Concepts of Isostasy; Airy and Pratt Model. Core and Mantle: Seismological and other geophysical constraints. The geodynamo - Convection in the mantle. Plate Tectonics. Types of plate margins and their Dynamics.

UNIT – III
Elements of Earth’s magnetism: Secular variation and westward drift. Solar activity and magnetic disturbance. Paleomagnetism

UNIT – IV
Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system/planet Earth. Geochemical classification of elements. Earth accretion and early differentiation. Isotopes and their applications in understanding Earth processes.

UNIT – V
Isotopes: Radiogenic and Stable. Radiogenic isotopes and their applications
Stable isotope fractionation. Oxygen isotopes. Sublithospheric Mantle (Mineralogy/phase transitions) Concept of mantle heterogeneity

UNIT – VI
Low-temperature geochemistry; surface and near-surface processes

Essential/recommended readings

- Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
- Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
- Condie, K.C. (2016) Earth as an evolving planetary system (3rd Edn.) Elsevier

Suggestive readings

- Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
- Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
- Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill
- Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
- Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
- Steiner, E. (2008). The chemistry maths book. Oxford University Press.
- Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press.
- Condie, K.C. (2016) Earth as an evolving planetary system (3rd Edn.) Elsevier

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DEPARTMENT OF PHYSICS & ASTROPHYSICS

Category-I

BSc. (H) Physics

DISCIPLINE SPECIFIC CORE COURSE – 4: MATHEMATICAL PHYSICS II

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Mathematical Physics II DSC – 4	4	2	0	2	Class XII Pass	-----

LEARNING OBJECTIVES

The emphasis of course is on applications in solving problems of interest to physicists. The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Use curvilinear coordinates to solve problems with spherical and cylindrical symmetries
- Represent a periodic function by a sum of harmonics using Fourier series
- Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method
- Understand the properties and applications of Legendre polynomials
- Learn about gamma and beta functions and their applications
- In the laboratory course, the students will learn to
    - Apply appropriate numerical method to solve selected physics problems both using user defined and in-built functions from Scilab/ Python
    - Solve non-linear equations
    - Perform least square fitting of the data taken in physics lab by user defined functions.
    - Interpolate a data by polynomial approximations
    - Generate and plot a function by its series representation
    - Generate and plot Legendre polynomials and verify their properties.
    - Numerically integrate a function and solve first order initial value problems numerically.

SYLLABUS OF DSC – 4

UNIT – I **(13 Hours)**

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Scale factors, element of area and volume in spherical and cylindrical coordinate Systems. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series), Parseval's Identity.

UNIT – II **(17 Hours)**

Frobenius Method and series solution of Differential Equations: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method for finding series solution and its applications, Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality of Legendre Polynomials, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials.

Some Special Integrals: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma and Beta Functions.

References:

Essential Readings:

1) Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.
2) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
3) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge Univ. Press.
4) Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3 Ed., 2017, CRC Press.
5) Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's Outlines Series.
6) Fourier analysis: With Applications to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.
7) Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
8) Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 7 Ed., 2013, Elsevier.

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and

Bartlett Learning.
4) Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGraw Hill.
5) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
6) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, 2017, Laxmi Publications Private Limited.

PRACTICAL COMPONENT – 60 Hours

The aim of this laboratory is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. The course will consist of practical sessions and lectures on the related theoretical aspects of the laboratory. Assessment is to be done not only on the programming but also on the basis of formulating the problem.

- Every student must perform at least 12 programs covering each unit.
- The list of recommended programs is suggestive only. Students should be encouraged to do more practice. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods.
- The implementation can be either in Python/ C++/ Scilab.

Unit 1: Root Finding: Bisection, Newton Raphson and secant methods for solving roots of equations, Convergence analysis.

Recommended List of Programs (At least two):

(a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.
(b) Solve transcendental equations like $\alpha = \tan(\alpha)$.
(c) To approximate nth root of a number up to a given number of significant digits.

Unit 2: Least Square fitting (At least one): Algorithm for least square fitting and its relation to maximum likelihood for normally distributed data.

a) Make a function for least square fitting, use it for fitting given data (*x, y*) and estimate the parameters a, b as well as uncertainties in the parameters for the following cases.
   i. Linear $(y = ax + b)$
   ii. Power law $(y = ax^b)$
   iii. Exponential $(y = ae^{bx})$
b) Weighted least square fitting of given data (*x, y*) with known error/uncertainty-values using user defined function.

Unit 3: Generating and plotting of a function using series representation (At least one):

a) To approximate the elementary functions (e.g. exp(x), sin(x), cos(x), ln(1+x), etc.) by a finite number of terms of Taylor's series and discuss the truncation error. To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualise the convergence of series.
b) Generating and plotting Legendre Polynomials using series expansion and verifying recurrence relation

Unit 4: **Interpolation:** Concept of Interpolation, Lagrange form of interpolating polynomial, Error estimation, optimal points for interpolation.

Recommended List of Programs (At least one)

(a) Write program to determine the unique polynomial of a degree n that agrees with a given set of $(n+1)$ data points (x_i, y_i) and use this polynomial to find the value of y at a value of x not included in the data.

(b) Generate a tabulated data containing a given number of values $(x_i, f(x_i))$ of a function f(x) and use it to interpolate at a value of x not used in table.

Unit 5: **Numerical Integration:** Newton Cotes Integration methods (Trapezoidal and Simpson rules) for definite integrals, derivation of composite formulae for these methods and discussion of error estimation.

Recommended List of Programs (At least three)

(a) Given acceleration at equidistant time values, calculate position and velocity and plot them.

(b) Use integral definition of ln(x) to compute and plot ln(x) in a given range. Use trapezoidal, Simpson and Gauss quadrature methods and compare the results.

(c) Verify the rate of convergence of the composite Trapezoidal and Simpson methods by approximating the value of a given definite integral.

(d) Verify the Orthogonality of Legendre Polynomials.

(e) To evaluate the Fourier coefficients of a given periodic function (e.g. square wave, triangle wave, half wave and full wave rectifier etc.). To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualise the convergence of series. Study of Gibbs phenomenon.

(f) Verify the properties of Dirac Delta function using its representation as a sequence of functions.

Unit 6: Numerical Solutions of Ordinary Differential Equations: Euler, modified Euler, and Runge-Kutta (RK) second and fourth order methods for solving first order initial value problems (IVP) and system of first order differential equations,

Recommended List of Programs (At least two)

(a) Solve given first order differential equation (Initial value problems) numerically using Euler RK2 and RK4 methods and apply to the following physics problems:

   i. Radioactive decay

   ii. Current in RC and LR circuits with DC source

   iii. Newton's law of cooling

(b) Write a code to compare the errors in various numerical methods learnt by solving a first order IVP with known solution.

(c) Solve a system of first order IVP numerically using Euler and Runge-Kutta methods. Application to physical problems.

References (for Laboratory work):

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).
4) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
5) An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).
6) Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
7) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India (2007).
8) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press; 3rd edition (2007)
9) Computational Problems for Physics, R. H. Landau and M. J. Páez, 2018, CRC Press.

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

DISCIPLINE SPECIFIC CORE COURSE – 5: ELECTRICITY AND MAGNETISM

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism DSC – 5	4	3	0	1	Class XII Pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Apply Coulomb's law to line, surface, and volume distribution of charges.
- Apply Gauss's law of electrostatics to distribution of charges
- Solve boundary value problems using method of images
- Understand the concept of electric polarization and bound charges in dielectric materials
- Understand and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents and magnetic susceptibility in magnetic materials
- Understand the impact of time-varying magnetic and electric fields in order to comprehend the formulation of Maxwell's equations.

<u>SYLLABUS OF DSC – 5</u>

UNIT – I (15 Hours)

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge, Divergence of electric field using the Dirac Delta function, Curl of electric field, Electric field vector as negative gradient of scalar potential, Ambiguities of electric potential, Differential and integral forms of Gauss's Law, Application of Gauss's law to various charge distributions having spherical, cylindrical and planar symmetries.

Boundary Value Problems in Electrostatics: Formulation of Laplace's and Poisson equations, First and second uniqueness theorems, Solutions of Laplace and Poisson equations in one dimension using spherical and cylindrical coordinate systems and solutions in three-dimensional using Cartesian coordinates applying separable variable technique, Electrostatic boundary conditions for conductors and capacitors.

UNIT – II **(11 Hours)**

Special techniques for the calculation of Potential and Field: The Method of Images is applied to a system of a point charge and finite continuous charge distribution (line charge and surface charge) in the presence of (i) a plane infinite sheet maintained at constant potential, and (ii) a sphere maintained at constant potential.

Electric Field in Matter: Polarization in matter, Bound charges and their physical interpretation, Field inside a dielectric, Displacement vector **D**, Gauss' law in the presence of dielectrics, Boundary conditions for **D**, Linear dielectrics, electric susceptibility and dielectric constant, Idea of complex dielectric constant due to varying electric field, Boundary value problems with linear dielectrics

UNIT – III **(19 Hours)**

Magnetic Field: Divergence and curl of magnetic field **B**, Magnetic field due to arbitrary current distribution using Biot-Savart law, Integral and differential forms of Ampere's law, Vector potential and its ambiguities, Coulomb gauge and possibility of making vector potential divergence less, Vector potential due to line, surface and volume currents using Poisson equations for components of vector potential.

Magnetic Properties of Matter: Magnetization vector, Bound currents, Magnetic intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability of diamagnetic, paramagnetic and ferromagnetic materials.

Electrodynamics: Faraday's law, Lenz's law, Inductance and electromotive force, Ohm's law ($\vec{J} = \sigma\vec{E}$), Energy stored in a magnetic field, Continuity equation, Displacement current and displacement current density, Basic introduction to Maxwell's equations in electromagnetism.

References:

Essential Readings:

1) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
2) Schaum's Outlines of Electromagnetics by J. A. Edminister and M. Nahvi
3) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
4) Electromagnetic Fields and Waves, Paul Lorrain and Dale Corson, 1991, W. H. Freeman.
5) Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
6) Electricity and Magnetism, Tom Weideman, University of California Davis. [url: https://zhu.physics.ucdavis.edu/Physics9C-C_2021/Physics%209C_EM%20by%20Tom%20Weideman.pdf]

Additional Readings:

1) Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

2) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3) Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.
4) Problems and Solutions in Electromagnetics (2015), Ajoy Ghatak, K Thyagarajan and Ravi Varshney.

PRACTICAL **– 30 Hours**

Every student must perform at least five experiments.

1) Magnetic field variation along the axis of a circular coil and in a Helmholtz coil ($(r > a, r = a$ and $r < a)$. Here, 'a' is radius of coil and 'r' is distance between the coils).
2) **B**-**H** curves for soft and hard ferromagnetic materials and comparison of their coercivity, retentivity and saturation magnetization for same applied magnetic field.
3) Measurement of field strength **B** and its variation in a solenoid (determine d**B**/dx)
4) Measurement of current and charge sensitivity of ballistic galvanometer
5) Measurement of critical damping resistance of ballistic galvanometer
6) Determination of a high resistance by leakage method using ballistic galvanometer
7) Measurement of self-inductance of a coil by Anderson's Bridge
8) Measurement of self-inductance of a coil by Owen's Bridge
9) To determine the mutual inductance of two coils by the Absolute method

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11^{th} Ed., 2011, Kitab Mahal
3) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers
4) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning
5) Practical Physics, G. L. Squires, 2015, 4^{th} Edition, Cambridge University Press

DISCIPLINE SPECIFIC CORE COURSE – 6: ELECTRICAL CIRCUIT ANALYSIS

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electrical Circuit Analysis DSC – 6	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course covers the basic circuit concepts in a systematic manner which is suitable for analysis and design. It aims at study and analysis of electric circuits using network theorems and two-port parameters.

LEARNING OUTCOMES

At the end of the course the student will be able to,

- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and their difference
- Solve complex electric circuits using network theorems.
- Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
- Evaluate the performance of two port networks.

SYLLABUS OF DSC – 6

THEORY COMPONENT

Unit 1: (8 Hours)

Circuit Analysis: Ideal voltage source, real voltage source, current source, Kirchhoff's current law, Kirchhoff's voltage law, node analysis, mesh analysis, Star and Delta conversion
DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RL circuit with initial current, time constant, RL and RC Circuits with source

Unit 2: (12 Hours)

AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak to peak, root mean square and average values, form factor and peak factor (for half-rectified and full-rectified sinusoidal wave, rectangular wave and triangular wave), voltage-current relationship in resistor, inductor and capacitor, phasor, complex impedance, power in AC circuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits

Unit 3: (10 Hours)
Network Theorems: Principal of duality, Superposition theorem, Thevenin theorem, Norton theorem, Their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits, Reciprocity Theorem, Millman's Theorem, Tellegen's theorem
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission Parameters, Impedance matching

References:
Essential Readings:
1) Electric Circuits, S. A. Nasar, Schaum's Outline Series, Tata McGraw Hill (2004)
2) Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education (2004)
3) Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
4) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
5) Principles of Electric Circuits, Thomas L. Floyd, 9/e (2016)

Additional Readings:
1) Network analysis, M. E. Van Valkenburg, Third edition, Prentice Hall
2) Network, Lines and Fields, John D. Ryder, Pearson Ed. II, 2015.
3) Electrical Circuits, K. A. Smith and R. E. Alley, 2014, Cambridge University Press

PRACTICAL COMPONENT – 60 Hours

Every student must perform at least seven experiments from the following list of experiments
1) Verification of Kirchoff's Law.
2) Verification of Superposition Theorem by using d.c. and a.c. voltage source
3) Verification of Norton's theorem.
4) Verification of Thevenin's Theorem and Maximum Power Transfer Theorem by using d.c. and a.c. voltage source
5) Determination of unknown capacitance using de Sauty's Bridge
6) Determination of time constant of RC and RL circuit
7) Study of frequency response of RC circuit
8) Study of frequency response of a parallel LCR Circuit and determination of its resonant frequency, impedance at resonance, quality factor and bandwidth.
9) Explore electrical properties of matter using Arduino:
    a. To study the characteristics of a series RC Circuit.
    b. To study the response curve of a series LCR circuit and determine its resonant frequency, impedance at resonance, quality factor and bandwidth

References (for Laboratory Work):

1) A Textbook of Electrical Technology, B. L. Thareja, A. K. Thareja, Volume II, S. Chand
2) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
3) Electric Circuits, S. A. Nasar, Schaum's Outline series, Tata McGraw Hill (2004)
4) Electrical Circuits, K. A. Smith and R.E. Alley, 2014, Cambridge University Press
5) Electrical Circuit Analysis, K. Mahadevan and C. Chitran, 2nd Edition, 2018, PHI Learning Pvt. Ltd.

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

<u>Category II</u>

B. Sc. Physical Science with Physics as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 2): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 2	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

LEARNING OUTCOMES

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

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

SYLLABUS OF PHYSICS DSC – 2

THEORY COMPONENT

Unit 1: (10 Hours)

Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

Unit 2: (8 Hours)

Magnetostatics: Magnetic force between current elements and definition of magnetic field **B**, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

Unit 3: (7 Hours)

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current

Unit 4: (5 Hours)

DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

References:

Essential Readings:

1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I, 1991, Oxford Univ. Press
3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

Additional Readings:

1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney.
3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995, McGraw Hill.

PRACTICAL COMPONENT – 60 Hours

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.
Every student should perform at least 06 experiments from the following list of experiments.

1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
2) Ballistic Galvanometer:
    a) Measurement of charge and current sensitivity
    b) Measurement of critical damping resistance
    c) Determine a high resistance by leakage method
    d) Determine self-inductance of a coil by Rayleigh's Method.
3) To compare capacitances using de Sauty's bridge.
4) Measurement of field strength B and its variation in a Solenoid
5) To study the Characteristics of a Series RC Circuit.
6) To study a series LCR circuit and determine its resonant frequency and quality factor.
7) To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
8) To determine a low resistance by Carey Foster bridge.
9) To verify the Thevenin, superposition and maximum power transfer theorems
10) To verify Norton theorem

References (for Laboratory Work):

1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
5) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

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

Category II

(Physical Science Courses (with Electronics) for Undergraduate Programme of study with Physics and Electronics discipline as Core Disciplines)

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 3): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 3	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

LEARNING OUTCOMES

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

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

SYLLABUS OF PHYSICS DSC – 3

THEORY COMPONENT

Unit 1: (10 Hours)
Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

Unit 2: (8 Hours)
Magnetostatics: Magnetic force between current elements and definition of magnetic field **B**, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

Unit 3: (7 Hours)
Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current

Unit 4: (5 Hours)
DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

References:

Essential Readings:

1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press
3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

Additional Readings:

1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney

3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995, McGraw Hill.

PRACTICAL COMPONENT – 60 Hours

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.
Every student should perform at least 06 experiments from the following list of experiments.

1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
2) Ballistic Galvanometer:
    e) Measurement of charge and current sensitivity
    f) Measurement of critical damping resistance
    g) Determine a high resistance by leakage method
    h) Determine self-inductance of a coil by Rayleigh's Method.
3) To compare capacitances using de Sauty's bridge.
4) Measurement of field strength B and its variation in a Solenoid
5) To study the Characteristics of a Series RC Circuit.
6) To study a series LCR circuit and determine its resonant frequency and quality factor.
7) To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
8) To determine a low resistance by Carey Foster bridge.
9) To verify the Thevenin, superposition and maximum power transfer theorems
10) To verify Norton theorem

References (for Laboratory Work):

1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
5) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

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

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 4): LINEAR AND DIGITAL INTEGRATED CIRCUITS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Linear and Digital Integrated Circuits Physics DSC 4	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This paper aims to provide the basic knowledge of linear and digital electronics. It discusses about the operational amplifier and its applications. Boolean algebra and combinational logic circuits are also discussed.

LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- To understand Op-Amp basics and its various applications.
- To become familiar with logic gates and boolean algebra theorems.
- To understand the minimization techniques for designing a simplified logic circuit.
- To design a half adder, full adder, half-subtractor, and full-subtractor.
- To understand the working of data processing circuits, multiplexers, de-multiplexers, decoders and encoders.
- To become familiar with the working of flip-flop circuits, its working and applications.

SYLLABUS OF PHYSICS DSC – 4

THEORY COMPONENT

Unit 1: (8 Hours)

Operational Amplifiers (Black box approach): Characteristics of an ideal and practical Operational Amplifier (IC 741), Open and closed loop configuration, CMRR, Slew Rate and the concept of Virtual Ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Wein bridge oscillator, (6) Comparator, and (7) Active low pass and high pass Butter worth filter (1st order only).

Unit 2: (6 Hours)

Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Basic postulates and fundamental theorems of Boolean algebra.

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP).

Unit 3: (6 Hours)

Arithmetic Circuits: Half and Full Adder, Half and Full Subtractor, 4-bit binary Adder/Subtractor

Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders

Unit 4: (5 Hours)

Sequential Circuits: SR, D, and JK Flip-Flops. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop.

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel in-Parallel-out Shift Registers (only up to 4 bits). Ring Counter.

Unit 5: (5 Hours)

Counters (4 bits): Asynchronous counter, Synchronous Counter.

D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, A-D conversion characteristics, successive approximation ADC.

References:

Essential Readings:

1) Op-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
2) Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.
3) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 8th Ed., 2018, Tata McGraw
4) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill
5) Digital Fundamentals, Thomas L. Flyod, Pearson Education Asia (1994).
6) Digital Principles, R. L. Tokheim, Schaum's outline series, Tata McGraw- Hill (1994).

PRACTICAL COMPONENT – 60 Hours

Every student should perform at least 04 experiments each from section A, B and C

Section A: Op-Amp. Circuits (Hardware design)

1) To design an inverting and non-inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
2) To design inverting and non-inverting amplifier using Op-amp (741,351) and study their frequency responses
3) To add two dc voltages using Op-Amp in inverting and non-inverting mode.
4) To design a precision Differential amplifier of given I/O specification using Op-amplifier.

5) To investigate the use of an op-amp as an Integrator.
6) To investigate the use of an op-amp as a Differentiator.
7) To design a Wien bridge oscillator for given frequency using an Op-Amplifier.
8) Design a Butter-worth Low Pass active Filter (1st order) and study frequency response.
9) Design a Butter-worth High Pass active Filter (1st order) and study frequency response.
10) Design a digital to analog converter (DAC) of given specifications.

Section B: Digital circuits (Hardware design)

1) (a) To design a combinational logic system for a specified Truth Table.
   (b) To convert Boolean expression into logic circuit & design it using logic gate ICs.
   (c) To minimize a given logic circuit.
2) Half Adder and Full Adder.
3) Half Subtractor and Full Subtractor.
4) 4 bit binary adder and adder-subtractor using Full adder IC.
5) To design a seven segment decoder.
6) To build Flip-Flop (RS, D-type and JK) circuits using NAND gates.
7) To build JK Master-slave flip-flop using Flip-Flop ICs.
8) To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.
9) To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

Section C: SPICE/MULTISIM simulations for electronic circuits and devices

1) To verify the Thevenin and Norton Theorems.
2) Design and analyze the series and parallel LCR circuits.
3) Design the inverting and non-inverting amplifier using an Op-Amp of given gain.
4) Design and Verification of op-amp as integrator and differentiator.
5) Design the 1st order active low pass and high pass filters of given cutoff frequency.
6) Design a Wein`s Bridge oscillator of given frequency.
7) Design clocked SR and JK Flip-Flop`s using NAND Gates.
8) Design 4-bit asynchronous counter using Flip-Flop ICs.

References (For Laboratory Work):

1) Fundamentals of Digital Circuits, Anand Kumar, 4th Edn, 2018, PHI Learning.
2) Digital Computer Electronics, A. P. Malvino, J.A. Brown, 3rd Edition, 2018, Tata McGraw Hill Education.
3) Digital Electronics, S. K. Mandal, 2010, 1st edition, Tata McGraw Hill.

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

Category-IV

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

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism GE – 11	4	3	0	1	Class XII pass	NIL

LEARNING OBJECTIVES

This course begins with theorems of network analysis which are required to perform the associated experiments in the laboratory. Then course delves into the elementary vector analysis, an essential mathematical tool for understanding static electric field and magnetic field. By the end of the course, the student should appreciate Maxwell's equations.

LEARNING OUTCOMES

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

- Apply Coulomb's law to line, surface, and volume distributions of charges.
- Apply Gauss's law of electrostatics to distribution of charges
- Understand the effects of electric polarization and concepts of bound charges in dielectric materials
- Understand and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents and ferromagnetism in magnetic materials

SYLLABUS OF GE – 11

THEORY COMPONENT

Unit 1: (15 Hours)

Network Analysis: Superposition, Thevenin, Norton theorems and their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits
Mathematical Preliminaries: Concept of scalar and vector fields, Gradient of a scalar field, Divergence and curl of vector fields and their physical interpretation, Conservative forces and Laplace and Poisson equations.
Concept of a line integral of a scalar and vector field, surface integral of vector fields and volume integral, Gauss's theorem, Stoke's theorem.

Unit 2: (15 Hours)

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge distributions, Electric field vector as negative gradient of scalar potential, Ambiguities of Electric potential, Differential and integral forms of Gauss's Law, Applications of Gauss's Law to various charge distributions with spherical, cylindrical and planar symmetries, Uniqueness theorem

Electric Field in Matter: Bound charges due to polarization and their physical interpretation. Average electric field inside a dielectric, Electric Field in spherical and cylindrical cavities of a dielectric, Displacement vector and its boundary conditions, Gauss' Law in the presence of dielectrics, Linear dielectrics: electric susceptibility and dielectric constant, Boundary value problems with linear dielectrics.

Unit 3: (15 Hours)

Magnetic Field: Divergence and curl of magnetic field B, Magnetic field due to arbitrary current distribution using Biot-Savart law, Ampere's law, integral and differential forms of Ampere's Law, Vector potential and its ambiguities.

Magnetic Properties of Matter: Magnetization vector, Bound Currents, Magnetic Intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability, Ferromagnetism (Hund's rule)

Electrodynamics: Faraday's Law, Lenz's Law, inductance, Electromotive force, Ohm's Law ($\vec{J} = \sigma\vec{E}$), Energy stored in a Magnetic Field. Charge Conservation, Continuity equation, Differential and integral forms of Maxwell's equations in matter.

References:

Essential Readings:

1) Introduction to Electrodynamics, D. J. Griffiths, 4th Edn., 2015, Pearson Education India Learning Private Limited.
2) Schaum's Outlines of Electromagnetics, M. Nahvi and J. A. Edminister, 2019, McGraw-Hill Education.
3) Electromagnetic Fields and Waves, Paul Lorrain and Dale Corson, 1991, W. H. Freeman.
4) Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
5) Network, Lines and Fields, John D. Ryder, 2nd Edn., 2015, Pearson.
6) Introductory Circuit Analysis, R. Boylestead, 2016, Pearson.
7) Electricity and Magnetism, Tom Weideman, University of California Davis. [url: https://zhu.physics.ucdavis.edu/Physics9C-C_2021/Physics%209C_EM%20by%20Tom%20Weideman.pdf]

Additional Readings:

1) Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
2) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley

PRACTICAL COMPONENT- 30 Hours

Learning Outcome:

- To understand working of Arduino Microcontroller System
- To use Arduino to measure time, count events and time between events
- To use Arduino to measure voltage/current/resistance
- To use Arduino to measure various physical parameters like magnetic field

Unit I (Mandatory): Arduino Programming

Introduction to Arduino Microcontroller platform. Getting acquainted with the Arduino IDE and Basic Sketch structure. Digital Input and output. Measuring time and events. Measuring analog voltage. Generating analog voltage using Pulse Width Modulation. Serial communication and serial monitor. Programming using Interrupts.

Unit II: Exploring electrical properties of matter using Arduino (at least one experiment)

- To study the characteristics of a series RC Circuit.
- To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, Impedance at resonance, (c) Quality factor Q, and (d) Band width.
- Diode Characteristics:
    - To study characteristics of diode and estimate Boltzman constant.
    - To study characteristics of LED and estimate Planck's constant

Unit III: Exploring magnetic properties of matter using Arduino

- To verify Faraday's law and Lenz's law by measuring induced voltage across a coil subjected to varying magnetic field. Also, estimate dipole moment of the magnet.

Unit IV: DC and AC Bridges (at least one experiment)

- To compare capacitances using de Sauty Bridge
- To determine a Low Resistance by Carey - Foster Bridge

Unit V: Network Theorems

(at least one experiment)

- To verify the Thevenin and Norton theorems
- To verify the Superposition, and Maximum Power Transfer Theorems

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed.2011, Kitab Mahal
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press

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

GENERIC ELECTIVE (GE - 12): THERMAL PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Thermal Physics GE – 12	4	3	0	1	Class XII pass	NIL	Physics and Astrophysics

LEARNING OBJECTIVES

This course will review the basic concepts of thermodynamics, kinetic theory of gases with a brief introduction to statistical mechanics. The primary goal is to understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through statistical mechanics.

LEARNING OUTCOMES

At the end of this course, students will,

- Get an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the basics of quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics.

In the laboratory course, the students are expected to measure of Planck's constant using black body radiation, determine Stefan's constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo-emf across two junctions of a thermocouple with temperature etc.

SYLLABUS OF GE – 12

THEORY COMPONENT

Unit 1: (12 Hours)

Laws of Thermodynamics: Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_P and C_V, work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit 2: (08 Hours)

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Clausius Clapeyron Equation, Expression for ($C_P – C_V$), C_P/C_V, TdS equations, energy equations for ideal gases.

Unit 3: (8 Hours)

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (zeroth order only), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case).

Unit 4: (7 Hours)

Theory of Radiation: Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit 5: (10 Hours)

Statistical Mechanics: Macrostate and Microstate, phase space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann law, Fermi-Dirac distribution law - Bose-Einstein distribution law - comparison of three statistics.

References:

Essential Readings:

1) A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1969, Indian Press.
2) Heat and Thermodynamics, M. W. Zemasky and R. Dittman, 1981, McGraw Hill.
3) Thermodynamics, Kinetic theory and statistical thermodynamics, F. W. Sears and G. L. Salinger. 1988, Narosa.
4) Thermal Physics, A. Kumar and S. P. Taneja, 2014, R. Chand Publications.
5) Thermal Physics: S. C. Garg, R. M. Bansal and C.K. Ghosh, 2nd Ed. Tata McGraw-Hill.

Additional Readings:

1) Concepts in Thermal Physics: Blundell and Blundell, 2nd Ed. 2009, Oxford Univ. Press.

2) An Introduction to Thermal Physics: D. Schroeder 2021, Oxford Univ. Press (earlier published by Pearsons).
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company.

PRACTICAL COMPONENT- 30 Hours

- Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the thermal physics lab, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

Every student must perform at least four experiments from the following list.
1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) Measurement of Planck's constant using black body radiation.
3) To determine Stefan's Constant.
4) To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5) To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method by steam or electrical heating.
6) To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7) To study the variation of thermos-emf across two junctions of a thermocouple with temperature.

References (For Laboratory Work):
1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal.
3) A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal, 1985, Vani Publication.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press.
5) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, New Central Book Agency

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

GENERIC ELECTIVE (GE - 13): MODERN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Modern Physics GE – 13	4	3	0	1	Class XII pass	NIL

LEARNING OBJECTIVES

The objective of this course is to teach the physics foundation necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei and elementary particles. These concepts are also important to understand phenomena in Laser physics, condensed matter physics and astrophysics.

LEARNING OUTCOMES

After getting exposure to this course, the following topics would have learnt,

- Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics, laying the foundation of modern physics.
- Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.
- The spontaneous and stimulated emission of radiation, optical pumping and population inversion, Basic lasing action.
- The properties of nuclei like density, size, binding energy, nuclear force and structure of atomic nucleus, liquid drop model and mass formula.
- Radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.
- Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.

In the laboratory course, the students will get opportunity to measure Planck's constant, verify photoelectric effect, and determine e/m of electron and work function of a metal. They will also find wavelength of Laser sources by single and double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.

SYLLABUS OF GE – 13

THEORY COMPONENT

Unit 1: (10 Hours)

Origin of Modern Physics: Blackbody Radiation: Failure of explanation from classical theory; Planck's idea of a quantum; Quantum theory of Light: Photo-electric effect and Compton scattering, de Broglie wavelength and matter waves; Davisson-Germer experiment; Wave description of particles by wave packets, Group and Phase velocities and relation between them.

Unit 2: (10 Hours)

Problems with Rutherford model: Instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen-like atoms and their spectra.

Uncertainty principle: Gamma ray microscope thought experiment; Wave-particle duality leading to Heisenberg uncertainty principle; Impossibility of an electron being in the nucleus, Energy-time uncertainty principle; origin of natural width of emission lines

Unit 3: (10 Hours)

Basics of quantum Mechanics: Two-slit interference experiment with photons and electrons; Concept of wave functions, linearity and superposition, Time independent Schrodinger wave equation for non-relativistic particles; Momentum and Energy operators; physical interpretation of a wave function, probabilities, normalization and probability current densities in one dimension. Problem: One dimensional infinitely rigid box. An application: Quantum dot.

Unit 4: (05 Hours)

X-rays: Ionizing Power, X-ray Diffraction, Bragg's Law. Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley's Law.

LASERs: Properties and applications of Lasers. Emission (spontaneous and stimulated emissions) and absorption processes, Metastable states, components of a laser and lasing action.

Unit 5: (10 Hours)

Nuclear Physics: Size and structure of atomic nucleus and its relation with atomic weight; Nature of nuclear force, Stability of the nucleus; N-Z graph, Drip line nuclei, Binding Energy, Liquid Drop model: semi-empirical mass formula.

Radioactivity: Different equilibrium, Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation:

Fission and fusion: Mass deficit and generation of energy; Fission: nature of fragments and emission of neutrons. Fusion and thermonuclear reactions driving stellar evolution (brief qualitative discussions only).

References:

Essential Readings:

1) Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2) Modern Physics by R. A. Serway, C. J. Moses and C. A. Moyer, 3rd edition, Thomson Brooks Cole, 2012.
3) Modern Physics for Scientists and Engineers by S. T. Thornton and A Rex, 4th edition, Cengage Learning, 2013.
4) Concepts of Nuclear Physics by B. L. Cohen, Tata McGraw Hill Publication, 1974.
5) Quantum Mechanics: Theory and Applications, Ajoy Ghatak and S. Lokanathan, Laxmi Publications, 2019

Additional Readings:

1) Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill.
2) Thirty years that shook physics: the story of quantum theory, George Gamow, Garden City, NY: Doubleday, 1966.
3) New Physics, ed. Paul Davies, Cambridge University Press (1989).
4) Quantum Theory, David Bohm, Dover Publications, 1979.
5) Lectures on Quantum Mechanics: Fundamentals and Applications, eds. A. Pathak and Ajoy Ghatak, Viva Books Pvt. Ltd., 2019
6) Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
7) Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999.

PRACTICAL COMPONENT – 30 Hours

- Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

Every student must perform at least 06 experiments from the following list of experiments.

1) Measurement of Planck's constant using black body radiation and photo-detector.
2) Photo-electric effect: estimate Planck's constant using graph of maximum energy of photo-electrons versus frequency of light.
3) To determine work function of material of filament of directly heated vacuum diode.
4) To determine the Planck's constant using LEDs, using at least 4 LEDs.
5) To determine the wavelength of H-alpha emission line of Hydrogen atom.
6) To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
7) To setup the Millikan oil drop apparatus and determine the charge of an electron.
8) To show the tunneling effect in tunnel diode using I-V characteristics.
9) To determine the wavelength of laser source using diffraction of single slit.

10) To determine wavelength and angular spread of He-Ne laser using plane diffraction grating.
11) To determine the wavelength of laser source using diffraction of double slits.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers.
3) A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11^{th} Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4^{th} Edition, Cambridge University Press.
5) B. Sc. Practical Physics, Geeta Sanon, R. Chand, 2016.

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

GENERIC ELECTIVE (GE - 14): INTRODUCTORY ASTRONOMY

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Introductory Astronomy GE – 14	4	3	1	0	Class XII pass	NIL

LEARNING OBJECTIVES

This course is meant to introduce undergraduate students to the wonders of the Universe. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics, and more recently chemistry and biology. They will be introduced to the Indian contribution to astronomy starting from ancient times up to the modern era. They will learn about diverse set of astronomical phenomenon, from the daily and yearly motion of stars and planets in the night sky which they can observe themselves, to the expansion of the universe deduced from the latest observations and cosmological models. Students will also be introduced to internet astronomy and the citizen science research platform in astronomy. The course presupposes school level understanding of mathematics and physics.

LEARNING OUTCOMES

After completing this course, student will gain an understanding of,

- Different types of telescopes, diurnal and yearly motion of astronomical objects, astronomical coordinate systems and their transformations
- Brightness scale for stars, types of stars, their structure and evolution on HR diagram
- Components of solar system and its evolution
- Current research in detection of exoplanets
- Basic structure of different galaxies and rotation of the Milky Way galaxy
- Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life
- Internet based astronomy and the collaborative citizen astronomy projects
- India’s contribution to astronomy, both in ancient times and in modern era.

SYLLABUS OF GE – 14 (Lecture-45 hours)

THEORY COMPONENT

Unit 1:

Introduction to Astronomy and Astronomical Scales: History of astronomy, wonders of the Universe, overview of the night sky, diurnal and yearly motions of the Sun, size, mass, density and temperature of astronomical objects, basic concepts of positional astronomy: Celestial sphere, Astronomical coordinate systems, Horizon system and Equatorial system

Unit 2:

Basic Parameters of Stars: Stellar energy sources, determination of distance by parallax method, aberration, proper motion, brightness, radiant flux and luminosity, apparent and absolute magnitude scales, distance modulus, determination of stellar temperature and radius, basic results of Saha ionization formula and its applications for stellar astrophysics, stellar spectra, dependence of spectral types on temperature, luminosity classification, stellar evolutionary track on Hertzsprung-Russell diagram

Unit 3:

Astronomical Instruments: Observing through the atmosphere (Scintillation, Seeing, Atmospheric Windows and Extinction). Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical telescopes, radio telescopes, Hubble space telescope, James Web space telescope, Fermi Gamma ray space telescope.

Astronomy in the Internet Age: Overview of Aladin Sky Atlas, Astrometrica, Sloan Digital Sky Survey, Stellarium, virtual telescope

Citizen Science Initiatives: Galaxy Zoo, SETI@Home, RAD@Home India

Unit 4:

Sun and the solar system: Solar parameters, Sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, origin of the solar system, the nebular model, tidal forces and planetary rings

Exoplanets: Detection methods

Unit 5:

Physics of Galaxies: Basic structure and properties of different types of Galaxies, Nature of rotation of the Milky Way (Differential rotation of the Galaxy), Idea of dark matter

Cosmology and Astrobiology: Standard Candles (Cepheids and SNe Type1a), Cosmic distance ladder, Olber's paradox, Hubble's expansion, History of the Universe, Chemistry of life, Origin of life, Chances of life in the solar system

Unit 6:

Astronomy in India: Astronomy in ancient, medieval and early telescopic era of India, current Indian observatories (Hanle-Indian Astronomical Observatory, Devasthal Observatory, Vainu Bappu Observatory, Mount Abu Infrared Observatory, Gauribidanur Radio Observatory, Giant Metre-wave Radio Telescope, Udaipur Solar Observatory, LIGO-India) (qualitative discussion), Indian astronomy missions (Astrosat, Aditya)

References:

Essential Readings:

1) Seven Wonders of the Cosmos, Jayant V Narlikar, Cambridge University Press
2) Fundamental of Astronomy, H. Karttunen et al. Springer
3) Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
4) Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders College Publishing.
5) The Molecular Universe, A. G. G. M. Tielens (Sections I, II and III), Reviews of Modern Physics, Volume 85, July-September, 2013
6) Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer

Useful websites for astronomy education and citizen science research platform

1) https://aladin.u-strasbg.fr/
2) http://www.astrometrica.at/
3) https://www.sdss.org/
4) http://stellarium.org/
5) https://www.zooniverse.org/projects/zookeeper/galaxy-zoo/
6) https://setiathome.berkeley.edu/
7) https://www.radathomeindia.org/

Additional Readings:

1) Explorations: Introduction to Astronomy, Thomos Arny and Stephen Schneider, McGraw

Hill
2) Astrophysics Stars and Galaxies K. D. Abhyankar, Universities Press
3) Textbook of Astronomy and Astrophysics with elements of cosmology, V. B. Bhatia, Narosa Publication.
4) Baidyanath Basu, An introduction to Astrophysics, Prentice Hall of India Private Limited.
5) The Physical Universe: An Introduction to Astronomy, F. H. Shu, University Science Books

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

DEPARTMENT OF CHEMISTRY
Category-I

B.Sc. (H) Chemistry

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4): CHEMISTRY OF S- AND P-BLOCK ELEMENTS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of s- and p-Block Elements (DSC-4: Inorganic Chemistry -II)	04	03	0	01	Class 12th Pass	----

Learning objectives

The objectives of this course are as follows:

- To develop the general principles of metallurgy and s-, p-block elements.
- To introduce the terms minerals, ores, concentration, benefaction, calcination, roasting, refining, etc. and explain the principles of oxidation and reduction as applied to the extraction procedures.
- To make students ware of different methods of purification of metals, such as electrolytic, oxidative refining, VanArkel-De Boer process and Mond's process are discussed and applications of thermodynamic concepts like that of Gibbs energy and entropy to the extraction of metals.
- To familiarize students with the patterns and trends exhibited by s- and p-block elements and their compounds with emphasis on synthesis, structure, bonding and uses.
- To impart information about the fundamentals of internal and external redox indicators, and iodometric/iodimetric titrations.

Learning outcomes

By studying this course, students will be able to:

- Learn the fundamental principles of metallurgy and understand the importance of recovery of by-products during extraction.
- Applications of thermodynamic concepts like that of Gibbs energy and

entropy to the principles of extraction of metals.

- Learn about the characteristics of s- and p- block elements as well as the synthesis, structure, bonding and uses of their compounds
- Understand the concept and use of internal and external redox indicators
- Comprehend the theory and application of iodometric and iodimetric titrimetric analysis

SYLLABUS OF DSC-4

UNIT – I: General Principles of Metallurgy **(6 Hours)**

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining. Brief discussion of metals and alloys used in ancient and medieval India.

UNIT – II: **Chemistry of s- Block Elements** **(15 Hours)**

General characteristics: melting point, flame colouration, reducing nature, diagonal relationships and anomalous behavior of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.

Common features such as ease of formation, thermal stability, energetics of dissolution, and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.

Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium.

Solutions of alkali metals in liquid ammonia and their properties

UNIT – III: Chemistry of *p*-Block Elements **(9 Hours)**

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group.

UNIT – IV: Compounds of *p*-Block Elements **(15 Hours)**

Acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat on the following:

- Hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P,As, Sb, Bi), Group 16 and Group 17.
- Oxoacids of phosphorus, sulphur and chlorine
- Interhalogen and pseudohalogen compound
- Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF_2).

Practical component – 30 Hours

1. **Redox Titrations**
   (i) Estimation of Fe(II) with $K_2Cr_2O_7$ using diphenylamine as internal indicator.
   (ii) Estimation of Fe(II) with $K_2Cr_2O_7$ using N-phenyl anthranilic acid as internal indicator.
   (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator.

2. **Iodo/Iodimetric Titrations**
   (i) Estimation of Cu(II) using sodium thiosulphate solution (Iodometrically).
   (ii) Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
   (iii) Estimation of antimony in tartaremetic iodimetrically.
   (iv) Estimation of Iodine content in iodized salt.

Essential/recommended readings

Theory:

1. Lee, J. D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J. E.; Keiter, E. A.; Keiter; R.L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
4. Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5. Housecraft, C. E.; Sharpe, A. G., (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
6. Canham, G. R., Overton, T. (2014), **Descriptive Inorganic Chemistry,** 6th Edition, Freeman and Company.
7. Greenwood, N. N.; Earnsaw, A., (1997), **Chemistry of Elements**, 2nd Edition, Elsevier.

Practicals:

1. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denney, R. C. (1989), Vogel's Text book of **Quantitative Chemical Analysis**, John Wiley and Sons.
2. Harris, D. C.; Lucy, C. A. (2016), **Quantitative Chemical Analysis**, 9th Edition, Freeman and Company.
3. Day, R. A.; Underwood, A. L. (2012), **Quantitative Analysis**, 6th Edition, PHI Learning Private Limited.

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): HALOALKANES, ARENES, HALOARENES, ALCOHOLS, PHENOLS, ETHERS AND EPOXIDES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Haloalkanes, Arenes, Haloarenes, Alcohols, Phenols, Ethers and Epoxides (DSC-5: Organic Chemistry-II)	04	02	0	02	Class 12^{th} Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart understanding of the chemistry of organic functional groups, which include haloalkanes, aromatic hydrocarbons, haloarenes and some oxygen containing functional groups, along with their reactivity patterns.
- To develop understanding of detailed reactions and mechanistic pathways for each functional group to unravel the spectrum of organic chemistry and the extent of organic transformations.
- To aid in the paramount learning of the concepts and their applications.

Learning outcomes

On completion of the course, the student will be able to:

- Understand reactions of arenes, haloarenes and some oxygen containing functional groups.
- Understand the concept of protection and deprotection
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Propose plausible mechanisms for the reactions under study.

SYLLABUS OF DSC-5

Unit - 1: Haloalkanes **(10 Hours)**

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution v/s elimination.

Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.

Unit - II: Aromatic Hydrocarbons **(06 Hours)**

Concept of Aromaticity and anti-aromaticity; Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/acylation with their mechanism. Directing effects of groups in electrophilic substitution.

Unit - III: Aryl halides **(04 Hours)**

Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S_NAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Unit - IV: Alcohols, Phenols, Ethers & Epoxides **(10 Hours)**

Alcohols: Relative reactivity of 1°, 2°, 3° alcohols, reactions of alcohols with sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation; Diols: oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation using Cumene hydroperoxide, Acidity and factors affecting it, Kolbe's–Schmidt reactions, Riemer-Tiemann reaction, Houben–Hoesch condensation, Schotten–Baumann reaction, Fries and Claisen rearrangements and their mechanism.
Ethers and Epoxides: Acid and Base catalyzed cleavage reactions.

Practical - 60 Hours

1. Acetylation of any one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (*β*-naphthol, salicylic acid) by any one method:
   i. Using conventional method ii. Using green approach
2. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*, *m*-, *p*-anisidine) or one of the following phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.
3. Bromination of acetanilide/aniline/phenol by anyone of the following:
   (a) Green method b) Conventional method
4. Nitration of nitrobenzene/chlorobenzene.
5. Haloform reaction of ethanol.
6. Oxidation of benzyl alcohol to benzoic acid
7. Estimation of the given sample of phenol/amine by:

a) Acetylation b) Bromate-Bromide method

8. Functional group tests for alcohols, phenols, carboxylic acids, phenols, carbonyl compounds, esters.

Essential/recommended readings

Theory:

1. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. (2002), **Organic Chemistry**, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), **Intermediate for Organic Synthesis,** I.K. International.
4. Solomons, T.W.G., Fryhle, C.B., Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.

Practical:

1. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, 4th Edition, Pearson Education.
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2005), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
3. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**, University Press.
4. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
6. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

Suggestive readings

1. Carey, F.A., Sundberg, R. J. (2008), **Advanced Organic Chemistry: Part B: Reaction and Synthesis**, Springer.
2. Bruice, P.Y. (2020), **Organic Chemistry**, 3rd Edition, Pearson.
3. Patrick, G. (2012), **BIOS Instant Notes in Organic Chemistry**, Viva Books.
4. Parashar, R.K., Ahluwalia, V.K. (2018), **Organic Reaction Mechanism,** 4th Edition, Narosa Publishing House.

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

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC-6): Thermodynamics and its Applications

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Thermodynamics and its Applications (DSC – 6: Physical Chemistry – II)	04	03	-	01	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students understand thermodynamic concepts, terminology, properties of thermodynamic systems, laws of thermodynamics and their correlation with other branches of physical chemistry and make them able to apply thermodynamic concepts to the system of variable compositions, equilibrium and colligative properties.

Learning outcomes

On completion of the course, the student will be able to:

- Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties.
- Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for an ideal gas under different conditions.
- Explain the concept of partial molar properties.

SYLLABUS OF DSC-6

UNIT – I: Basic Concepts of Chemical Thermodynamics (06 Hours)

Intensive and extensive variables; state and path functions; isolated, closed and open systems.

Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule.

UNIT – II: **First law and Thermochemistry** **(15 Hours)**

Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.

UNIT – III: Second Law **(15 Hours)**

Concept of entropy; statement of the second law of thermodynamics, Carnot cycle. Calculation of entropy change for reversible and irreversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases). Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

UNIT – IV Third Law **(03 Hours)**

Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.

UNIT – V Systems of Variable Composition **(06 Hours)**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases.

Practical – 30 Hours

Thermochemistry:

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulphuric acid or enthalpy of neutralization).

(b) Determination of heat capacity of a calorimeter for different volumes using heat gained equal to heat lost by cold water and hot water.

(c) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(d) Determination of the enthalpy of ionization of ethanoic acid.
(e) Determination of integral enthalpy solution of endothermic salts.
(f) Determination of integral enthalpy solution of exothermic salts.
(g) Determination of basicity of a diprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(h) Determination of enthalpy of hydration of salt.
(i) Study of the solubility of benzoic acid in water and determination of ΔH.

Any other experiment carried out in the class.

Essential/recommended readings
Theory

1. Peter, A.; Paula, J. de. (2011), **Physical Chemistry**, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L., **A Textbook of Physical Chemistry**, Vol 3, 5th Edition, McGraw Hill Education.
5. McQuarrie, D. A.; Simon, J. D. (2004), **Molecular Thermodynamics**, Viva Books Pvt. Ltd.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

1. Levine, I.N. (2010), **Physical Chemistry**, Tata Mc Graw Hill.
2. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S. (2011), **Commonly asked Questions in Thermodynamic**s. CRC Press.

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

Category II

BSc. Life Science with Chemistry as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Bonding and Elements in Biological System CHEM-DSC-02	4	2	0	2	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- Students gain basic knowledge of chemical bonding in compounds which is a necessary pre-requisite in understanding the general properties of the compound.
- Unit 2 reviews the importance of inorganic chemical species, especially metals in biological systems, their classification and detailed discussion of toxic metals.
- The discussions also provide them the details of sodium-potassium pump, role of some metal ions such as calcium, magnesium and the role of iron in transport and storage system

Learning outcomes

By the end of the course, the students will be able to:

- Understand the concept of lattice energy using Born-Landé and Born Haber Cycle and their applications
- Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory.
- Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.
- Know about the essential, non-essential, trace and toxic metal ions and their role in biological system and effects of their deficiency. They will also learn their dose response relationship curves.
- Understand active and Passive transport and diagrammatically explain the working of

the sodium-potassium pump in organisms and the factors affecting it

- Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity
- Storage and transport of iron in bio-systems

SYLLABUS OF DSC-4

Unit I: Chemical Bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waals forces

Unit II: Elements in Biological System (12 Hours)

Classification of elements in biological system, Geochemical effect on the distribution of metals, Metal ions present in biological systems with special reference to Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+} and Zn^{2+}, Sodium / K-pump, Role of Ca^{2+} (blood clotting and structural), Role of Mg^{2+} in chlorophyll and energy production, Excess and deficiency of some trace metals, Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Dose response relationship curves of metal ions, Iron and its application in bio-systems, Storage and transport of iron.

PRACTICALS: 60 Hours

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate using HCl by acid base titration.
3. Estimation of carbonate and hydroxide present together in a mixture.
4. Estimation of carbonate and bicarbonate present together in a mixture.
5. Estimation of free alkali present in different soaps/detergents
6. Estimation of oxalic acid using $KMnO_4$ by redox titration.
7. Estimation of Mohr's salt using $KMnO_4$ by redox titration.
8. Determination of dissolved oxygen in water.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$
11. Paper Chromatographic separation of mixture of metal ions

a. Cu^{2+}, Cd^{2+}
b. Ni^{2+}, Co^{2+}.

12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

References:

Theory:

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins **Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Crichton, R.; (2019), **Biological inorganic chemistry**: **a new introduction to molecular structure and function**, third edition, Elsevier, Academic Press.
6. Kaim, W; Schwederski, B.; Klein, A. (2013), **Bioinorganic Chemistry - Inorganic Elements in the Chemistry of Life: An Introduction and Guide**, 2nd Edition, Wiley.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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

Category II

BSc. Physical Science with Chemistry as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Periodic Properties and Chemical Bonding DSC-4 Chemistry-II	4	2	0	2	Class 12^{th} Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van derWaal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds

Learning outcomes

By the end of the course, the students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules). Understand the importance and applications of hydrogen and van der Wall bonding

SYLLABUS OF DSC-4

Unit I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

UNIT II: Chemical Bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waal's Forces

PRACTICALS: 60 Hours

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate with HCl
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Mohr's salt by titrating it with $KMnO_4$.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} or Ni^{2+}, Co^{2+}.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using
   a). internal indicator
   b). external indicator
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
11. Paper Chromatographic separation of mixture of metal ions
    a). Cu^{2+} , Cd^{2+}
    b). Ni^{2+} , Co^{2+}
12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

References:

Theory:

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
4. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994),**Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
6. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
7. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

Practical:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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

Category-I
B.Sc. (H) Analytical Chemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: DSC-4:AC-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		
Course Title: SEPARATION METHODS-I **Course Code:** Analytical Chemistry-2 (DSC4:AC-2)	04	02	00	02	Class XII Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquire basic knowledge of the analytical chemistry of important techniques that will provide the basis for their industrial production methods.
- To provide an adequate mastery of analytical methods used for the determination of commercial/domestic raw materials and finished product quality.

Learning outcomes

By the end of this course, students will be able to:

- Become familiar with fundamental concepts of partition coefficients and their role in achieving separations across different types of chromatography.
- Develop the core skills to parse existing chromatographic protocols and identify the key factors influencing a chromatography experiment.
- Understand the underlying assumptions of the most common chromatographic separation techniques and approaches to method validation.
- Understand the concept of solubility and their application in separation using distribution law.

SYLLABUS OF Analytical Chemistry-2 (DSC-4: AC-2)

Theory Component

UNIT – I: Chromatography (08 Hours)

Classification of chromatographic methods: Principles of differential migration, description of chromatographic process, distribution coefficients, modes of chromatography. the chromatography (elution time and volume) capacity factor, column efficiency and resolution, sample preparation.

UNIT – II: Techniques of paper chromatography (06 Hours)

Experimental modifications, various modes of developments, nature of paper, detections of spots, retardation factors, factors that affect reproducibility of R_f values (due to paper, solvent system, sample, development procedures), selection of solvent, quantitative analysis, applications.

UNIT – III: Thin Layer Chromatography (06 Hours)

Stationary phase, adsorbents, liquid phase support, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, R_f values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications.

UNIT – IV: Solvent Extraction (04 Hours)

Distribution law, determination of distribution ratio, batch extraction, continuous extraction, discontinuous extraction, counter-current extraction.

UNIT –V: Dialysis and membrane filtration (06 Hours)

General laboratory methods, filters-nitrocellulose, fiberglass and polycarbonates.

Practical component – 60 Hours

1. Separation and identification of amino acids present in the given mixture by **radial** and **ascending** paper Chromatography (*Perform both*).
2. Separation of ortho-nitrophenol & para-nitrophenol and *o*- and *p*-amino phenol by thin layer chromatography (TLC) and calculation of their R_f values.
3. Separation of constituents of leaf pigments by thin layer chromatography and paper chromatography (*radial & ascending both*).
4. Separation of a mixture of compounds by solvent extraction.
5. Separation of a mixture of naphthalene, benzoic acid and 2-naphthol.
6. Separation of a mixture of 1,4-dimethoxybenzene, 2-chloro benzoic acid and *p*-cresol.
7. Analysis of soil samples (*at least three soil samples to be collected for analysis*) collected from college nursery, sports ground Delhi villages/ Yamuna River bank.

   (**a**) Determination of pH of soil samples.
   (**b**) Determination of total soluble salts.
   (**c**) Determination of carbonate and bicarbonate.
   (**d**) Determination of calcium, magnesium and iron.

(**e**) Determination of conductance of the soil samples.

8. Industrial visit to STP plant.

Essential/recommended readings

- Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.
- Harris, D. C. (2007), Quantitative Chemical Analysis, 6th Edition, Freeman
- Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D.Van Nostrand Company Inc.

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

DISCIPLINE SPECIFIC CORE COURSE – 5: DSC5:C2

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PERIODIC PROPERTIES AND CHEMICAL BONDING CHEMISTRY-2 (DSC5-C2)	04	02	0	02	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van der Waal forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds.

Learning outcomes

By the end of this course, students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the importance and applications of hydrogen and van der Wall bonding.

SYLLABUS OF Chemistry-2 (DSC-5:C2)

UNIT – I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes.

UNIT – II: Bonding in Coordination Compounds (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.
Metallic Bonding, Hydrogen Bonding, van der Waals Forces.

Practical – 60 Hours

1. Preparation of standard solutions of different normality and molarity of Mohr's salt and oxalic acid.
2. Estimation of free alkali present in different soaps and detergents (*At least two samples to be taken*).
3. Estimation of oxalic acid by titrating it with $KMnO_4$ (*Provide at least two unknown solutions*).
4. Estimation of Mohr's salt by titrating it with $KMnO_4$ (*Provide a tleast two unknown solutions*).
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} and Ni^{2+}, Co^{2+}.

Essential/recommended readings

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), Inorganic Chemistry 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Inorganic Chemistry, 5th Edition, W. H. Freeman and Company.

4. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
6. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
7. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
8. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

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

DISCIPLINE SPECIFIC CORE COURSE – 6: Mathematics-1:DSC6

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus Mathematics-1 (DSC6)	04	**03**	**01**	**0**	**Class 12th Pass**	----

Course Objectives

The Learning Objectives of this course are as follows:

- The primary objective of this course is to introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems.
- Students will be able to understand/create various mathematical models in everyday life.

Course Learning Outcomes: This course will enable the students to:

- Understand continuity and differentiability in terms of limits and graphs of certain functions.
- Describe asymptotic behaviour in terms of limits involving infinity.
- Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
- Apply the concepts of asymptotes, and inflexion points in tracing of Cartesian curves.
- Compute the reduction formulae of standard transcendental functions with applications.

Syllabus: Theory Component

Unit 1: Limits, Continuity and Differentiability – 20 Hours

Limit of a function, $\varepsilon-\delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the *n*th derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit 2: Mean Value Theorems and its Applications – 20 Hours

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit 3: Tracing of Curves and Reduction Formulae – 20 Hours
Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing(cartesian and polar equations). Reduction formulae for $\int \sin^n x\,dx, \int \cos^n x\,dx,$ and $\int \sin^m x \cos^n x\,dx$ and their applications.

Practical Component (if any): NIL

Essential/recommended readings

- Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). *Integral Calculus*. Pothishala Pvt. Ltd. Allahabad.

Additional Readings:

- Apostol, T. M. (2007). *Calculus*: *One-Variable Calculus with An Introduction to Linear Algebra* (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013).*Elementary Analysis*: *The Theory of Calculus* (2nd ed.).Undergraduate Texts in Mathematics, Springer. Indian reprint.

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

Category I

BSc. (Hons.) Industrial Chemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: (DSC-4) Fossil Fuels and Cleansing Agents

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fossil Fuels and Cleansing Agents (DSC-4: Industrial Chemistry -II)	04	02	0	02	Class 12th Pass	----

Learning Objectives

- After studying this course, student shall be able to understand the different aspects of industrial processes of fossil fuels in detail.
- Optimised use of limited resources of non-renewable energy and technology investment in improving the production of renewable cleaner energy sources and biofuels.
- The analytical approach of this course is to enhance the reasoning and to understand the mechanical part of the industry.

Learning outcomes

By the end of the course, the students will be able to:

- Know about fuels, composition, carbonization of coal, liquefaction, and coal tar based chemicals and layout for key processes in oil refining.
- Understand the role of petroleum and petrochemical industry, composition, applications, process-cracking. Increasing demand for non-petroleum fuels, synthetic fuels.
- Understand different fossil fuel products and processes
- Know types of oils, familiarized with rancidity, saponification value, iodine number, Superiority of synthetic detergents, gain knowledge about surfactants.

SYLLABUS OF DSC-4

UNIT – I: Fuel Chemistry and Introduction to Coal (10 Hours)

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Introduction of coal, uses of coal (fuel and non-fuel) in various industries (at least three examples), its types and composition, carbonization of coal. Coal gas, producer gas and water gas—composition and their uses, uses of coal-tar based chemicals, Requisites of a good metallurgical coke, Coal liquefaction and Solvent refining.

UNIT – II: Petroleum and Petrochemical Industry (12 Hours)
Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional distillation (principle and process), Cracking (thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG,CNG,LNG, bio-gas, biofuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels

UNIT – III: Oils and Fats (8 Hours)
Classification of oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, soap and synthetic detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS).

Practical component- 60 Hours

Industrial Chemistry-II

1. Determination of alkali in water samples and soaps.
2. Determination of iodine value of the oils/ fats.
3. Determination of saponification value of the oils/ fats.
4. Determination of acid value of the oils/ fats.
5. To determine the moisture content of different fuels.
6. Estimation of hardness of water by titration with soap solution.
7. Preparation of soap.
8. Preparation of biodiesel from waste cooking oil and its characterization.
9. To compare the viscosity of biodiesel and vegetable oil.
10. To determine the density of the given fuel sample.
11. Characterization of different petroleum products using UV and IR.

Essential/recommended readings
Theory:

1. Vermani, O. P.; Narula, A. K. (2004), **Industrial Chemistry,**Galgotia Publications Pvt. Ltd., New Delhi.
2. Bhatia, S. C. (2004), **Chemical Process Industries**, Vol. I & II, CBS Publishers, New Delhi.
3. Jain, P. C.; Jain, M. (2013), **Engineering Chemistry**, DhanpatRai& Sons, Delhi.
4. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), **Engineering Chemistry**, Vikas Publications.
5. Sharma, B. K. (1997), **Engineering Chemistry**, Goel Publishing House, Meerut.

Practical:

1. Verma, S. and Goyal, R. K. (2021) **Fuel Chemistry Theory and Practical**,1st Edition Aaryush Publications, Muzaffarnagar (U.P.)
2. Ahluwalia, V. K. and Aggarwal, R. **Comprehensive Practical Organic Chemistry, Preparation and Quantitative Analysis** ,University Press, New Delhi.

3. Sharma, R.K., Sidhwani,I.T.,Chaudhari,M.K. (2013),**Green Chemistry Experiments: A monograp**h, I.K. International Publishing House Pvt Ltd. New Delhi.

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

DISCIPLINE SPECIFIC CORE COURSE –DSC 5: Periodic Properties and Chemical bonding

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Periodic Properties and Chemical bonding (DSC-5: Chemistry -II)	04	02	0	02	Class XII Pass	---

Learning Objectives

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van der Waal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds

Learning outcomes

By the end of the course, the students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the importance and applications of hydrogen and van der Wall bonding.

SYLLABUS OF DSC- 5

UNIT – I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

UNIT – II: Chemical bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waal's Forces

Practical component – 60 Hours

Chemistry-II,

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate with HCl.
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Mohr's salt by titrating it with $KMnO_4$.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} or Ni^{2+}, Co^{2+}.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using
    a. internal indicator
    b. external indicator
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
11. Paper Chromatographic separation of mixture of metal ions
    a. Cu^{2+}, Cd^{2+}
    b. Ni^{2+} , Co^{2+}
12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

Essential/recommended readings

Theory:

9. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education
10. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.

11. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
12. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India
13. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994),**Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
14. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
15. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

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

DISCIPLINE SPECIFIC CORE COURSE – DSC 6: Mechanics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mechanics DSC - 6	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with a review of vector algebra and ordinary differential equations. The students will learn Newton's laws of motion, conservation of momentum, conservation of energy, concept of simple harmonic motion, Newton's laws of gravitation, elasticity and the Special Theory of Relativity. They will be able to apply the concepts learnt to several real world problems.

Learning Outcomes

Upon completion of this course, students will be able to,

- Learn the laws of motion and their application to various dynamical situations.
- Understand the concept of conservation of momentum, angular momentum and energy. Their application to basic problems.
- Understand the motion of simple pendulum
- Understand the laws of gravitation and basic idea of global positioning system
- Understand the elastic properties
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

SYLLABUS OF DSC – 1

Vectors: Review of vector algebra. Scalar and vector product

(2 Hours)

Ordinary Differential Equations: First order homogeneous differential equations, second order homogeneous differential equation with constant coefficients

(4 Hours)

Brief review of Newton's laws of motion, dynamics of a system of particles, centre of mass, determination of centre of mass for continuous systems having spherical symmetry. Conservation of momentum and energy, work – energy theorem for conservative forces, force as a gradient of potential energy, angular momentum, torque, conservation of angular momentum

(9 Hours)

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, kinetic energy and potential energy, total energy and their time average for a body executing simple harmonic motion

(4 Hours)

Newton's law of gravitation, motion of a particle in a central force field, Kepler's laws, weightlessness, geosynchronous orbit, basic idea of global positioning system

(4 Hours)

Elasticity: Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on awire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus

(3 Hours)

Postulates of special theory of relativity, Lorentz transformation relations, length contraction, time dilation, relativistic transformation of velocity

(4 Hours)

PRACTICAL COMPONENT (60 Hours)

Every student should perform at least 06 experiments from the following list.

1) Measurements of length (or diameter) using vernier calliper, screw gauge and travellingmicroscope.
2) Determination of height of a building using a sextant.
3) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration dueto gravity (g)
4) Determination of moment of inertia of a flywheel.
5) Determination of Young's modulus of a wire by Optical Lever Method.
6) Determination of modulus of rigidity of a wire using Maxwell's needle.
7) Determination of elastic constants of a wire by Searle's method.
8) Determination of value of g using bar pendulum.
9) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, AsiaPublishing House.
2) Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India
3) Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. practical physics, Geeta Sanon, R. Chand, 2016

Essential Readings:

FOR THEORY COMPONENT

1) Schaum's Outline of Vector Analysis, 2nd Edn., Murray Spiegel, Seymour Lipschutz, Tata McGraw-Hill, (2009)
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e, Charles Kittel, et. al., 2017, McGraw Hill Education
4) Mechanics, D. S. Mathur and P. S. Hemne, 2012, S. Chand.

.**Suggestive Readings:**

1) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
2) University Physics, H. D. Young and R. A. Freedman, 14/e, 2015, Pearson Education.
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
4) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.

COMMON POOL OF GENERIC ELECTIVES
OFFERED BY DEPARTMENT OF CHEMISTRY

GENERIC ELECTIVES -12: Coordination and Organometallic Compounds

Credit 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		
Coordination and Organometallic Compounds (GE-2)	4	2	0	2	Class XII Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce students to some important d-block metals and their compounds which they are likely to come across.
- To make students learn about organometallic compounds, a frontier area of chemistry providing an interface between organic and inorganic chemistry.
- To familiarize students with coordination compounds which find manifold applications in diverse fields.

Learning outcomes

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of tetrameric methyl lithium and understand the concept of multicenter bonding in these compounds
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Use IR data to explain the extent of back bonding in carbonyl complexes
- Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Understand the properties of coordination compounds and VBT and CFT for bonding in coordination compounds

- Explain the meaning of the terms Δ_o, Δt, pairing energy, CFSE, high spin and low spin and how
- CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy

Theory:

Unit 1: Coordination Chemistry **4 Hours**

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit 2:Bonding in coordination compounds **14 Hours**

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_o.

Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Unit 3: Organometallic Compounds **12 Hours**

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene. 18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Practicals: **60 Hours**

1. Gravimetry

Discuss basic principles of gravimetry (precipitation, co-precipitation and post precipitation, digestion, washing etc)

(i) Estimation of Ni(II) using dimethylglyoxime (DMG).
(ii) Estimation of copper as CuSCN.
(iii) Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

2. Inorganic Preparations

(i) Schiff's base involving ethylenediamine and salicylaldehyde (or any other amine and aldehyde/ketone) and to check its purity using TLC.

(ii) Nickel/ Copper complex of the above prepared Schiff's base and its characterisation using UV/Vis spectrophotometer. The IR spectra also to be interpreted

(iii) tetraamminecopper (II) sulphate

(iv) potassium trioxalatoferrate (III) trihydrate.

(v) tetraamminecarbonatocobalt(III) nitrate

References:

Theory:

1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
2. Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), **Inorganic Chemistry**, Pearson.
3. Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
4. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry.** John Wiley & Sons.
5. Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry** Wiley-VCH.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Schiff Base Complex of Cu (II) with Antibacterial and Electrochemical Study, Arjun C. Bhowmick, Majharul I. Moim, Miththira Balasingam **, American Journal of Chemistry** 2020, 10(2): 33-37, DOI: 10.5923/j.chemistry.20201002.03

Keywords: Organometallic compounds, metal carbonyls, synergistic effect, Coordination compounds, VBT, Crystal field theory, Splitting of d levels, Dq

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

GENERIC ELECTIVES -13: – CHEMISTRY OF OXYGEN CONTAINING FUNCTIONAL GROUPS AND THEIR APPLICATIONS TO BIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Oxygen containing Functional Groups and their Applications to Biology (GE-5)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To teach the fundamental chemistry of oxygen containing functional groups.
- To establish these concepts typical reactions of alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives.
- To make students understand the relevance of oxygen containing functional groups to biology and the importance of these compounds in real world.

Learning outcomes

By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on reaction chemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Understand the applications of functional group chemistry to biology.

Syllabus - Theory:

Unit 1: Alcohols (upto 5 Carbon) **5 Hours**

Structure and classification of alcohols as 1^o, 2^o & 3^o, Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer Oxidation, Biological oxidation Reactions

Unit 2: Phenols **4 Hours**

Acidity of phenols and factors affecting their acidity, Reactions: Electrophilic substitution reactions, *viz.* nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation; Reaction due to OH group: Schotten-Baumann reaction

Unit 3: Aldehydes and Ketones (Aliphatic and Aromatic) **12 Hours**

Reactions: Nucleophilic addition, nucleophilic addition-elimination reaction including reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol condensation and its biological application, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemmensen reduction, Wolff Kishner reduction, Meerwein-Pondorff Verley reduction, enzyme-catalyzed additions to α,β-unsaturated carbonyl compounds.

Unit 4: Carboxylic acids and their derivatives (Aliphatic and Aromatic) **9 Hours**

Reactions: Hell-Volhard Zelinsky reaction, acidity of carboxylic acids, effect of substitution on acid strength, Claisen condensation and its biological applications, decarboxylation in biological systems, relative reactivities of acid derivatives towards nucleophiles, activation of carboxylate ions for nucleophilic acyl substitution reactions in biological systems, Reformatsky reaction, Perkin condensation.

Practicals: : **60 Hours**

Preparations: (Mechanism of various reactions involved to be discussed) (Recrystallization, determination of melting point and calculation of quantitative yields to be done in all cases)

1. Oxime of aldehydes and ketones

2. 2,4-Dinitrophenylhydrazone of aldehydes and ketones

3. Aldol condensation using green method.

4. Benzoin condensation using Thiamine Hydrochloride as a catalyst.

5. Alkaline hydrolysis of amide/ester.

6. Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) or one of the following phenols (*β*-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.

7. Identification of functional group for monofunctional organic compounds (Alcohols, phenols, aldehydes, ketones, carboxylic acids).

References:

Theory:

1. Sykes, P. (2005), **A Guide Book to Mechanism in Organic Chemistry**, Orient Longman.
2. Eliel, E. L. (2000), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Mehta B.; Mehta M. (2015), **Organic Chemistry**, PHI Learning Private Limited Bahl,
5. Bahl, A., Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
6. Bruice, Paula Y. (2020), **Organic Chemistry**, 8th Edition, Pearson.

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.

Keywords: Alcohols, Lucas Test, Phenol, Aldehydes, Ketones, Nucleophilic addition, nucleophilic addition – elimination, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Enzyme-catalysed reaction, Carboxylic acid, Claisen condensation

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

GENERIC ELECTIVES-14: MOLECULES OF LIFE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Molecules of Life (GE-6)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To deliver information about the chemistry of carbohydrates, proteins & enzymes and its relevance in the biological system using suitable examples.
- To place key emphasis on understanding the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural details.

Learning outcomes

By the end of the course, the students will be able to:

- Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.
- Gain an insight into the mechanism of enzyme action and inhibition.
- Understand the basic principles of drug-receptor interaction and SAR.

Syllabus - Theory:

Unit 1: Carbohydrates **12 Hours**

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2: Amino Acids, Peptides and Proteins **10 Hours**

Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by

Edman method) and C– terminal amino acid (with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl) & C-activating groups (only DCC) and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.

Unit 3: Enzymes and correlation with drug action **08 Hours**

Classification of enzymes and their uses (mention Ribozymes). Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, $-NH_2$ group, double bond and aromatic ring.

Practicals: **(60 Hours)**

1. Estimation of glucose by Fehling's solution.
2. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).
3. Study of the titration curve of glycine.
4. Estimation of proteins by Lowry's method.
5. Study of the action of salivary amylase on starch under optimum conditions.
6. Qualitative tests for amino acids, proteins and carbohydrates.
7. Separation and identification of mixture of sugars by paper chromatography.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry**, 9th Ed., W. H. Freeman Co Ltd.

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. **Manual of Biochemistry Workshop**, 2012, Department of Chemistry, University of Delhi.

Teaching Learning Process:

- Chalk and black board method. Along with pedagogy of flipped classroom

- Certain topics like mechanism of enzyme action and enzyme inhibition can be taught through audio-visual aids.
- Students should be encouraged to participate actively in the classroom through regular presentations on curriculum-based topics, peer assessment, designing games based on specific topics etc.
- As the best way to learn something is to do it yourself, practicals are planned in such a way so as to reinforce the topics covered in theory.

Assessment Methods:

- Graded assignments
- Class tests and Quizzes
- Class seminars by students on course topics with a view to strengthening the content through width and depth
- Continuous evaluation for the practicals
- End semester university theory and practical examination.

Keywords: Carbohydrates, point, Amino acids, Enzymes, SAR, Drug Receptor Theory

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

GENERIC ELECTIVES -15 : CHEMICAL KINETICS AND PHOTOCHEMISTRY

Credit 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		
Chemical Kinetics and Photochemistry (GE-8)	4	2	0	2	Class XII Pass	-----

Learning Objectives

- To make students learn about the fundamentals of chemical kinetics, rates of chemical reactions, complex reactions, theories of reaction rate and the laws of photochemistry aimed at understanding electronic transitions upon irradiation of electromagnetic radiation in UV-Vis region.

Learning outcomes

By the end of the course, the students will be able to:

- Understand the concept of rate of a reaction, order and molecularity of a reaction, various factors affecting the rate and theories of reaction rates.
- Students will be able to apply the learnt concepts in studying the reaction kinetics of various reactions.
- Understand the basic concepts of photochemistry, photochemical and photosensitized reactions and their role in biochemical systems.

Syllabus - Theory:

Unit 1: Chemical Kinetics **20 Hours**

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants), half–life of a reaction, general methods for determination of order of a reaction. kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms). Concept of activation energy and its calculation from Arrhenius equation. Theories of reaction rates: Collision theory and activated complex theory of bi-molecular reactions. Comparison of the two theories (qualitative treatment only)

Unit 2: Photochemistry **10 Hours**

Characteristics of electromagnetic radiation, Jablonski Diagram. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes.

Practicals: **(60 Hours)**

Chemical Kinetics

Study the kinetics of the following reactions by integrated rate method:

a) Acid hydrolysis of methyl acetate with hydrochloric acid.

b) Compare the strength of HCl and H2SO4 by studying the kinetics of hydrolysis methyl acetate.

c) Initial rate method: Iodide-persulphate reaction

d) Integrated rate method: Saponification of ethyl acetate.

e) Study the reaction kinetics of Iodination of acetone.

References:

Theory:

1. Castellan, G.W. (2004), **Physical Chemistry**, Narosa.

2. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 5, 6th Edition, McGraw Hill Education.

3. Kapoor, K.L. (2013), **A Textbook of Physical Chemistry**, Vol 6, 3rd Edition, McGraw Hill Education.

Practicals:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

Teaching Learning Process:

- Teaching Learning Process for the course is visualized as largely student-focused
- Transaction through an intelligent mix of conventional and modern methods
- Engaging students in cooperative learning.
- Learning through quiz design.
- Problem solving to enhance comprehension.

Assessment Methods: Assessment will be done on the basis of regular class test, presentations and assignments as a part of internal assessment during the course as per the curriculum. End semester university examination will be held for both theory and practical. In practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Keywords: Rate Law, Rate constant. Arrhenius Equation, Lambert-Beer's law, Jablonski Diagram

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

GENERIC ELECTIVES -16: BASICS OF POLYMER CHEMISTRY

Credit 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		
Basics of Polymer Chemistry (GE-10)	4	2	0	2	Class XII Pass	-----

Learning Objectives

- To help the student to know about the synthesis, properties and applications of polymers.

Learning outcomes

By the end of the course, the students will be able to:

- Know about classification of polymeric material.
- Learn about different mechanisms of polymerization and polymerization techniques
- Evaluate kinetic chain length of polymers based on their mechanism
- Differentiate between polymers and copolymers
- Learn about different methods of finding out average molecular weight of polymer.
- Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm)
- Learn properties and applications of various useful polymers in our daily life

Syllabus Theory:

Unit 1: Introduction to polymers **10 Hours**

Different schemes of classification of polymers, Polymer nomenclature, configuration and conformation of polymers, Molecular forces and chemical bonding in polymers, Texture of Polymers

Functionality and its importance:

Criteria for synthetic polymer formation, basic methods of polymerization processes and their mechanism: addition, condensation, Relationships between functionality, extent of reaction and degree of polymerization.

Unit 2: Properties of Polymers **10 Hours**

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).
Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity,
Morphology of crystalline polymers, Factors affecting crystalline melting point.
Molecular weight distribution and determination of molecular weight of polymers (Mn, Mw, etc.) by end group analysis, viscometry and osmotic pressure methods. Molecular weight distribution and its significance.

Unit 3: Preparation, properties and applications **10 Hours**

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl acetate), acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers: polyacetylene, polyaniline, poly(p-phenylene sulphide, polypyrrole, polythiophene

Practicals: **(60 Hours)**

Polymer Synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA).
2. Preparation of nylon 6,6
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resole resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight of polyvinyl propylidene in water by viscometry.
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis of polymethacrylic acid.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method.
2. Determine the melting point of crystalline polymer.
3. Measurement of glass transition temperature, T_g.s

References:

Theory:

1. Carraher,C. E. Jr. (2013), **Seymour's Polymer Chemistry**, Marcel Dekker, Inc.
2. Odian, G. (2004), **Principles of Polymerization**, John Wiley.
3. Billmeyer, F.W. (1984), **Text Book of Polymer Science**, John Wiley.
4. Ghosh, P. (2001), **Polymer Science & Technology**, Tata Mcgraw-Hill.
5. Lenz, R.W. (1967), **Organic Chemistry of Synthetic High Polymers**, Intersecience (Wiley).

Practical:

1. Allcock, H.R.; Lampe, F. W.; Mark, J. E. (2003), **Contemporary Polymer Chemistry**, Prentice-Hall.
2. Fried, J.R. (2003), **Polymer Science and Technology**, Prentice-Hall.
3. Munk, P.; Aminabhavi, T. M. (2002), **Introduction to Macromolecular Science,** John Wiley & Sons.
4. Sperling, L.H. (2005), **Introduction to Physical Polymer Science**, John Wiley & Sons.

Teaching Learning Process:

- Student centred teaching Learning process.
- Blend of conventional blackboard teaching and modern teaching learning tools
- Focus on real life applications of concepts
- Problem solving and quizzes for enhanced understanding of the concepts
- Engaging students in collaborative learning.
- Pre-lab learning of theoretical concept of the experiment.
- Performing the experiment, recording the data, calculating the result.
- Interpreting the result.
- Comparing the results of the class.
- Discussing the sources of error.

Assessment Methods:

- Class Tests at Periodic Intervals.
- Written assignment(s)
- Continuous evaluation of laboratory work and record file.
- Oral assessment, quizzes.
- Mock practical examination.
- Semester end University examination.

Keywords: Bonding, Texture, Polymerization, Crystallization, Properties, Applications.

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

GENERIC ELECTIVES 17: CHEMISTRY: MOLECULAR MODELLING, ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Credit 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		
Chemistry: Molecular Modelling, Artificial Intelligence and Machine Learning (GE-14)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To make students familiar with modernscientific machine (programming) language i.e., Python, Artificial Intelligence (AI) & Machine Learning (ML) and their potential applications in chemistry.
- To provide elementary ideas of the techniques prevailing in the field of AI and ML and their applications to research problems especially related to research and development of new materials and pharmaceutical compounds with desired properties.

Learning outcomes

By the end of the course, the students will be:

- Conversant with the Python Programming Language.
- Familiar with Elementary techniques of AI and ML
- Able to apply techniques of AI & ML in basic problems of research in some important areas of research in Chemistry.

Syllabus Theory:

Part A: Molecular Modelling

Introduction to computational chemistry: **7 Hours**

Overview of Computational Methods in Chemistry (Ab initio, DFT, Semi- empirical, Molecular Mechanics

Potential Energy Surfaces **4 Hours**

The concept of Potential energy surface, Intrinsic Reaction Coordinates, Stationary points, Equilibrium points – Local and Global minima, Geometry optimization and energy minimization.

Molecular Mechanics **4 Hours**

Force Fields (A brief idea of a basic force field), Elementary idea of MM1, MM2, MM3, MM4, MM+, AMBER etc. A brief Idea of Molecular Docking

Part B: Artificial Intelligence & Machine learning in Chemistry **15 Hours**

An overview of computationally readable and processible representationof molecules, e.g., SMILES, mol files. Chemical space and access to chemical databases. Statistical treatment of data: regression analysis andtypes of regression. Elementary Idea of Quantitative structure-activity relationship (QSAR).

An insight into Artificial Intelligence & Machine learning and potentialareas of applications in chemistry. Dimensional reduction; Principal Component Analysis (PCA) and the importance and necessity of nonlinearity in Artificial Intelligence.

Genetic algorithm, basics of random mutation hill climbing (RMHC) and simulated annealing.

Practicals: **(60 hours)**

Molecular Modeling based Exercise

1) Write the Z-Matrix of a given set of molecules.

2) Carry out geometry optimisation on H_2O, H_2S, H_2Se molecules and compare the optimized bond angles and dipole moments from the results obtained. Obtain the ESP-mapped density surfaces and interpret the results obtained with reference to bonding in these molecules.

Suggestive: A comparative analysis of results of the above exercise may be carried out using different quantum mechanicalmethods.

3) Calculate the energy of the following chemical species andarrange them in order of increasing stability.

1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3- methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.

4) Carry out the geometry optimisation on the following chemical species and compare the shapes and dipole moments of the molecules.

1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2- propanol.

Correlate the computationally obtained values of the dipolemoments with the experimental values of the boiling points: (118ºC, 100 ºC, 108 ºC, 82 ºC, of 1-butanol, 2-butanol, 2-methyl-1- propanol, and 2-methyl-2- propanol respectively).

5) Based on the implicit electronic structure calculations, determine the heat of hydrogenation of Ethene.

6) Based on the calculations of enthalpies of the participating chemical species on

optimized geometry of the molecules, calculate the reaction enthalpy at 298 K for the following,industrially important reactions:

$CH_4 + H_2O \rightarrow CO + 3H_2$ (steam reforming of methane)

$N_2 + 3\ H_2 \rightarrow 2NH_3$ (Haber-Bosch process)

7) Carry out geometry optimisation and determine the energy of the participating chemical species in the following reactions Using these results calculate the resonance energy of thiophene.
8) Carry out geometry optimization & energy calculations on the following species and obtain Frontier Molecular Orbitals. Visualize the Molecular Orbitals of these species and interpret the results for bonding in these molecules.

Benzene, Naphthalene, and Anthracene.

9) Compare the gas phase basicities of the methylamines by comparing the enthalpies of the following reactions:
10) On the basis of results of geometry optimization and energy calculations, determine the enthalpy of isomerization of cis andtrans 2-butene.
11) QSAR based exercise on problems of interest to chemist.
12) Perform a conformational analysis of butane. Plot the graph between the angle of rotation and the energy of the conformers using spreadsheet software.
13) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
14) Perform a geometry optimization followed by a frequency assessment (opt+freq keyword) using the B3LYP method and 6-31-G(d) basis set on a given set of small molecules i.e. BH_3, CH_4.

Suggestive: A greater number of molecules may be studied as per instructions received from the concerned teacher.

15) Based on the fundamentals of conceptual DFT calculate the ionization potential (IP), electron affinity (EA), electronegativity and electron chemical potential of a given set of molecules.
16) Perform molecular docking of Sulfonamide-type D-Glu inhibitor into MurD active site using Argus lab.

Artificial Intelligence (AI) and Machine Learning (ML) based exercise on problems of interest to chemist

17. Travelling salesman problem and electrical circuit design (minimization of path-length).
18. Genetic algorithm, in solving matrix form of linear equations
19. Non-linear least-square fitting problem.
20. Particle Swarm Optimization on the sphere function.

Important Instruction Note on working approach:

- A student is required to perform/investigate a minimum of 10 exercises in total.
- The exercises mentioned above will be performed by the student strictly in accordance with the instructions received and only under the supervision of the teacher concerned.
- Any other exercise may be carried out with prior permission, input, discussion and instructions received from the teacher concerned.

References:

1. Lewars, E. (2003), **Computational Chemistry**, Kluwer academicPublisher.
2. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
3. Cartwright C.; Kharma N., (2008), **Using artificial intelligence in chemistry and biology**, First Edition, CRC Press Taylor & Francis Group
4. Hippe; Z., **Artificial Intelligence in Chemistry: Structure Elucidation and Simulation of Organic Reactions**, (1991) Academic Press, Elsevier
5. Soft Computing in Chemical and Physical Sciences A Shift in Computing Paradigm (Kanchan Sarkar, Sankar Prasad Bhattacharyya) (z-lib.org)
6. Understanding Properties of Atoms, Molecules and Materials (PRANAB. SARKAR, Sankar Prasad Bhattacharyya) (z-lib.org)

Web Resources:

1. https://www.afs.enea.it/software/orca/orca_manual_4_2_1.pdf
2. https://dasher.wustl.edu/chem430/software/avogadro/learning-avogadro.pdf
3. http://www.arguslab.com/arguslab.com/ArgusLab.html
4. https://barrett- group.mcgill.ca/tutorials/Gaussian%20tutorial.pdf
5. https://gaussian.com/techsupport/
6. https://gaussian.com/man/
7. https://gaussian.com/wp-content/uploads/dl/gv6.pdf
8. https://dasher.wustl.edu/chem478/software/spartan-manual.pdf
9. http://www.mdtutorials.com/gmx/
10. https://vina.scripps.edu/manual/

Teaching Learning Process: Hands-on laboratory exercises Conventional teaching learning method. Engaging students in collaborative learning

Keywords: Molecular Modeling, Potential Energy Surface (PES), Geometry Optimization, Frequency calculation, Artificial Intelligence, Machine Learning, Nural Networks, Genetic Algorithm.

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

GENERIC ELECTIVES 18: ROLE OF METALS IN MEDICINES

Credit 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		
Role of Metals in Medicines (GE-16)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To make the learners familiar about role of metal ions in some commercially available medicines.

Learning outcomes

By the end of this course student will be able to learn:

- Role of metal ions in various biomolecules and their functions.
- Role of metals in commercially available medicines and their functions

Syllabus Theory:

Unit 1: Bio role of Metals **04 Hours**

Brief introduction of following metals in biological system
Fe, Cu, Zn, Mn, Cr(III), V, Mo, W, Co, Ni, Na, K, Mg and Ca
Chemical structure, Commercial name, Name of the disease it is made for and its brief mechanism of action shall be taught for all the mentioned metals below.

Unit 2: Diagnostic and therapeutic agents **08 Hours**

Diagnostic and therapeutic agents with Pt (Cisplatin) and Ga for cancer, Au (auranofin) for arthritis and V for diabetes.

Unit 3: Metals in drugs **06 Hours**

Li_2CO_3 (Camcolit) for manic-depressive illness, $NaHCO_3$ (Alka-seltzer) for heartburn, $Al(OH)_3$ (Gaviscon) for heartburn, As (melarsoprol) for sleeping sickness, Bi subsalicylate (pepto-Bismol) for heartburn and diarrhea, Bi subcitrate (De-nol) peptic ulcer, Zinc oxide with Fe_2O_3 (Calamine lotion) as antimicrobial agent.

Unit 4: Metals in Multivitamins **06 Hours**

Cyanocobalamin (Co), Ferrous fumerate (Fe), Magnesium oxide (Mg), Zinc Sulfate (Zn), Manganese sesulphate (Mn), Copper Sulfate (Cu), Sodium selenite (Se) and Chromium trichloride (Cr).

Unit 5: Radiopharmaceuticals and MRI contrast agents **06 Hours**

^{99m}Tc for heart, brain and bone imaging, ^{123}I radiopharmaceuticals, $BaSO_4$for X-ray contrast agent, Gd (III) for MRI contrast agents.

Practicals: **(60 hours)**

Volumetric titrations:

1. To estimate the acidity of commercially available antacids.
2. To estimate the concentration of Fe in commercially available medicines.
3. To estimate the concentration of Ca in commercially available medicines.
4. To estimate the strength of carbonate in tablets containing Li_2CO_3
5. To estimate the sodium bicarbonate in synthetic/commercially available drug.
6. To estimate the zinc and iron present in Calamine lotion.
7. To estimate the Mg present in multivitamins.

References:

1. **Metals in Medicine**, John Wiley & Sons Ltd, Nov 2009
2. Chapter-9, **Metals in Medicine**, Stephen J. Lippard
3. Jones, Chris and Thornback, John, **Medicinal applications of coordination chemistry**, Cambridge, UK: Royal Society of Chemistry, 2007

Teaching Learning Process:

- Hands-on laboratory exercises
- Conventional teaching learning method. Engaging students in collaborative learning

Assessment Methods:

- Continuous evaluation of laboratory work and record file. Oral assessment, quizzes.
- Presentation on lab practices.
- Semester end examination.

Key words: Diagnostic, therapeutic agents, multivitamins, radiopharmaceuticals and MRI contrast agents.

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

GENERIC ELECTIVES -19: ENERGY AND THE ENVIRONMENT

Credit 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		
Energy and the Environment (GE-17)	4	3	0	1	Class XII Pass	---

Learning Objectives

- To develop basic understanding of energy, issues related to energy, importance of energy in terms of economy, health and the environment.
- To understand different sources of energies, renewable and non-renewable sources of energy. To understand the importance of green fuels.
- To make the students understand the adverse effect of pollution, and possible remediations.

Learning Outcomes

By the end of this course student will be able to learn:

- Describe basic energy concepts
- Account for conventional and renewable energy technologies and their application
- Reflect and evaluate the environmental impact of energy production and the relationship between energy production, consumption and climate change
- Reflect on energy costs, analyse the consequences of today's energy consumption
- Efficient use of energy, water and other resources, Use of renewable energy, such as solar energy
- Pollution and waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality, Use of materials that are non-toxic, ethical and sustainable
- Consideration of the environment in design, construction and operation

Syllabus Theory:

Unit 1: **13 Hours**

Introduction, chemistry and energy, conversion of chemical energy to electrical energy, Carbon cycle, Greenhouse gases, Global warming and climate change, Carbon footprint, zero-carbon or low-carbon energy. Electrical energy and steam energy, Energy Alternatives, Hidden Costs of Energy.

Unit 2: **10 Hours**

Production methods for electric power: Non-Renewable (conventional) sources of energy: Fossil fuels: Coal, petroleum and Natural gas. Energy transformation. Renewable energy sources: solar, hydropower, wind, geothermal, wave, ocean thermal, tidal, ocean currents, nuclear energy, biomass.

Unit 3: **12 Hours**

Production methods for electric power: Renewable (green) energy, conversion and storage systems. Nuclear fusion, Hydrogen fuels, photovoltaic solar cells, hydroelectric. Sustainable energy, biomass, Biofuels, production of biofuels, advantages, blending of biofuels with conventional fuels, Carbon Capture and Reuse, Waste to Energy Technologies.

Unit 4: **10 Hours**

Air Pollution, Urban and Indoor Air Pollution, Pollution and waste reduction measures, chemical remediation of air pollution. Effect of pollution on health and economy.

Practicals: **(30 Hours)**

Tutorials

1. Conversion of biomass to biofuels (2-3 different biofuels)
2. Working on solar cell model.
3. Working on wind turbine model.
4. Working on geothermal energy model.
5. Working on hydroelectric plant model.
6. Presentations by students

References:

Theory

1. Rao, C S., **Environment pollution control Engineering**, New Age International reprint 2015, 2nd edition
2. Bharucha, E., **Textbook of Environmental Studies**, Universities Press (2005)
3. Wright, R.T., **Environmental Science-Towards a sustainable Future**, Prentice Hall (2008) 9th edition.
4. Ahluwalia, V. K., **Energy and Environment**, The Energy and Resources Institute (TERI) (2019).

References:

Practicals

- Challapalli Narayan Rao, **Practical approach to implementation of Renewable Energy Systems,** Evincepub Publishing, 2022

Keywords: Energy, Renewable and non-renewable energy resources, Synthetic fuels, Biofuels, Carbon footprint, air pollution, remediation, pollution related health and economy.

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

GENERIC ELECTIVES -20 : CHEMISTRY OF FRAGRANCES AND FLAVOURS: AN INDUSTRY'S PERSPECTIVE

Credit 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		
Chemistry of Fragrances and Flavours: An Industry's Perspective (GE-18)	4	3	0	1	Class XII Pass	----

Learning Objectives

- To make the students understand the applications of chemistry in the world of flavours and fragrances. The use of fragrance is ubiquitous and is a global human phenomenon. Over the course of time, countless numbers of flavors and fragrances have found their way into everyday life, notably into foods, beverages and confectionery items; into personal care products (soaps, toothpastes, mouthwashes, deodorants, bath lotions and shampoos), perfumes, and other cosmetics as well as pharmaceutical formulations. Indeed, flavors and aromas are added to make such products more attractive or to mask the taste or smell of less pleasant ones.

Learning Outcomes

By the end of this course student will be able to learn:

- Synthesis of various fragrance and flavour ingredients
- Formulation methods, how different factors affects the formulation process in Fragrance and Flavour industry
- Uphold safety regulation and execute quality processes
- Quality control in manufacturing process, legal aspects, classification of odour and odorants.
- Different methods used for separation, purification and isolation of perfumes and flavours like distillation, extraction, crystallization, etc.

Syllabus Theory:

Unit 1: Fragrances **18 Hours**

- Introduction to fragrances, types of fragrances (Fragrance families and classification)
- History of perfumes, Perfumery raw materials, classification of odour, odour type and odorants
- India in the context of Fragrance Industry
- ABCs of perfumery, odour aspects of perfumes, fragrance pyramid, fragrance families
- Some basic chemical knowledge to provide a better understanding of the structure of molecules possessing a sensory power, The volatility and solubility of sensory molecules
- Chemistry of aromatic compounds in perfume making, Composition of fragrances
- Current trends in fragrances, sensory analysis of different products
- Study of the raw materials used in perfumery (origin, extraction method, and olfaction)
- Key chemical reactions for conversion of raw materials to fragrances
- Extraction of essential oils used in perfumery
- Difference between alcohol and oil-based perfumes
- Outline of health, safety and sustainability parameters in perfumer

Unit 2: Sustainable Fragrance by Design **4 Hours**

- The challenges of sustainability and how it impacts the industry
- Sustainability charter
- Green chemistry principles
- Commitment to Biodiversity

Unit 3: Flavours **18 Hours**

- Introduction to flavours, types of flavours, flavour raw materials
- Understanding of terms like, Flavour and Flavouring agents. Attributes of flavour, taste, odour, odour stimulation, basic tastes and the human olfactory system.
- Stability of flavour in food, sensory evaluation of flavours in foods, Various flavour formulation
- Systematic approach to understanding flavour formation during food processing, food matrix, interaction of added flavours
- Flavour enhancers, modifiers, precursors, suppressors, solvents.
- Key chemical reactions for conversion of raw materials to flavours
- Forms of flavour and the manufacturing processes involving all types of flavours. Aroma recovery during processing.
- Biogenesis of flavours in fruits and vegetables, reaction flavours, off flavours.
- Stability of flavor in food, sensory evaluation of flavours in foods
- Selection and application of flavours in foods and beverages
- Legal aspects (natural flavours and natural flavouring substances, nature identical flavouring substances, artificial flavouring substances), and the FSSA act.

Unit 4: Extraction, Isolation and Purification of Perfumes and Flavour Compounds

05 Hours

- Extraction techniques for the separation of volatile oils from natural source-including. Distillation, Evaporation, Crystallization and Adsorption, supercritical fluid extraction methods of isolation of important ingredients

Practicals: (30 hours)

1. Extraction of D-limonene from orange peel using liquid CO_2.
2. Extraction of caffeine from coffee beans using liquid CO_2.
3. Extraction of essential oils from lemon using steam distillation
4. Extraction of essential oils from lemon using liquid CO_2.
5. Extraction of essential oils from fragrant flowers.
6. Determination of esters by Thin Layer Chromatography
7. Memorisation of different raw materials used in perfumery, perfume language, Memorisation of perfumes
8. Testing up of different flavours
9. Analysis of spectra of perfume formulations.

References:

1. Arctander, S. (2008), **Perfume and flavour materials of Natural origin,** Allured Publishing Corporation, USA
2. Arctander, S. (2017), Volume I and II, **Perfume and Flavour Chemicals**, (Aroma Chemicals), Allured Publishing Corporation, USA
3. Curtis,T.; Williams, D. C.(2001) 2nd Edition, **An Introduction to Perfumery**, Micelle Press, USA.
4. Sell,C. (2008), **Understanding Fragrance Chemistry,** Allured Publishing Corporation, USA
5. Calkin,R.R., Jellinek, J.S., **Perfumery: Practice and Principles,** John Wiley & Sons Inc.
6. Gimelli, S.P. (2001), **Aroma Science,** Micelle Press, USA
7. Arctander, S. (2019), **Perfume and Flavour Materials of Natural Origin,** Orchard Innovations
8. https://www.beyondbenign.org/lessons/essential-oil-extraction-using-liquid-co2/

Keywords: Fragrances, Flavours, pharmaceutical formulation, distillation, extraction techniques

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

GENERIC ELECTIVES -21 : GREEN CHEMISTRY

Credit 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		
Green Chemistry (GE-20)	4	2	0	2	Class XII Pass	----

Learning Objectives

Huge rise in environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up has forced the society to become more and more environmentally conscious. Future chemists and innovators are compelled to work towards sustainable practices. Green chemistry has arisen from these concerns. It is not a new branch of chemistry but helps to improve the creative and innovative thinking in undergraduate students. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Innovations and applications of green chemistry in education have helped companies to gain environmental benefits as well as to achieve economic and societal goals also. Undergraduate students are the ultimate scientific community of tomorrow. Training them to practice chemistry in the safest way possible is key towards safe working conditions in the laboratories as well as the chemical industry and extends to society in a sustainable future for the planet.

Learning Outcomes:

By the end of this course, students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- Appreciate the use of catalyst over stoichiometric reagents
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.
- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD)
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry

Syllabus :

Unit 1: Introduction **08 Hours**

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

• Need of green chemistry

• Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).

• A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit 2: Twelve Principles of Green Chemistry **12 Hours**

The twelve principles of the Green Chemistry with their explanation, Special emphasis on the following:

• Prevention of waste / byproducts, pollution prevention hierarchy.

• Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.

• Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.

• Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

• Green energy and sustainability.

• Real-time analysis for pollution prevention.

• Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation

Unit 3: **10 Hours**

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical: **(60 Hours)**

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.

2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using *p*-toluidine and *o*-vanillin/*p*-vanillin.
6 Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (*cis-trans* isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

References:

Theory:

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry, American Chemical Society**, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practical:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
4. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
5. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

6. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Keywords: Green chemistry, Twelve principles of green chemistry, Atom economy, Waste minimization, green metric, green solvents, Solvent free, Catalyst, Bio-catalyst, Renewable energy sources, Hazardous, Renewable feedstock, Ionic liquids, Supercritical fluids, Inherent safer design, green synthesis, combinatorial, Sustainable development, Presidential green chemistry awards.

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

BHASKARACHARYA COLLEGE OF APPLIED SCIENCE

Category I

B.Sc. (Honours) Polymer Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry and Engineering of Polymer Reactions (CEPR)	4	3	0	1	12^{th} with PCM	--

Learning Objectives

- To learn about the different polymerizations
- To study kinetics of chain growth and step growth polymerization
- To understand general concepts, principles, kinetics and methodology of polymerization

Learning outcomes

The Learning Outcomes of this course are as follows:

- Know about overview of aspects of polymer engineering
- Understand essential fundamentals and chemistry of the polymerization processes.
- Learn about various terms such as reaction initiation, propagation and termination

SYLLABUS OF DSC-4

UNIT – I **06 Hours**

INTRODUCTION

Introduction to polymerization process, control of polymer synthesis; thermodynamic and kinetic control, diffusion control, polymer end chain control & control strategies, Introduction to reactor design, Interpretation of batch reactor data; design equations for ideal reactors, namely batch, CSTR, plug flow, design equation for single reaction systems using batch and semi batch, CSTR, PFR, Multiple reactor system; reactor in series and parallel, preference of type of reactor used

UNIT – II **09 Hours**

RADICAL CHAIN POLYMERIZATION

Introduction, thermodynamic and kinetic aspect of radical chain polymerization, rate of polymerization, kinetic chain length, Mayo's equation, cage efficiency, selection criteria of initiators, ceiling temperature, Tromsdorff effect, inhibition and retardation Ziegler-Natta catalyst and stereoregular polymerizations, Radical chain copolymerization (reactivity ratio, copolymer equations)

UNIT – III **06 Hours**

REDOX & OTHER INITIATIONS

Initiation in aqueous media, initiation in non-aqueous media, rate of redox polymerization, photochemical initiation, rate of photo-polymerization, initiation by ionizing radiation, electrolytic polymerization, plasma polymerization.

UNIT – IV **09 Hours**

IONIC CHAIN & CONTROLLED POLYMERIZATIONS

Classification of ionic species, effect of solvents, initiation, propagation and termination in ionic polymerization, cationic polymerization, anionic polymerization, introduction of Atom Transfer Radical Polymerization (ATRP), Reversible Addition-Fragmentation Chain Transfer Polymerization (RAFT) and Nitroxide mediated polymerization (NMP)

UNIT – V **09 Hours**

STEP GROWTH POLYMERIZATION

Reaction engineering of step growth polymerization: basic properties & examples of commercially important polymers, reactivity of functional groups kinetics of step polymerization, self-catalyzed & external catalysis of polymerization, molecular weight distribution in linear & nonlinear polymerization, effect of non-equivalence of functional groups, equilibrium considerations,

UNIT – VI **06 Hours**

POLYMERIZATION TECHNIQUES

Bulk, solution, precipitation, suspension & emulsion polymerization.

Practical - 30 Hours

- To prepare polystyrene/poly(methyl methacrylate) by bulk polymerization and determine the rate of polymerization.
- To study the effect of reaction temperature on free radical polymerization of styrene/MMA.
- To study the effect on initiator concentration of free radical polymerization of styrene/MMA.
- Redox initiated polymerization of MMA & investigate the effect of viscosity on polymerization kinetics
- Redox polymerization of acrylamide
- To investigate Trommsdorff effect in bulk polymerization of MMA
- Solution polymerization of methyl methacrylate/styrene.
- Suspension polymerization of styrene/MMA.
- Emulsion polymerization of styrene/ methyl methacrylate.
- Preparation of Poly (vinyl butyral).

Essential/recommended readings

- Odian, G., (2004) Principles of Polymerization, Wiley-interscience.
- Billmeyer F.A., (2011) Textbook of Polymer Science, John-Wiley & Sons.
- Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
- Flory P.J., (2007) Principles of Polymer Chemistry, Asian Books Private Limited.
- Levenspiel, O. (1998). Chemical reaction engineering. John Wiley & Sons.

Suggestive readings

- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Lenz, R. W. (1967). Organic chemistry of synthetic high polymers.
- Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rd Edition

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

DISCIPLINE SPECIFIC CORE COURSE – 5: POLYMER RHEOLOGY (PR)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMER RHEOLOGY (PR)	4	3	0	1	12th Pass	---

Learning Objectives

- To enhance fundamental knowledge of flow behaviour of polymer melts
- To understand the concept of mixing of polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of measurement of viscosity in handling of rheological instruments
- Interpret rheology of polymer melts by mechanical models

SYLLABUS OF DSC- 5

UNIT – I **(12 Hours)**

RHEOLOGICAL PRINCIPLES

Viscosity and polymer processing, rheological properties of fluids, shear stress in polymers, Newtonian & non-Newtonian flow, polymer melt viscosities (ideal molten chains, microscopic studies of melts), flow in channels, simple shear flow, melt-flow index, Weissenberg effect, die swell, melt fracture, creep & creep compliance, stress relaxation, isochronous stress-strain curves

UNIT – II **(15 Hours)**

MELT FLOW ANALYSIS

Types of fluid & rheological models, rheological measurements by capillary, parallel plate and cone & plate viscometers, simple elongational flow and its significance, dynamic flow behavior, time dependent fluid behavior

UNIT – III **(09 Hours)**

RHEOLOGICAL MODELS

The elastic and viscoelastic state of polymers – viscoelasticity, viscoelastic models: Maxwell model, Voigt-Kelvin model, Boltzmann superposition principle, dynamic mechanical testing

UNIT – IV **(09 Hours)**

MIXING OF POLYMERS

Types of mixing, concept and importance of master batches, mixing of additives with the polymers, melt compounding

Practical - **30Hours**

- Determination of melt flow index of a polymer such as PP, PS, LDPE etc.
- Determination of intrinsic viscosity by Ubbelohde viscometer.
- Determination of rheological properties of polymer melts by rheometers.
- Measurement of resin/paint viscosity by Ford cup 4.
- Measurement of dynamic viscosity by Brookfield Viscometer.
- Compounding of polymers and investigation of their rheological behavior.
- Industry/R&D organization visit.

Essential/recommended readings

- Gupta B.R., (2004) Applied Rheology in Polymer Processing, Asian Books.
- Rosen S.L., (2012) Fundamental Principles of Polymeric Materials, Wiley-Interscience.
- Ghosh P., (2010) Polymer Science and Technology of Plastic and Rubber, Tata McGraw Hill.
- Aklonis J., Macknight W.J., (2005) Introduction to Polymer Viscoelasticity, John Wiley & Sons
- Middleman, S. (1968). Flow of high polymers; continuum and molecular rheology.

Suggestive readings

- Bird R.B., Armstrong R.C., Hassager O., (1977) Dynamics of Polymeric Liquids (volume 1), John Wiley & Sons, New York.
- Shaw M.T., (2012) Introduction to Polymer Rheology, John Wiley & Sons.
- Dealy, J. M., & Wissbrun, K. F. (2012). Melt rheology and its role in plastics processing: theory and applications. Springer Science & Business Media.
- Hiemenz, P. C., & Lodge, T. P. (2007). Polymer chemistry. CRC press.

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

DISCIPLINE SPECIFIC CORE COURSE – 6: POLYMER TECHNOLOGY(PT)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMER TECHNOLOGY(PT)	4	3	0	1	12th Pass	-

Learning Objectives

- To learn about the production, properties and applications of thermoset and thermoplastic polymers
- To learn about the chemistry and manufacturing of flexible and rigid polyurethane foams
- To understand the modification of unsaturated polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn preparation of thermoplastic polymers
- Learn preparation of thermosetting polymers
- Apply the knowledge of polymer synthesis to obtain polymers with desired properties

SYLLABUS OF DSC-6

UNIT – I **(27 Hours)**

THERMOPLASTIC POLYMERS

Manufacturing process, properties and applications of the following polymers:

- Polyethylene (LDPE,LLDPE,VLDPE, HDPE)
- Polypropylene and related copolymers
- Polystyrene ABS, HIPS and related copolymers
- Poly (vinyl chloride) and related copolymers
- Poly (vinyl acetate) and related polymers
- Acrylic polymers (PMMA,PEA, PAA, PAN, Polyacrylamide)
- Aliphatic polyamides (Nylon 6, Nylon 66, Nylon 6,10)
- Polyester (PET, PBT)

UNIT – II **(18 Hours)**

Manufacturing process, curing, properties, and applications of the following polymers:

- Unsaturated polyester resins

- Phenol formaldehyde resins (resols and novolacs)
- Urea and melamine formaldehyde resins
- Epoxides
- Polyurethanes (Flexible & Rigid foams)

Practical - 30 Hours

- Preparation of PMMA bone cement.
- Preparation and testing of epoxy resins
- Preparation of Nylon 6,10 by interfacial polymerization
- Preparation of phenolic resin for adhesive applications.
- Preparation of unsaturated polyester resin and determination of molecular weight by acid value/hydroxyl value.
- Synthesis of copolymer of styrene & maleic anhydride, and styrene & MMA and determination of reactivity ratios.
- To prepare melamine formaldehyde product viz. crockery etc.
- Synthesis of Polyurethane Foams
- Preparation of sodium polyacrylate salt and poly(acrylic acid) from polyacrylamide.

Essential/recommended readings

- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Mittal Vikas, (2011) High Performance Polymers and Engineering Plastics, Wiley.
- Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
- Billmeyer F.A., (2011) Textbook of Polymer Science, John-Wiley & Sons.
- Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rd Edition

Suggestive readings

- Flory P.J., (2007) Principles of Polymer Chemistry, Asian Books Private Limited.
- Mark J.E. Erman B., Eirich F.R., (2005) The Science and Technology of Rubber, Elsevier Academic Press.
- Sperling, L. H. (2005). Introduction to physical polymer science. John Wiley & Sons.
- Crompton R.T., (1989) Molecular Motions in High Polymers, Pergamon Press N.Y.
- Crompton T.R., (1989) Analysis of Polymers, Pergamon Press N.Y.
- Treloar, L. R. G. (1983). Mechanical Properties of Solid Polymers, IM Ward, John Wiley & Sons Ltd, Chichester.

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

Category-IV

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

GENERIC ELECTIVES (GE-4): BIOMEDICAL APPLICATIONS OF POLYMERS(BAP)

Credit 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		
BIOMEDICAL APPLICATIONS OF POLYMERS (BAP)	4	2	0	2	12th Pass	---

Learning Objectives

- To acquire knowledge of biopolymer and biodegradation
- To gain knowledge of applications and testing of biopolymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concepts and requirement of biomaterials and biocompatibility
- Apply the knowledge of various biomaterials for a desired bio-application

SYLLABUS OF GE-4

UNIT – I **(06 Hours)**

BASICS OF BIOMATERIALS

Concept of biocompatibility and biodegradability, responsiveness, estimations of degradation and biocompatibility, Important biomaterials: hydrogel, fibres, bio-ceramics, bio-elastomers and membranes

UNIT – II **(04 Hours)**

POLYMERS AS BIOMATERIALS

Polyester and polysaccharides, natural gums, biodegradable polymers, polymers and hydrogels

UNIT – III **(10 Hours)**

BIOMATERIALS FOR ORGAN TRANSPLANTS AND TISSUE ENGINEERING

Properties and applications of polymers for organ transplant e.g. dental cement, orthopedic, skin, artificial kidney etc., basic concepts of tissue engineering, Important polymers for tissue engineering: cellulose, chitosan and alginates

UNIT – IV **(10 Hours)**

DRUG DELIVERY AND WOUND CARE

Introduction to drug delivery, polymers in controlled drug delivery, dressing strips, polymer drug vessels, core shell and nanogels, polymers for antimicrobial activity, bio-conjugates

Practical **- 60 Hours**

- Evaluate the biocompatibility of polymeric samples.
- Determination of the degradation behavior of polymers such as thermal, hydrolytic degradation etc.
- Preparation of membranes and measurement of absorption behavior.
- Preparation and characterization of dental cement.
- Preparation of a hydrogel and its characterization.
- Determination of tensile strength of biopolymers.
- Determine the swelling rate of biopolymers
- Preparation of nanogel and find its water absorption
- preparation and characterization of membrane for skin transplant

Essential/recommended readings

- Tiwari A., Tiwari A., (2013) Nanomaterials in drug delivery, Imaging and Tissue Engineering, Wiley.
- Pilla S., (2011) Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley.
- Ratner, Buddy D., Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons. "Biomaterials science: an introduction to materials in medicine." San Diego, California (2004): 162-4.
- Park, J. B., & Bronzino, J. D. (2002). Biomaterials: principles and applications. crc press.

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Suggestive readings

- Ratner D., Hoffman A.S., (1996) An Introduction to Materials in Medicine, Academic Press.
- Saltzman W.M., (2001) Drug delivery–Engineering principles for drug therapy, Oxford University Press.
- Kalia S., Averous L., (2011) Biopolymers: Biomedical and Environmental Applications, John Wiley & Sons.

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

GENERIC ELECTIVES (GE-5): POLYMERS FOR PACKAGING (PP)

Credit 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		
POLYMERS FOR PACKAGING (PP)	4	2	0	2	12th Pass	---

Learning Objectives

- To learn about the basic necessities and importance of packaging
- To acquire knowledge of various types of packaging materials

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apprehend the basic concepts of packaging and its utilization for desired applications
- Assess the quality of packaging material and packaged product

SYLLABUS OF GE-5

UNIT – I **(06 Hours)**

PACKAGING SYSTEMS

Types of packaging systems: box, bottle, tetra, pouch, shrink, vacuum, gas, controlled atmosphere packaging (CAP), modified atmosphere packaging (MAP), and aseptic packaging

UNIT – II **(08 Hours)**

POLYMERS IN PACKAGING

Properties and applications: LLDPE, LDPE, HDPE, HMHDPE, PP, PVC, nylons, polyester, polycarbonate, PS, EPS, PLA, PVA and Starch

UNIT – III **(08 Hours)**

PACKAGING PROCESS TECHNIQUES

Preparation of packaging materials by thermoforming, co-extrusion, extrusion-stretch blow molding, injection molding, BOPP films

UNIT – IV **(08 Hours)**

TESTING OF POLYMER PACKAGING MATERIAL

Bursting strength, tensile strength, tear strength, puncture test, impact test (Drop, falling dart), permeability test (water vapour, oxygen), biodegradability, sealing strength

Practical - 60 Hours

- To identify packaging materials with the help of FT-IR, DSC, TGA etc.
- Determination of physico-mechanical properties (density, burst strength, tensile strength, tear strength, puncture test strength, impact strength etc).
- Determination of water vapor transmission rate of packaging material.
- To test sealing strength integrity of packaging materials.
- To check biodegradability of packaging material.
- Preparation biodegradable packaging film
- Determination of water vapor transmission rate of packaging material.
- To test seal strength integrity of packaging materials.
- To check biodegradability of packaging material.
- To determine compatibility of film.

Essential/recommended readings

- Robertson G.L., (2005) Food Packaging Principles and Practice, CRC press.
- Paine F.A. and Paine H.Y., (1992) A Handbook of Food Packaging, Blackie Academic and Professional.
- Sharma S., Aggarwal M., Sharma D., (2019), Food Frontiers, New Delhi Publisher
- N. C. Saha, M. Garg, S. Dey Sadhu, A. K. Ghosh(2022) Food Packaging-Materials, Techniques and Environmental Issues" by published by Springer.
- Garg, M., Meena, P.L., Sadhu, S.D., Alam, T. (2019). Food Packaging: A Practical Guide : Viba Press Pvt. Ltd.

Suggestive readings

- Robertson G.L., (2012) Food Packaging–Principles and Practice, CRC Press.
- Coles R, McDowell D., Kirwan M.J., (2003) Food Packaging Technology, Blackwell.
- Sukhareva L.A., Yakolev V.S., Legonkova O.A., (2008) Polymers for packaging materials for preservation of foodstuffs, VSP.

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

GENERIC ELECTIVES (GE-6): POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS (PEEA)

Credit 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		
POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS (PEEA)	4	2	0	2	12th Pass	----

Learning Objectives

- To learn about basic concepts of polymer electrical and electronic properties
- To gain knowledge of electrical and electronics applications of polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Synthesize a conducting polymer for a specific application
- Apply the knowledge of properties of polymers required for electrical and electronics applications

SYLLABUS OF GE-6

UNIT – I **(08 Hours)**

INTRODUCTION TO POLYMERS

Petro polymers, conducting polymers, biopolymers, composites, Band diagram, processing of polymers, doping (chemical and ion), advantages and disadvantages of conducting polymers, limitations

UNIT – II **(08 Hours)**

PREPARATION OF CONDUCTING POLYMERS

Synthetic methods: chemical, electrochemical, photochemical etc. (polyaniline, polypyrrole, polythiophene, polyacetylene, etc.), methods to enhance the processability of conducting polymers

UNIT – III **(08 Hours)**

PROPERTIES

Dielectric strength, dielectric loss, charge storage capacity, electrical conductivity, heat capacity, magnetism, hysteresis loop, shape memory, mechanical properties, EMI shielding

UNIT – III **(06 Hours)**

ELECTRONIC APPLICATIONS

Semiconducting organic materials, polymer based electronic devices, organic field effect transistor, organic transistors, plastic solar cell, light emitting diode, supercapacitor, sensors etc.

Practical - **60 Hours**

- Preparation of conducting polyaniline and measurement of their conductivity.
- Preparation of polypyrrole and measurement of their conductivity.
- Preparation of polythiophene and measurement of their surface resistivity.
- Preparation and testing of conducting polymers for sensor applications.
- Measurement of multilayer insulation of a thin film.
- Measurement of dielectric strength of a polymer film.
- Measurement of mechanical properties of insulating cable
- Preparation polymer sample and analyzed its dielectric strength
- Preparation of a conducting polymer nanocomposites.
- Preparation polymeric semiconductor

Essential/recommended readings

- Skotheim T.A., Elsenbaumer R.L., Reynolds J.R., (1998) Handbook of conducting polymers, Vol. 1 and Vol. 2, Marcel Dekker.
- Nalwa H.S., (1977) Organic Conductive Molecules and Polymers, John Wiley & Sons.
- Bredas J.L., Silbey R., (1991) Conjugated Polymers: The Novel Science and Technology of Highly Conducting and Nonlinear Optically Active Materials, Kluwer Academic Publishers.
- Bikales M., Menges O.B., (1986) Encyclopedia of Polymer science and Engineering, Second Edition, Vol.5, John Wiley & Sons.

Suggestive readings

- Lyons M.E.O., (1994) Electroactive polymers, Plenum Press.
- Margolis J., (1993) Conducting Polymers and Plastics, Chapman & Hall.

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

DEPARTMENT OF ANTHROPOLOGY

Category-I
BSc. (Hons.) Environmental Science

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Human Origins and Evolution

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Origins and Evolution	4	3	0	1	12th Pass	----

Learning Objectives

1. The course will enhance students understanding of human variation in the light of human origins.
2. The course will help students to develop concepts pertaining to the relation of modern humans with living and non-living primates.

Learning Outcomes

Students will learn on evolutionary relationships of different extinct/hominids in the context of emergence of modern human beings. Students will also learn the gradual biological and behavioral processes of becoming human.

Syllabus:

Unit-1 **(12 Hours)**

Primate origins and radiation: phylogenetic relationships of living primates with special reference to Miocene hominoids

Unit-2 **(12 Hours)**

Australopithecines: distribution, features and their phylogenetic relationships. Appearance of genus Homo: Homo habilis

Homo erectus from Asia, Europe and Africa: Distribution, features and their phylogenetic status

Unit-3 **(12 Hours)**

The origin of Homo sapiens: Fossil evidences of Neanderthals.

Origin of modern humans (Homo sapiens sapiens): Archaic and Modern humans, Distribution and features

Unit-4 **(9 Hours)**
Hominization process: Bio-cultural Evolution

Practical – **30 Hours**

Craniometry:
a) Maximum Cranial Length
b) Maximum Cranial Breadth
c) Maximum Bizygomatic Breadth
d) Maximum Frontal Breadth
e) Minimum (Least) Frontal Breadth
f) Nasal Height
g) Nasal Breadth
h) Bi-Mastoid Breadth
i) Greatest Occipital Breadth
j) Upper Facial Height
k) Cranial Index
l) Nasal Index

Osteometry: Measurements of Human long bones (6)
Identification of casts of fossils of family hominidae: Drawing and comparison of cranial characteristics.

References

1. Indera P. Singh and Bhasin, M.K. (1968) Anthropometry. Kamla-Raj Enterprises, Chawri Bazar, Delhi.
2. Buettner-Janusch, J. (1966). Origins of Man: Physical Anthropology. John Wiley & Sons, Inc., New York, London, Sydney.
3. Craig Stanford et al. (2013). Biological Anthropology. Pearson, New York. [Unit-1: Page-261-300; Unit-2: Page-324-335; Unit-3: Page-342-375; Unit-4: Page-382-412; Unit-5 and 6: Page-418-441]
4. Nystrom P. and Ashmore P. (2011). The Life of Primates. PHI Learning Private Limited, New Delhi.
5. Seth P. K. and Seth S. (1986). The Primates. Northern Book Centre, New Delhi, Allahabad.
6. Singh I. P. and Bhasin M.K. (1989). Anthropometry: A Laboratory Manual on Biological Anthropology.
7. Stanford C.; Allen J.S. and Anton S.C. (2012). Biological Anthropology: The Natural History of Mankind.
8. Swindler D. R. (2009). Introduction to the Primates. Overseas Press India Pvt. Ltd., New

Keywords
Human origin, Primates, Australopithecine, Homo erectus and evolution

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

DISCIPLINE SPECIFIC CORE COURSE -5 (DSC-5) – : Fieldwork Traditions and Ethnography

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fieldwork Traditions and Ethnography	4	3	0	1	12th Pass	----

Learning Objectives:

- How ethnographers conceptualize, conduct, and analyse their research;
- The types of research practices for generating data
- The ethics of ethnographic research, in relationship to disciplinary history

Learning Outcomes:

- Ability to conduct ethnographic research
- Generate data and write field notes
- Analyse and interpret ethnographic data

Syllabus:

Unit 1 Fieldwork Tradition (12 Hours)

The emergence of fieldwork tradition in Anthropology; Ethnography, its Nature, Trajectories, Genres; Ethnography: Process and Product

Unit 2 Idea of Field (12 Hours)

Concept of field: Idea of Place and Space, and its changing contours, Multi-sited Ethnography and Virtual Spaces.

Unit 3 Doing ethnography (12 Hours)

Doing ethnographic Fieldwork: Fieldwork Identity; Rapport and Relations; Representation and Emotions; Ethical issues.

Unit 4 Field Methods and Writing (09 Hours)

Observation, Interview, Case Study, Life History, Genealogy, Sensory Ethnography, Reflexivity and Ethnographic Writing

Practical – 30 Hours

Designing Ethnographic Research: Identifying a problem, Defining the universe, Literature Review, selecting appropriate methods; doing Fieldwork: field diaries and field notes; Analysis and Writings.

1. Students are required to visit different field sites and come up with observational and experiential learnings
2. Presentations based on a Research Project

References

1. Clifford, J., & Marcus, G. E. (2011). *Writing culture: The poetics and politics of ethnography*. Berkeley, California: University of California Press.
2. O'Reilly, K. (2009). *Key Concepts in Ethnography (SAGE key concepts)*. Sage Publications.
3. Narayan, K. (2012). *Alive in the writing: Crafting ethnography in the company of Chekhov*. Chicago: University of Chicago Press.
4. Robben, C.G.M. and Jeffrey A. Sluka. (2012). Ethnographic Fieldwork: An Anthropological Reader. Oxford: Wiley-Blackwell.
5. Srinivasa, M. N., Shah, A. M., & Ramaswamy, E. A. (2008). *The fieldworker and the field*. New Delhi: Oxford University Press.
6. Srivastava, V. K. (2005). *Methodology and fieldwork*. New Delhi: Oxford University Press.

Keywords: Fieldwork, Ethnography, Ethics, Writing, Reflexivity

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

DISCIPLINE SPECIFIC CORE COURSE -6 (DSC-6) – : Human ecology and biological adaptation

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human ecology and biological adaptation	4	3	0	1	12th Pass	----

Learning Objectives

1. To introduce human ecology through biological perspectives where impetus will be laid on building a sense of awareness, empathy and understanding of existing environmental problems at various subsistence levels.
2. The course focuses on environmental matters that need attention on imperative basis.

Learning Outcomes

1. The students will be trained to identify biological adaptation strategies that can throw light on the resilient measures in different environmental stresses.
2. The students can be better equipped to understand the impact of various environments on everyday human life and can critically reflect on adoption of a healthy and sustainable environment.
3. The students can be encouraged to come up with innovative strategies to reduce the environmental menace created by humankind and aim towards a sustainable future.

Syllabus:

Unit I: Fundamentals of Human ecology (12 Hours)

- Human ecology and its interdisciplinary approaches
- Complexity and diversity of human population with respect to environment
- Concepts of human ecology and adaptation with special emphasis on biological dimensions

Unit II: Tools to understand human ecology (12 Hours)

- Methods of studying human ecology
- Indigenous knowledge for sustainability in various environments

Unit III: Human adaptation: Population and environment (12 Hours)

- Adaptation to various ecological stresses
- Ecological rules and their applicability to human populations

Unit IV: Human health and environment (09 Hours)

- Impact of various environments on human health
- Impact of urbanization and industrialization on humans

Practical – 30 Hours

A. *Size and Shape Measurements*:

1. Stature
2. Sitting Height
3. Body Weight
4. Total Upper Extremity Length
5. Total Lower Extremity Length
6. Nasal Breadth
7. Nasal Height

B. *Size and Shape Indices:*

1. Body Mass Index
2. Relative Sitting Height
3. Relative Upper Extremity Length
4. Relative Total Lower Extremity Length
5. Nasal Index

C. 1-2 public talks/workshops/project over the academic semester on research topics on human ecology and biological adaptation. These talks would bring students with brainstorming discussion on current issues.

References

1. H. Schutkowski. (2006) Human Ecology: Biocultural adaptations in Human communities, Springer Verlag, Germany (Unit 1).
2. Wilk. Richard and Haenn Nora (2006). The environment in Anthropology. New York University Press. NY. (Unit 2).
3. Ember and Ember (2014) Anthropology, Pearson publication, Hudson Avenue, New Jersey. (Unit 3)
4. Wilk. Richard and Haenn Nora (2006): The environment in Anthropology. New York University Press. NY. (Unit 4)

Teaching Learning Process

1. Classroom teachings
2. Seminars and presentations
3. Practical classes
4. Workshop

Keywords: adaptation, human ecology, ecological stresses, health

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

CATEGORY-IV

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

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE-7): Physical fitness, Activity and Performance

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Physical fitness, Activity and Performance	4	3	0	1	12th Pass	---

Learning Objectives:

The course is structured around the relevance of being physically fit in today's environment. It will further focus on increasing one's performance and activity through anthropological knowledge.

Learning Outcomes:

1. The students will learn about various components of health-related and skill related physical fitness.
2. The students will learn about the importance of physical fitness in performing and sustaining daily activities.
3. They will also learn about the relevance of physical fitness and performance in sports science and how it helps in designing the most appropriate athletic training program.
4. They will learn how anthropological knowledge is of immense importance in fitness and performance.

Syllabus

Unit I: Introduction to physical fitness and performance (12 Hours)

Definition, scope, and relevance of physical fitness and performance, ways to improve physical fitness and performance, various types of physical fitness and performance test

Unit II: Measure of physical fitness and performance (12 Hours)

Cardiovascular endurance, Muscular strength, Muscular endurance, Flexibility, Body composition, skill related components of physical fitness

Unit III: Physical fitness and performance in sports and health science (12 Hours)

Importance of physical fitness and performance in preventing chronic and lifestyle disease, talent identification in sport science by determining an athlete's strengths and weaknesses, doping and performance.

Unit IV: Anthropological knowledge in physical fitness and performance (09 Hours)

Relevance of anthropology in studying physical fitness, activity and performance, understanding physical fitness and performance by taking into consideration the ethnic and racial differences

Practical – 30 Hours

1. Physical fitness and performance test
2. **Physiological Measurements**- Blood pressure, Heart rate, Pulse rate
3. **Somatometric Measurements-** Height, weight, skinfolds, hip circumference, waist circumference, mid-upper arm circumference, neck circumference, calf circumference, thigh circumference

1-2 workshops/projects over the academic semester on topics related to anthropology. It would bring students to brainstorming discussions on current issues and help them develop innovative ideas.

References:

1. Physical working capacity and physical fitness; relationship of body measurements with cardio-vascular and respiratory functions- Physical Activity and Health by C. Bouchard, S.N Blair,W.L Haskell Chapter 3(Page 37-42)
2. Irurtia, Alfredo, Víctor M. Torres-Mestre, Álex Cebrián-Ponce, Marta Carrasco-Marginet, Albert Altarriba-Bartés, Marc Vives-Usón, Francesc Cos, and Jorge Castizo-Olier. "Physical Fitness and Performance in Talented & Untalented Young Chinese Soccer Players." In *Healthcare*, vol. 10, no. 1, p. 98. MDPI, 2022.
3. Vaara, Jani P., Heikki Kyröläinen, Jaakko Niemi, Olli Ohrankämmen, Arja Häkkinen, Sheila Kocay, and Keijo Häkkinen. "Associations of maximal strength and muscular endurance test scores with cardiorespiratory fitness and body composition." *The Journal of Strength & Conditioning Research* 26, no. 8 (2012): 2078-2086.
4. Pate, Russell, Maria Oria, and Laura Pillsbury. "Health-related fitness measures for youth: flexibility." In *Fitness Measures and Health Outcomes in Youth*. National Academies Press (US), 2012.
5. Chen, W., Hammond-Bennett, A., Hypnar, A., & Mason, S. (2018). Health-related physical fitness and physical activity in elementary school students. *BMC public health*, *18*(1), 195. https://doi.org/10.1186/s12889-018-5107-4

6. Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., Lambourne, K., Szabo-Reed, A. N., & This summary was written for the American College of Sports Medicine by (2016). Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. *Medicine and science in sports and exercise*, *48*(6), 1223–1224. https://doi.org/10.1249/MSS.0000000000000966
7. Eston, R. and Reilly, T. (2009).KINANTHROPOMETRY AND EXERCISE PHYSIOLOGY LABORATORY MANUAL Volume One: Anthropometry. Tests, procedures and data. Routledge.

Teaching Learning Process

- Classroom teachings
- Seminars and Interactive sessions
- Practical classes/ Field work

Keywords: Physical fitness, performance, health science

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

GENERIC ELECTIVES (GE-8): CUSTOMARY LAW

Credit 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		
Customary Law	4	3	0	1	12th Pass	---

Learning objectives:

The course is designed to help students understand the approaches to the study of different types of law, particularly customary law. It will also help students to learn the contradictions, inconsistencies inherent in the interface between customary law and the state law.

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

- Locate nuances of diverse customs from around the world based on ethnographic works.
- Make critical evaluation of gendered laws which are intricately enmeshed within the social fabric.
- Gain insights into the workings of state agency that blurs the boundary of customary law and the state.

Syllabus:

Unit 1: Understanding Customary Law **(12 Hours)**

Customary Law: Concepts and Approaches; Types of Customary Law: Restitutive, Repressive; Anthropological literature: Bronislaw Malinowski, Evans-Pritchard, Meyer Fortes, Max Gluckman, Leopold Pospisil

Unit 2: Custom, Crime and Justice **(12 Hours)**

Law and Justice in simple societies; Classification of Crimes among indigenous communities; Oath taking and Ordeal; modes of dispute settlement

Unit 3: Gender and Customary Law **(12 Hours)**

Gendered laws, Inheritance, Succession, Custody of Children and Properties, Political Representation

Unit 4: Customary Law and the State Law **(09 Hours)**

Interface between customary law and state law; Codification of customary law and its implications

Practical – **30 Hours**

- Review of ethnographic works and find out: (i) types of crime, (ii) modes of dispute settlement, (iii) rationale behind ordeals/oaths.
- Project report on (i) customary law and the state law interface, or (ii) Cultural context of a dispute and search for its settlement in one or other legal domains.

References:

1. Evans-Pritchard, E. E and Meyer Fortes. 1940. *African Political Systems*. London: Oxford University Press.
2. Gluckman, Max. 1956. *Custom and Conflict in Africa*. Basil Blackwell Ltd.
3. Malinowski, B. 1926. *Crime and Custom in Savage Society*. London: Routledge & Kegan Paul Ltd.
4. Pospisil, Leopold. 1971. *Anthropology of Law: A comparative theory*. New York: Harper and Row Publishers.
5. Srivastava, Vinay Kumar. 2021. *India's Tribes: Unfolding Realities.* New Delhi: Sage Publications Indian Pvt. Ltd.
6. Zhimo, A.G. 2019. 'Indigenous system of Governance and its implication: The case of Sumi Naga. *Indian Anthropologist.* 49 (2): 41-56.

Keywords:

Customary law, oath taking, custom, dispute, state law

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

GENERIC ELECTIVES (GE-9): Ethics and Legality in Human Research

Credit 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		
Ethics and Legality in Human Research	4	3	0	1	12th Pass	---

Learning Objectives

1. To understand bio-social ethical aspects of human research
2. To understand aspects of health research from ethical and legal perspectives

Learning Outcomes

The students will learn the basic understanding of ethics in different types of human research and learn the skills to assess ethical dimensions of research works based on human populations

Syllabus:

Unit 1: Introduction to the ethical dimensions of human research; history of ethics in human research; Ethical vs legal regulations **(12 Hours)**

Unit 2: Research Disclosure; Importance of Truth telling; Participant Information sheet; Participant's Capacity to understand human research, Voluntariness and Consent, **(12 Hours)**

Unit 3: Human rights; Confidentiality of participant's information; Risks and benefits, Vulnerability, research integrity **(12 Hours)**

Unit 4: Ethical guidelines of Indian Council of medical Research; Regulatory framework **(9 Hours)**

Practical: (30 Hours)

Report of ethical assessment based on research work related to human research.

References

Macklin R. Ethics in global health: research, policy, and practice [1 ed.]. Oxford University Press, 2012

Stephen Garrard Post Encyclopedia of bioethics [Volume 3, 3rd ed]. Macmillan Reference USA, 2004

Alastair V. Campbell. Bioethics: The Basics [1 ed.]. Routledge, 2013

Keywords

Ethics, human, participants, consent, confidentiality

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

GENERIC ELECTIVES (GE-10): Quality of life and well-being

Credit 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		
Quality of life and well-being	4	3	0	1	12th Pass	----

Learning Objectives:

- To understand the concept of QoL and well-being.
- To learn about various domains and indicators related to QoL and well-being.
- To know the measures of QoL and well-being as per different community or geographical setting.
- To identify the similarity and differences in these two concepts.
- To understand the change in QoL and well-being as per disease severity and duration of symptoms in different age group and gender.

Learning outcomes:

- Learner will be able to understand the basic concept of QoL and well-being.
- Information about measures of well-being and QoL will be instilled.
- Learners will get to know about indicators and theoretical models of well-being and QoL
- Knowledge about evaluation of chronic illness treatment through wellbeing and HRQoL will be imparted.

Syllabus:

Unit 1: Fundamentals of quality of life and well being (12 Hours)

Concept of Quality of life (QoL), subjectivity and multidimensionality models, standard of living, life satisfaction, philosophical foundation, definitions and measures of QoL and well being

Unit 2: QoL and Chronic illness (12 Hours)

Quality of life as an evaluation tool for the treatment (HRQoL), functioning domains under QoL: physical, mental, emotional, intellectual, spiritual, and social functioning, impact of Covid-19 on QoL and well-being

Unit 3: Theories and indicators of QoL and well-being (12 Hours)

Hedonic and Eudaimonic well- being, objective, subjective and relational well-being, integrative theories of subjective QoL. Effect of technology, economic, political, socio-cultural, resource, domain dynamics on QoL and well-being.

Unit 4: Types of well-being **(09 Hours)**

Work, residential, material, social, family, marital, health, leisure. quality of life and well-being of Women, older adults, children, youth, geographic population segments etc.

Practical: **(30 Hours)**

To assess QoL and wellbeing of different population at different age groups.

1-2 workshops/projects over the academic semester on topics related to quality of life and wellbeing in anthropology. It would bring students to brainstorming discussions on current issues and help them develop innovative ideas.

References:

1. An Interdisciplinary Perspective edited by Shruti Tripathi, Rashmi Rai, Ingrid Van Rompay-Bartels, 1st edition, 2021, CRC press, Boca Raton https://doi.org/10.1201/9781003009139
2. https://www.springer.com/series/8365
3. Handbook of Active Ageing and Quality of Life,2021, ISBN: 978-3-030-58030-8
4. Well-Being as a Multidimensional Concept: Understanding Connections among Culture, Community, and Health, 2019, EDITED BY JANET M. PAGE-REEVES
5. Upton, D., Upton, P. (2015). Quality of Life and Well-Being. In: Psychology of Wounds and Wound Care in Clinical Practice. Springer, Cham. https://doi.org/10.1007/978-3-319-09653-7_4
6. https://www.cdc.gov/hrqol/wellbeing.htm

Teaching Learning Process

1. Classroom teachings
2. Seminars and Interactive sessions
3. Practical classes/ Field work

Keywords: Quality of life, wellbeing, Hedonic, Eudaimonic

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

GENERIC ELECTIVES (GE-11): Tribes of India

Credit 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		
Tribes of India	4	3	0	1	12th Pass	---

Learning Objectives: The course is designed to help students understand the contested and problematic nature of the term 'tribe' and its definitional attributes. It also seeks to elucidate pressing issues faced by the tribes in India by focus on the contemporary issues, challenges and crisis that confront the rural and tribal communities in India.

Learning outcomes: At the end of the course, the student will be able to**:**

1. Comprehend the problematic nature of the concepts of tribe and indigenous; how it differs from caste.
2. Understand critical issues, problems and challenges related to tribal societies both in historical and contemporary perspectives.
3. Evaluate, plan and implement any project work in rural and tribal areas and be able to suggest remedial measures for critical issues.

Syllabus:

Unit 1: On the concept of tribe **(12 Hours)**

Concept and approaches to the study of tribes; classification, distribution and cosmogeny of tribes in India; Scheduled Tribe and Indigenous people; Particularly Vulnerable tribal groups

Unit 2: Tribes and institution **(12 Hours)**

Tribal kinship system, types of family, rules of marriage, tribal polity and governance, subsistence economy and tribal market, tribal religion: nature-man-spirit complex, witchcraft

Unit 3: Tribes, Development, and Globalization: **(12 Hours)**

Impact of development schemes on tribal societies; Displacement caused by large infrastructure projects; Globalization and the shift from isolation to integration.

Unit 4: Tribes and Policy **(09 Hours)**

National Tribal Policy; Forest Rights, Food security, land acquisition, mining, tribal migrants

Practical – **30 Hours**

Practical would involve examination of material culture including technologies used by the hunter and gatherers, horticulturalist pastoral and agriculture communities. Functional analysis of traps for fishing, hunting, digging stick, sickle and different types of knives and other equipment used for hunting. Different types of house forms, dress patterns etc. and their ecological adaptation in different climatic zones will also be required to studied functionally as well structural point of view. Student would also prepare a project report based upon empirical data collected on tribal issues

References:

Bailey, F.G. 1960. Tribes, caste and Nations: A study of political activity and political change inttighland Orissa.

Béteille, André. 1998. The Idea of Indigenous People. Current Anthropology, Vol. 39, No. 2 (April 1998), pp. 187-192.

Bhandari, J. S., and Subhadra Channa. 1997. Tribes and government policies. New Delhi: Cosmo Publications

Channa, Subhadra Mitra. 2020. Anthropological Perspectives on Indian Tribes. New Delhi: Orient Blackswan Private Limited

Chaudhury, Sukant K., and Patnaik, Soumendra Mohan. 2008. Indian Tribes and the `Mainstream. New Delhi. Rawat Publisher

Fürer-Haimendorf, Christoph von. 1985. Tribal populations and cultures of the Indian subcontinent. Handbuch der Orientalistik, Bd. Leiden: E.J. Brill.

Miri, Mrinal. 2003. Identity and the moral life. New Delhi: Oxford University Press.

Vidyarthi, L.P. 1977. Tribal Culture of India: concept publishing company.

Xaxa, Virginius. 2008. State, society, and tribes: issues in post-colonial India. New Delhi: Dorling Kindersley (India)

Teaching Learning Process

Lectures and Discussions

Seminars and Presentations

Keywords: Scheduled Tribe, Caste, Tribal Development, Tribal Policy, Indigenous People

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

GENERIC ELECTIVES (GE-12): Environment and Health

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Environment and Health	**4**	**3**	**0**	**1**	**12th Pass**	**----**

Learning Objectives

1. To understand basic concepts of environmental health
2. To assess environmental pollutant classes
3. To assess the risk of environmental exposures and health impacts

Learning Outcomes

The students will learn the basic concepts of environmental and health, various exposures and pollutant classes, burden of disease and health impacts of ecological exposures

Syllabus:

Unit 1: Introduction to environment health. Epidemiological studies related to environmental health **(12 Hours)**

Unit 2: Water, Sanitation and Hygiene; impact of air pollution (ambient and indoor), water pollution and noise pollution on human health **(12 Hours)**

Unit 3: Human health under different socio-cultural environment, Built environment, Urban environment, Green spaces and occupational hazards, hygiene and health **(12 Hours)**

Unit 4: Food safety, toxins and waste management, chemicals and heavy metals **(09 Hours)**

Practical: **30 Hours**

Project report based on data collection related to environmental health

References

1. Hermen Koren. Handbook of environmental health and safety [volume_II, 4th ed.]. CRC Press, 2002
2. Morton Lippmann. Environmental toxicants: human exposures and their health effects [3rd ed]. John Wiley &Sons, 2009
3. B. Wisner J. Adams. Environmental Health in Emergencies and Disasters [1 ed.]. World Health Organization, 2003
4. Bernard J. Healey, Kenneth T. Walker. Introduction to Occupational Health in Public Health Practice (Public Health Environmental Health) [1 ed.]. Jossey-Bass;2009

Teaching Learning Process
The process of learning will involve acquisition of domain knowledge and understanding of skills required for conducting research in environmental health. Process will involve lectures and presentations and report submission.

Keywords
Pollutants, Environment, Exposure, Assessment, Water and Air pollution, social environment.

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

Category I

BSc. (Honours) Biological Science
(Sri Venkateswara College)

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell Biology (BS-DSC-201)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the basic concepts and processes in cyto-biology.
- To understand the structure and function of cell organelles, how they communicate with each other and how division and regulation takes place in cells.
- The practical content of this course is designed to understand the cell measurement methods, cell division, staining procedure and tonicity through different laboratory exercises.

Learning outcomes

On successful completion of course, the student will:

- Understand the cell and its biology which will help them to get an insight into theorigin of cells, cellular structure, various components of cells and functions.
- Understand the chemical composition, physicochemical and functional organization oforganelle.
- Demonstrate the knowledge of common and advanced laboratory practices in cyto-biology.
- Acquire knowledge about how cells divide by means of meiosis and mitosis and willbe able to correlate different factors which control cell cycle progression.

SYLLABUS OF DSC-1

UNIT – I Overview of Cell and Cell membrane (07 Hours)

History of cell biology, cell theory, Structure and functions of membrane, models of membrane structure, transport across membranes (with examples): simple diffusion, facilitated diffusion, active transport (Na+/K+ pumps, Co-transport, proton pumps) and passive transport. Phagocytosis, pinocytosis, exocytosis.

UNIT – II Cell Organelles (13 Hours)

Mitochondria, chloroplast and nucleus: Ultrastructural organization and functions, marker enzymes, transport mechanisms in mitochondria and chloroplasts (Tim/Tom; Tic/Toc); and transport via nuclear pore complex.
Endomembrane system: Ultrastructural organization and functions of Rough and smooth endoplasmic reticulum, Golgi apparatus and lysosomes (GERL complex), tonoplast.
Glyoxysomes and Peroxisomes: Structure and function.

UNIT – III Cytoskeletal System (03 Hours)

Structure and organization of microfilaments, intermediate filaments, microtubules, their functions in plants and animals (in brief).

UNIT – IV Cell wall and extracellular matrix (04 Hours)

Cell wall organization (Primary and secondary cell wall), components of cell wall, Extracellular Matrix and Cell junctions, adhesive junctions, gap junctions and tight junctions, plasmodesmata. Function of cell wall.

UNIT – V Cell Division (03 Hours)

Overview of cell cycle. Regulation: Various checkpoints and the role of cyclins andCdks (Cyclin dependent kinases). Overview of mitosis and meiosis and theirsignificance

Practical component – 60 Hours

1. Estimation of cell size by micrometry/ camera lucida
2. To study plasmolysis and deplasmolysis in a cell/ Isolation of protoplast from tomato and its survival in hypo, hyper and isotonic solution
3. Study the effect of organic solvent/temperature on membrane permeability.
4. Demonstrate the phenomenon of protoplasmic streaming.
5. Study of ultrastructure of a cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Endoplasmic reticulum, Lysosomes) through electron micrographs.

6. Study of cytoskeletal structures through photographs.
7. Study of different stages of mitosis by temporary preparation of onion root tips.
8. Study of different stages of meiosis by temporary preparation /permanent slides.
9. Staining and visualisation of mitochondria by Janus green stain

Essential/recommended readings

1. Becker, W. M., Kleinsmith, L. J., Bertni, G. P. (2009). *The World of the Cell* (7thEd.). Pearson Benjamin Cummings Publishing, San Fransisco.
2. Cooper, G.M. and Hausman, R.E., (2009). *The Cell: A Molecular Approach*.(7thed.). ASM Press & Sunderland (Washington DC), Sinauer Associates, MA.
3. Karp, G., (2010). *Cell and Molecular Biology: Concepts and Experiments* (8thed.). John Wiley & SonsA Guidebook to mechanism in organic chemistry (2003) 6 th ed., Sykes, P. NewYork: John Wiley & Sons. Inc

Suggested readings

1. EDP De Robertis, and RE De Robertis (2009). *Cell and Molecular Biology* (8th Ed.).Lippincott Williams and Wilkins, Philadelphia.
2. Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7^{th}ed.).
   W.H. Freeman & Company (New York).

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

DISCIPLINE SPECIFIC CORE COURSE – 5

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Diversity of Life Forms-II (BS-DSC-202)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- Designed with an aim to provide scope and historical background of evolution and diversity in plants and animals.
- impart knowledge regarding basic concepts of origin of chordates and make the students understand the characteristics and classification of animals with notochord.
- Outline various mechanisms involved in thriving/survival of the animals within their geographic realms.
- Understand important aspects of Gymnosperm classification, structure and economic importance.
- Provide an adequate exposure to fundamentals of plant systematics and most practiced classification systems.
- Emphasis will be on developing interest and invoking a sense of responsibility among students toward sustenance of plant and animal biodiversity.

Learning outcomes

Upon completion of the course, the students will be able to:

- Understand different characteristic features of different plant and animal life forms, classes of chordates, level of organization and evolutionary relationship between differentsubphyla and classes, within and outside the phylum.
- Study about diversity in animals and plants making students understand about theirdistinguishing features.
- Appreciate similarities and differences in life functions among various groups of animals and plants.
- Know about the habit and habitat of animals in marine, freshwater and terrestrial ecosystems.
- Understanding of systematics its importance in biodiversity management, nomenclature and classification systems of the plants.

SYLLABUS OF DSC- 2

UNIT – I Gymnosperms (04 Hours)

Position of Gymnosperms in five kingdom classification. General characteristics, Outline classification and economic importance. Morphology, structure and reproduction of *Pinus* and *Ginkgo*. Evolutionary tendencies in Gymnosperms-a comparative study

UNIT – II Plant taxonomy (07 Hours)

Angiosperm systematics: Fundamental concept of Plant Taxonomy (Identification, nomenclature, classification); Taxonomic resources; Herbarium- functions and important herbaria of India and world, Botanical gardens, Flora, monographs and keys (Single-access and multi-access) herbaria of India and world, Botanical gardens, Flora, monographs and keys (Single access andmultiple access)

UNIT – III Classification **(04 Hours)**

Historical background of plant classification; Artificial (Linnaeus), Natural (Bentham and Hooker), Phylogenetic system of classification; APG system.

UNIT – IV Diversity of Chordates **(11 Hours)**

Introduction to Biodiversity, types of Biodiversity, General characteristics and Classification of chordates (upto order): Protochordata, Aganatha, Pisces: Osteichthyes, Chondrichthyes, Amphibia, Reptilia, Aves and Mammals.

UNIT – V Biogeography **(04 Hours)**

Zoogeographical realms, Distribution of vertebrates in different realms

Practical component: 60 Hours

FLORA

1. *Cycas*: T.S (temporary mount) leaf, specimen: male cone and megasporophyll; T.S.corolloid root (temporary mount), T.S. microsporophyll, L.S. ovule (permanent slides).
2. *Pinus:* Study of morphology, dwarf and long shoots, male and female cone, T.S. needle(temporary mount), L.S. male and female cone (permanent slides).
3. Study the characteristic features of ***any one*** member of the family:
   (a) Malvaceae
   (b) Fabaceae/Lamiaceae
   (c) Euphorbiaceae
   (d) Asteraceae
   (e) Liliaceae
4. Mounting of a properly dried and pressed specimen of any wild plant with herbariumlabel (to be submitted on the herbarium sheet with appropriate label)

FAUNA

5. Study of following specimens: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Draco, Naja, any two common birds.
6. Slide/ Virtual demonstration of Placoid, Ctenoid and Cycloid scales
7. Identification and classification of one endangered amphibian, reptile, bird and mammalof any one zoogeographical region in Indian.
8. Report on: Biodiversity Park/reserve/ NBPGR.

Essential/recommended readings

1. Young, J. Z., (2004). The Life of Vertebrates. III Edition. Oxford university press.

2. Parker T.J. and Haswell W.A. Textbook of Zoology Vertebrates. VII Edition, Volume II
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Kaur I., Uniyal P.L. (2019). *Text Book of Gymnosperms*. New Delhi, Delhi: Daya Publishing House.
5. Vashistha, B.R., Sinha, A.K., Kumar, A. (2010). *Botany For Degree Students, Gymnosperms.* New Delhi, Delhi: S Chand Publication.
6. Bhatnagar, S.P., Moitra, A. (1996). *Gymnosperms*. New Delhi, Delhi: New Age International (P) Ltd Publishers.
7. Singh, G., (2018). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing Co. Pvt. Ltd.

Suggested readings

1. Ennos, R., & Sheffield, E., (2000). Plant Life. UK: University Press, Cambridge.
2. Ingrowille, M., (1992). Diversity and Evolution of land plants. Chapman and Hall
3. Wilson, E. O., (1998). Biodiversity. National Academic Press.
4. Pough H. Vertebrate life. VIII Edition, Pearson International.
5. Simpson, M.G. (2010). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.SA

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

DISCIPLINE SPECIFIC CORE COURSE –6 :

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics, Ionic Equilibria and Nanomaterials, (BS-DSC-203))	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce materials at nanoscale, their preparation, characterization techniques and applications in real life.
- Develops basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium.
- It provides basic understanding of the behaviour of electrolytes and their solutions.
- The course will also cover thermodynamic studies with the calculation of energies and interaction of biomolecules withtheir neighbouring environment.

Learning outcomes

By the end of the course, the student will be able to:

- Understand the concept of nano-dimensions.
- Know the various methods of preparation of nanomaterials.
- Know the different characterization techniques used for the analysis of nanomaterials andunderstand the basic principle behind these techniques.
- Understand the diverse properties of nanostructures.
- Appreciate the real-world applications of nanomaterials.
- Understand the laws of thermodynamics, basic principles of thermochemistry andequilibria and successfully extend the concepts learnt in this course to biological systems.
- Understand concept of pH and its effect on the various physical and chemical propertiesof the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study thebehaviour of reactions in equilibrium.
- Explain the concept of ionization of electrolytes with emphasis on weak acid and baseand hydrolysis of salt.
- Apply the concepts of pH and electrolytes while studying other chemistry courses andeveryday life.

SYLLABUS OF DSC-3

UNIT – I Nanomaterials of Biological importance (15 Hours)

Overview of nanomaterials, classification, properties, role of size, methods of synthesis (Chemical methods: chemical reduction, coprecipitation, sol-gel, microemulsions or reverse micelles, solvothermal synthesis, Green or biological methods using bacteria, Fungi, etc, Plants based methods using tea leaves, cinnamon bark, etc), characterization techniques (UV-Vis, IR, SEM, TEM, XRD), optical properties of gold and silver metallic nanoparticles, concept of surface plasmon resonance, carbon nanotubes, inorganic nanowires, quantum dots & semiconductor nanoparticles, metal-based nanostructures (Iron Oxide & ZnO nanoparticles), polymer-based nanostructures, protein-based Nanostructures, natural and artificial nanomaterials, bionanomaterials and bio-nanocomposites, bioinorganic nanomaterials, DNA and its nanomaterials, biomimetics, self-assembled nanostructures, control of nanoarchitecture, Applications of nanomaterials in drug delivery, tissue engineering, medicine, orthopaedics, bioimaging, dental implants and biosensors

UNIT – II Chemical energetics **(05 Hours)**

Review of laws of thermodynamics, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, enthalpy of neutralization, integral and differential enthalpies of solution and dilution, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Statement of third law of thermodynamics and calculation of absolute entropies of substances.

UNIT – III Ionic Equilibria **(10 Hours)**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions and their applicationsin biological systems, Henderson-Hasselbalch equation. Solubility and solubility product ofsparingly soluble salts – applications of solubility product principle.

Practical component: TOTAL HOURS: 60

1. Synthesis of silver nanoparticles (AgNPs) by chemical reduction method and theirspectroscopic characterization using UV-visible spectrophotometer.
2. Green synthesis of silver nanoparticles (AgNPs) using soluble starch or cinnamon barkand their characterization using UV-visible spectroscopy.
3. Phytochemicals mediated synthesis of gold nanoparticles (AuNPs) using tea leaves and tostudy the effect of size on color of gold nanoparticles.
4. Preparation of magnetic nanoparticles (MNPs) of Fe_3O_4 using green tea leaf extract.
5. Synthesis of pure ZnO and Cu-doped ZnO nanoparticles by precipitation method and itscharacterization using UV-visible spectroscopy.
6. XRD pattern of nanomaterials and estimation of particle size. (Students can be providedwith XRD patterns of known materials and asked to interpret the data.)
7. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
8. Determination of integral enthalpy (endothermic and exothermic) solution of salts.
9. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammoniumchloride-ammonium acetate.
10. Measurement of the pH of buffer solutions and comparison of the values with theoreticalvalues.

11. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base anddetermination of dissociation constant of a weak acid.

Essential/recommended readings

1. Atkins, P., Overton, T., Rourke, J., Weller, M. & Armstrong, F. (2011-12).
2. Shriver and Atkins' Inorganic Chemistry. Oxford, UK: Oxford University Press.
3. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, JohnWiley and Sons.
4. Malhotra, P.; Gulati, S., Novel Inorganic Solids and Nanomaterials, (2022) I.K.International Pvt Ltd.
5. Gulati, S., Sharma, J. L., Manocha, S. (2017). Practical Inorganic Chemistry. New Delhi,India: CBS publishers and distributors Pvt. Ltd.
6. Orbaek, W.; McHale, M.M.; Barron, A. R.; Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory, J. Chem. Educ. 2015, 92, 339−344.
7. Gulati, S.; Shukla, S.; Kumar, S., Practical Green Chemistry, Strategies, Tools &Experiments, SKP Publishers and Distributors, 2019.
8. Shukla, S.; Gulati, S.; Kumar, S., A textbook of Green Chemistry, Benign by Design,SKP Publishers and Distributors, 2019.
9. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; Synthesis of ZnO Nanoparticlesby Precipitation Method, Orient J Chem 2015, 31(2).
10. Kumar, S., Kapoor, V, Gulati, S, Experiments in Physical Chemistry, (2017), Book AgeSeries.
11. Kapoor, K.L. (2017). A Textbook of Physical Chemistry, Thermodynamics and ChemicalEquilibrium, Vol. 2. India: McGraw-Hill Education.
12. Khosla, B. D., Garg, V. C., Gulati, A. (2011). Senior Practical Physical Chemistry. NewDelhi, India: R. Chand & Co.
13. Rastogi, R. P., Mishra, R. R. (2009). *An Introduction to Chemical Thermodynamics*.India: Vikas Publication.
14. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, OxfordUniversity Press.
15. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
16. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

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

DEPARTMENT OF ENVIRONMENTAL SCIENCE

Category-I
BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 4 (DSC-EVS-4): WATER AND WATER RESOURCES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
WATER AND WATER RESOURCES	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning objectives
The Learning Objectives of this course are as follows:
- Gain insights into the hydrological cycle, properties of water, physico-chemical and biological
- Understand parameters and indies of water quality
- Classify types of water resources and thus develop practices for their sustainable use and management
- Investigate problems associated with water shortages in India and familiarize with case studies on international and national conflicts on water.

Learning outcomes
After this course, students will be able to learn the following skills.
- Acquire skills to identify potential water resources in a given region and manage existing water resources
- Analyze data on water resources to understand the current environmental challenge and prevent the future ones
- Make informed decisions on using and choosing appropriate methods for water resource management and develop nature-based methods to improve the health of water bodies
- Develop low-cost methods for purifying drinking and natural water
- Correlate water resource management practices with socio-economic challenges and prospects
- Relate and interpret the data on water resources data with other related sustainability challenges

SYLLABUS OF DSC-4
Theory (02 Credits: 30 lectures)

UNIT – I Introduction (2 Hours)
Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo- transpiration; classification of water resources (oceans, rivers, lakes and wetlands).

UNIT – II Properties of water (4 Hours)
Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical:major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos,zooplankton, macro-invertebrates and microbes.

UNIT – III Surface and subsurface water (6 Hours)
Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting in urban settings.

UNIT – IV Wetlands and their management (4 Hours)
Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971;major wetlands of India.

UNIT –V Marine resource management (3 Hours)
Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).

UNIT – VI Water resources in India (4 Hours)
Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management.

UNIT –VII Water resource conflicts (4 Hours)
Water resources and sharing problems, case studies on Kaveri and Krishna River water disputes; Multipurpose River valley projects in India and their environmental and social impacts; case studies of dams; Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts.

UNIT – VIII Major laws and treaties (3 Hours)
National water policy; water pollution (control and prevention) Act 1972; Indus water treaty; Ganges water treaty; Teesta water treaty; National River linking plan: ecological and economic impacts.

Practicals/Hands-on Exercises – based on theory **(02 Credits: 60 hours)**

1. Estimate water quality based on physico-chemical parameters, such as pH, electrical conductivity, salinity, total dissolved and suspended solids, iron contents, and dissolved oxygen
2. Classify and characterize aquifers of Indian states and analyse “Safe” and “Over-exploited” zones of two states based on groundwater use.

3. Determine alkalinity, alkalinity hazard and SAR of water samples and recommend their use for various purposes.
4. Identify and map water resources in NCT Delhi and correlate its current status with changing land use in past 60 years
5. Estimate sediment load in Yamuna River at different sections of its course in Delhi regions
6. Assess water quality (pH, TDS, TH, EC, BOD, Heavy Metals) and determine the water portability of samples collected from different sites of NCT Delhi.
7. Conduct an online survey to assess people's knowledge, perception and attitude towards water quality issues and their impact on the environment and health.
8. Analyze water conservation strategies in North-eastern and Western states of India from the data available from State Government Agencies.
9. Document and compare water conservation strategies in different agroclimatic zones of India
10. Analyze watershed management strategies in selected river basins of India.
11. Develop integrated water management strategies for two contrasting river basin of India.

Essential/recommended readings

- McNabb, D.E., 2017. *Water Resource Management: Sustainability in An Era of Climate Change*. Springer.
- Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. *Water Resource Systems Planning andAnalysis*. Englewood Cliffs, NJ, Prentice Hall.
- Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
- CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
- Bogardi, J.J., Gupta, J., Nandalal, K.W., Salamé, L., van Nooijen, R.R., Kumar, N., Tingsanchali, T., Bhaduri, A. and Kolechkina, A.G. eds., 2021. *Handbook of Water Resources Management: Discourses, Concepts and Examples*. Springer International Publishing.
- de Oliveira Vieira, E., Sandoval-Solis, S., de Albuquerque Pedrosa, V. and Ortiz-Partida, J.P., 2020. *Integrated Water Resource Management*. Springer International Publishing.
- Garg, V., Singh, V.P. and Raj, V. eds., 2017. *Development of Water Resources in India*. Springer International Publishing.
- Grigg, N.S., 2016. *Integrated Water Resource Management: An interdisciplinary Approach*. Springer.
- Mimikou, M.A., Baltas, E.A. and Tsihrintzis, V.A., 2016. *Hydrology and Water Resource Systems Analysis*. CRC Press.
- Vickers, A. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.

Suugested readings

- Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
- Hidalgo, M.E.A., 2013. A Decision Framework for Integrated Wetland-River Basin Management in a Tropical and Data Scarce Environment: UNESCO-IHE PhD Thesis. CRC Press.
- Information Resources Management Association (Editor) (2017). *Hydrology and Water Resource Management: Breakthroughs in Research and Practice*, 1st edition IGI Global.

- Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
- McNabb, D.E., 2017. *Water Resource Management: Sustainability in An Era of Climate Change*. Springer.
- Schward & Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
- Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-EVS-5): LAND AND SOIL: CONSERVATION AND 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		
LAND AND SOIL: CONSERVATION AND MANAGEMENT	**4**	**2**	**0**	**2**	**Class XII pass**	**NA**

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into fundamentals of land and soil degradation
- Understand deeply the properties of soil and how the quality of land and soil degrades due to anthropogenic activities
- Develop solutions to combat land and soil degradation based on natural processes

Learning outcomes

After this course, students will be able to

- Acquire skills in managing soil and land sustainably
- Analyze data on soils and land use to identify the principal factor(s) governing sustainability
- Develop methods to address environmental issues related to soil health and changing land use
- Correlate positive or negative impacts of soil and land use on ecosystems and society
- Relate and interpret the soil and land use data with the sustainability of a region
- Use soil and land use data to develop evidence-based land use guidelines

SYLLABUS OF DSC-2

Theory (02 Credits: 30 lectures)

UNIT – I Introduction (3 Hours)
Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

UNIT – II Fundamentals of soil science (5 Hours)
Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphoruseconomy of soil; soil biodiversity; soil taxonomy maps.

UNIT – III Soil degradation – causes (5 Hours)
Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.

UNIT – IV Landuse changes and land degradation (7 Hours)
Land resources: types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

UNIT – V Costs of land degradation (7 Hours)
Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.

UNIT – VI Controlling land degradation (3 Hours)
Sustainable land use planning; role of databases and data analysis in landuse planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Determine and assess soil texture, color, structure, water, and temperature using the jar test and soil textural triangle. Discuss and describe the soil profiles for different types of ecosystems.
2. Characterize the given soil samples for the proportion of soil particle size fractions.
3. Determine bulk density, moisture content, and water holding capacity of garden soil and compare it with other soil types

4. Estimate variations in pH, alkalinity, acidity, and salinity of the given soil sample. Establish the relationship between soil quality and crop productivity.
5. Evaluate given soils samples for soil organic matter contents and comment on their productivity
6. Calculate permeability of soil samples and comment on its impact on plant growth
7. Separate minerals using the selective dissolution method
8. Estimate PO_4-P of soils using ammonium molybdate reactions by spectrophotometric analysis
9. Estimate SO_4-S contents of soils by titrating with the barium chloride solution
10. Extract, investigate and interpret soil health data (micronutrient status, macronutrient status, and pH) for Northern, Western, and North-Eastern states of India. For the selected states, discuss the various soil types, agriculture practices, cropping patterns, crop production, conservation, and management strategies.
11. Extract, investigate and interpret the available datasets on soil maps, soil databases, and land degradation maps for India and draw suitable inferences. Conduct a perception-based study on the importance of soils and various impacts of soil and land degradation through an online survey.
12. Assessment of fertilizer management and integrated nutrient management practices for selected crops in India.

Essential/recommended readings

- Brady, N.C. & Well, R.R. 2007.*The Nature and Properties of Soils* (13th edition), Pearson Education Inc.
- Hazelton, P. and Murphy, B., 2021. *Understanding Soils in Urban Environments*. CSIRO publishing.
- Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman & Littlefield Publishers.
- Kutz, M., 2018. *Handbook of Environmental Degradation of Materials*. William Andrew.
- Mir, B.A., 2021. *Manual of Geotechnical Laboratory Soil Testing*. CRC Press.
- Pansu, M. and Gautheyrou, J., 2007. *Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods*. Springer Science & Business Media.
- Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17: 358-366.

Suugested readings

- Fahad, S., Sonmez, O., Saud, S., Wang, D., Wu, C., Adnan, M. and Turan, V. eds., 2021. *Sustainable Soil and Land Management and Climate Change*. CRC Press.
- Jones, J.B., 2001. *Laboratory Guide for Conducting Soil Tests and Plant Analysis*. CRC press.
- Loconto, P.R., 2022. *Laboratory Experiments in Trace Environmental Quantitative Analysis*. CRC Press.
- Marsh, W. M. & Dozier, J. 1983. *Landscape Planning: Environmental Applications*. John Wileyand Sons.
- Patnaik, P., 2017. *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*. CRC Press.

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

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC-EVS-6): ECOLOGY AND ECOSYSTEMS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ECOLOGY AND ECOSYSTEMS	**4**	**2**	**0**	**2**	**Class XII pass**	**NIL**

Learning objectives
The Learning Objectives of this course are as follows:
- Develop an understanding of ecosystems and their structural and functional aspects
- Reveal interconnectedness and interdependentness among all the biotic and abiotic components of the environment
- Gain insights into the dynamic nature of the ecological processes in maintaining equilibrium in nature.

Learning outcomes
After this course, students will be able to
- Acquire skills in ecological census techniques
- Analyze the status of biodiversity and ecosystem structure
- Develop methods to assess the changes in ecosystems with time and space
- Correlate effects of anthropogenic factors on ecosystem stability
- Relate and interpret the connections between environmental factors and ecosystem changes
- Use ecological data to predict the impact of a given factor on ecosystem and biodiversity

SYLLABUS OF DSC-6
Theory (02 Credits: 30 lectures)

UNIT – I Introduction (3 Hours)
Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes.

UNIT – II Ecology of individuals (5 Hours)
Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niches: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

UNIT – III Ecology of populations (5 Hours)
Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth; deterministic and stochastic models of population dynamics; ruderal, competitive and stress-tolerance strategies.

UNIT – IV Ecology of communities (5 Hours)
Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession.

UNIT – V Ecosystem ecology (5 Hours)
Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.

UNIT – VI Biogeochemical cycles and nutrient cycling (4 Hours)
Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

UNIT – VII Biological invasions (3 Hours)
Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Using and choosing quadrat types for vegetation analyses
2. Carry out vegetation analysis using line-transect techniques
3. Estimate the populations of aquatic beetles and bugs in ponds by the mark-capture method
4. Conduct bird surveys in your college/nearby garden using the point transect method
5. Determine the variations in abundance of micro-, meso-, and macrofauna in soils of different land use
6. Estimate the diversity of species within a community or habitat and comment

on alpha diversity

7. Analyze the rate and extent of change in species along a gradient from one habitat to others and comment on beta diversity
8. Considering the analyses of practicals 6 and 7, estimate the gamma diversity and comment.
9. Prepare and interpret the species accumulation curve for the total species richness of an area

10-13 Compare and classify communities for (a) similarity and differences, (b) influential environmental variables, (c) interspecific association

Essential/recommended readings

- Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2020. *The Ecology of Plants. 3rd Ed.* Sinauer associatesincorporated.
- Henderson, P.A., 2009. *Practical Methods in Ecology*. John Wiley & Sons.
- Jorgensen, S.E. ed., 2009. *Ecosystem Ecology*. Academic press.
- Morin, P.J., 2009. *Community Ecology*. John Wiley & Sons.
- Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Sounders.
- Rockwood, L.L., 2015. *Introduction to Population Ecology*. John Wiley & Sons.
- Sutherland, W.J. ed., 2006. *Ecological Census Techniques: A Handbook*. Cambridge university press.

Suugested readings

- Groom. B. & Jenkins. M. 2000. *Global Biodiversity: Earth's Living Resources in the 21stCentury.* World Conservation Press, Cambridge, UK.
- Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem Functioning: Synthesis and Perspectives.* Oxford University Press, Oxford, UK.
- Pastor, J., 2008. Mathematical Ecology of Populations and Ecosystems. John Wiley & Sons.
- Pimentel, D. (Ed.). 2011. *Biological invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species*. CRC Press.
- Ranta, E., Lundberg, P. and Kaitala, V., 2005. Ecology of Populations. Cambridge University Press.
- Wilson, E. O. 1985. The biological diversity crisis. *BioScience* **35**: 700-706.

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

GENERIC ELECTIVES (GE-EVS-05): CIRCULAR ECONOMY AND ENVIRONMENTAL SUSTAINABILITY

Credit 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		
CIRCULAR ECONOMY AND ENVIRONMENTAL SUSTAINABILITY	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Critically evaluate five mega trends involving climate, development, ecology, economy, and technology and their linkages with energy and resources
- Inculcate principles and methods of circular economy and design resource-efficient, low carbon paradigm.
- Analyze business models/institutes/communities and associated processes and services and develop recommendations for integrating principles of circular economy
- Adopt routes of circular economy in personal, family, community, and institutional settings.

Learning outcomes

After the course, the students will be

- Equipped with tools and techniques of circular economy to develop a sustainable institute or community
- Acting as a consultant to industries and international organizations aiming for a circular economy
- Serving as a catalyst in evolving an ecoliterate society and industry and promoting sustainable polices

SYLLABUS OF GE-1

Theory (02 Credits: 30 lectures)

UNIT – I Circular economy (3 Hours)

Concept and definitions; Closed loop ecosystems; Systems thinking; Benefits to environment, economy and society (03 lecture)

UNIT – II Principles of circular economy (4 Hours)

Sustainable procurement; Ecodesign; Industrial and territorial ecology; Economics of functionality; Responsible consumption; Extending the duration of use; Recycling (04 lecture)

UNIT – III Steps for transition towards a circular economy (7 Hours)
Large-scale transition to non-polluting sources of energy; Durable products requiring less materials and energy; Incentivization of recycling, re-use, and repair; Replacement of hazardous materials with safer alternatives (07 lecture)

UNIT – IV Circular economy implementation (7 Hours)
Micro-level: Firm-level engineering and managerial level; Meso-level: Industrial ecology, Industrial symbiosis, Eco-clusters, Eco-industrial parks; and Macro level: General policies, Plans, Green and sustainable entrepreneurship. (07 lecture)

UNIT –V Challenges in implementing circular economy (7 Hours)
Achievability and desirability; Disrupting consumer's convenience; Local regulations versus the circular economy concept; Lack of infrastructure for waste treatment; Lack of recycling technology; Poor business model plan (07 lecture)

UNIT –VI Case studies from India and other parts of the world (2 Hours)

Practicals/Hands-on Exercises – based on theory (60 hours)

1. Evaluate the status of your institute with respect to efforts on circular economy using qualitative and quantitative surveys
2. Survey your institute and depict the journey of waste in your institute highlighting the factors/actors that are barrier to and facilitator of complete waste recycling
3. Collect spatial and temporal data on types of wastes being generated and identify the recycling hotspots and the gap in adopting circular economy principles
4. Based on activities 1 – 3, develop a consolidated waste recycling plan highlighting targets for Institute and each Department
5. Recycle and reuse the waste clothes produced at home and make a presentation in the class to increase their lifecycle and estimate its impact on ecological footprint of the family/institute
6. Coordinate with different groups working on waste recycling focusing on different types of wastes segregated at home/institute, for example, plastics/ glass/furniture/ metal/cans/paper waste and present as group activity
7. Visit an industrial area to analyse the status of circular economy concepts being practiced and give recommendations to improve the industrial sustainability (submit the report)
8. Conduction workshop in the Institute to educate students of other courses for converting wastes into useful products
9. Run a repair café where students and staff bring their broken stuff and get it repaired with the help of experts available at the Institute
10. Conduct a swap shop and swap party where people bring their old clothes for exchange
11. Estimate the impact of activities 8–10 reduction in ecological footprints
12. Conduct a drive to collect e-waste from the institute and the neighbourhood localities and donate it to the recycling facilities and estimate its impact on environment.
13. Based on the activities 1–12, plan and conduct awareness camps in the neighbourhood to educate and motivate people about importance of reuse and recycling and empower them with recycling methods

Essential/recommended readings

- Charter, M. ed., 2018. *Designing for the Circular Economy*. Routledge, London, UK.
- Hawken, P., Lovins, A.B. and Lovins, L.H., 2013. *Natural Capitalism: The Next Industrial Revolution*. Routledge.
- Lacy, P. and Rutqvist, J., 2015. *Waste to Wealth: The Circular Economy Advantage*. London: Palgrave Macmillan.
- Mavropoulos, A. and Nilsen, A.W., 2020. *Industry 4.0 and Circular Economy: Towards a Wasteless Future or A Wasteful Planet*? John Wiley & Sons.
- Stahel, W.R. and MacArthur, E., 2019. *The Circular Economy: A User's Guide*. Routledge, NY, USA.

Suugested readings

- Crocker, R., Saint, C., Chen, G. and Tong, Y. eds., 2018. *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (pp. 1-353). Bingley, UK: Emerald Publishing Limited.
- Delchet-Cochet, K. ed., 2020. Circular Economy: From Waste Reduction to Value Creation. John Wiley & Sons.
- Frodermann, L., 2018. *Exploratory Study on Circular Economy Approaches*. Springer, Fachmedien Wiesbaden.
- Ghosh, S.K., Samanta, S., Hirani, H. and da Silva, C.R.V. eds., 2022. *Effective Waste Management and Circular Economy: Legislative Framework and Strategies*. CRC Press.

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

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE-EVS-6): WETLANDS FOR INDUSTRIES AND ENVIRONMENT

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
WETLANDS FOR INDUSTRIES AND ENVIRONMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Delineate, and classify the target wetland
- Identify common wetland plants and indicators of wetlands
- Assess landscape for wetland management and conservation
- Evolve a wetland construction and restoration plan
- Suggest appropriate changes for effective wetland regulation law and policy

Learning outcomes

After successful completion of this course, students will be able to:

- Apply basic principles of wastewater treatment for environmental and industrial applications
- Develop plans for monitoring wetland health and designing a constructed wetland
- Assess the feasibility of constructed wetlands for wastewater treatment
- Operate and maintain wetlands in nature and industries

SYLLABUS OF GE-EVS-6

Theory (02 Credits: 30 lectures)

UNIT – I Ecology and socio-economy of wetlands (11 Hours)

Wetland types and functions; Ramsar Convention, Vegetation type and dynamics; Soil types; Geology and geomorphology; Hydrological regimes: Water quality and balance, Sedimentation; Indicators; Biodiversity and its significance; Ecological and economic benefits: Provisioning, Regulating, Cultural and Supporting services, Socio-economic and cultural diversity in human society living in and around wetlands; Income and employment generation by wetlands; Community resource use and management practices. (11 lectures)

UNIT – II Wetlands and water treatments (8 Hours)

Principles and efficacy of natural wetlands; Economics of treatment; Case studies from India and other countries; Types of constructed wetlands and their principles; Potential of constructed wetlands for treating different types of wastewaters (agriculture, domestic, industry, municipal, runoff, and sludge); Operation and maintenance; Case studies from India and other countries (8 lectures)

UNIT – III Wetland management (11 Hours)
Delineation and mapping; Features and associated factors; Monitoring ecosystem health; Major threats; Setting up goals and objectives; Institutional arrangements, Wetlands ecosystem services maps; Ecosystem services trade-offs; Landscape-scale Management; Interventions to sustain biodiversity and ecosystem services; Mobilizing community participation and generating finance; Cross-sectoral integration; Integration of wetland conservation in development plans, acts, and rules; Adaptive management. (11 lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Identify a potential area for wetland construction, propose its purpose and goal, and develop the construction plan giving details of location, type, current land use, biodiversity, and hydrologic regime
1. Prepare water budgets and hydrographs of the selected area based on the data on water inputs and outputs collected from concerned institutes
2. Field surveys and analyze vegetation characteristics of a pristine wetland present in the nearby location of the study site
3. Analyze adaptive strategies of selected native plants to hydrologic regime suitable for wetland construction and develop planting strategies of species assemblage
4. Analyze soil type and determine its physico-chemical properties (pH, TDS, EC, CEC, Redox potential, etc.)
5. Evolve soil amendment method to improve texture, percolation, and nutrient composition. suitable for the hydrogeomorphic model and selected plant species
6. Surveying wetlands to identify suitable indicators for mapping and delineating wetlands zone of influence and evaluate anthropogenic activities as major threats to wetlands
7. Develop wetlands ecosystem services (ES) potential maps and evaluate ES trade-offs
8. Analyze different models for wetland construction and, based on the nature of the water regime and basic methods of wetland construction, recommend the hydrogeomorphic model suitable for the selected landscape

Essential/recommended readings

- Aber, J.S., Pavri, F. and Aber, S., 2012. *Wetland Environments: A Global Perspective*. John Wiley & Sons.
- Keddy, P.A., 2010. *Wetland Ecology: Principles and Conservation*. Cambridge University Press.
- Shuqing, An., and Jos, T.A. Verhoeven (Eds)., 2019. *Wetlands: Ecosystem Services, Restoration and Wise Use Series: Ecological Studies*, Volume 238, Springer, Cham.
- Stefanakis, A.I. ed., 2018. *Constructed Wetlands for Industrial Wastewater Treatment*, Wiley, Blackwell.
- Tiner, R.W., 2016. *Wetland Indicators: A Guide to Wetland Formation, Identification, Delineation, Classification, and Mapping*. CRC Press.

Suugested readings

- Austin, G. and Yu, K., 2016. *Constructed Wetlands and Sustainable Development*. Routledge.
- Lopez, R.D., Lyon, J.G., Lyon, L.K. and Lopez, D.K., 2013. *Wetland Landscape Characterization: Practical Tools, Methods, and Approaches for Landscape Ecology*. CRC Press.
- Windham-Myers, L., Crooks, S. and Troxler, T.G. eds., 2018. *A Blue Carbon Primer: The State of Coastal Wetland Carbon Science, Practice and Policy*. CRC Press.

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

GENERIC ELECTIVES (GE-EVS-7): CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT

Credit 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		
CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Inculcate interdependent and interrelated theories of corporate branding, environmental sustainability, and social equity
- Understand the working and driving forces of CSR and its significance as a stepping stone to Sustainable Business Models
- Gain insights into CSR as a tool to ensure social justice and adopt environmental wisdom from industries
- Empower with emerging frameworks and practices in CSR for environmental sustainability and improve quality of life

Learning outcomes

After the course, students will be able to:

- Explain the concept of CSR from an environmental sustainability perspective and its significance in next-generation marketing strategies
- Apply concepts of CSR to develop strategies for responsible marketing, business success, and environmental protection.
- Develop systems thinking and evolve as a responsible consumer
- Decipher linkages between concepts of circular economy, sharing economy, and carbon/ecological footprints, and identify opportunities and challenges to specific businesses and target consumers.
- Gain insights into five dimensions of sustainability performance: economic, environmental, governance, social and ethical
- Practice sustainability management, implement cleaner technologies, and argue in favour of environmental protection.

SYLLABUS OF GE-EVS-7

Theory (02 Credits: 30 lectures)

UNIT – I Sustainable Development (8 Hours)

Definitions, goals and frameworks; Sustainability: Definition and concept, Bottom of the pyramid and fairtrade; Evolution of concepts, Socio-ethical and environmental aspects, Benefits in strategic planning; Associated world's leaders and corporations, Financial, social and reputational benefits, Circular and share economy (8 lectures)

UNIT – II Corporate social responsibility (CSR) (6 Hours)

CSR: Definition and concept, Philosophy and practices of CSR; Measuring CSR; Impact of CSR on rural livelihoods, natural resources management, biodiversity conservation; Carbon footprint; Cleaner technologies; Emerging CSR policies in India

UNIT – III CSR and Sustainability (9 Hours)

Why and when to apply CSR activities, Competitiveness vs Ethical, Green markets and budget, Bottlenecks of being sustainable, Public-private partnerships for socio-ecological entrepreneurship, Vocal for local embedding sustainability; Business strategies for sustainable individuals, firms, and industries, Power-Inequality-Environment-CSR nexus, Managing, Monitoring, and Reporting CSR, Beyond framing CSR as strategic, political or utopian (9 lectures)

UNIT – IV Case studies (7 Hours)

CSR applications for improving livelihoods, enhancing soil health and crop productivity in stress environment, adaptation to climate change, and diversification of crop patterns improving rural wastewater management (7 lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Analyze variations in CSR efforts in saving the environment by countries differing in biodiversity and ecosystem diversity
2. Critically analyze OECD Guidelines for Multinational Enterprises on corporate responsibility
3. Select a company/business organization and, based on its activities and products, identify the environmental issues that need to be addressed for societal need
4. Evaluate diverse environmental issues based on their impact on society and organizational brand value and develop its vision document and a CSR plan for environmental conservation
5. Determine priorities and evolve a code of conduct document for the selected company to maximize its CSR for environmental issues
6. Based on the activities of the target business organization, develop an action plan and policies to suit the international guidelines and standards of CSR for environmental conservation

7. Identify the constraints to implement the guidelines and standards set based on dialogue with different stakeholders and surveying the local circumstances
8. Analyze the variations in guidelines and standards to meet the CSR in countries differing in biodiversity and cultural values
9. Identify the environmental indicators to formulate a monitoring and reporting system for CSR success
10. Evolve the appropriate communication style for different internal and external stakeholders
11. Field surveys and lab-based assays for monitoring the targeted ecosystem, biodiversity, environmental compartment, and socio-ecological systems for the impact of CSR

Essential/recommended readings

- Bachnik, K., Kaźmierczak, M., Rojek-Nowosielska, M., Stefańska, M. and Szumniak-Samolej, J. (eds.), 2022. *Corporate Social Responsibility and Sustainability: From Values to Impact*. Routledge.
- Camilleri, M.A., 2017. *Corporate Sustainability, Social Responsibility and Environmental Management*. Cham, Switzerland: Springer International Publishing.
- Geoffrey H., 2010. *When Principles Pay: Corporate Social Responsibility and the Bottom Line*, Columbia University Press.
- McKenna, K., 2015. *Corporate Social Responsibility and Natural Resource Conflict*. Routledge.

Suugested readings

- Roberts, L., Georgiou, N. and Hassan, A.M., 2022. Investigating biodiversity and circular economy disclosure practices: Insights from global firms. *Corporate Social Responsibility and Environmental Management*. DOI: 10.1002/csr.2402
- Ringham, K., 2017. CSR and Sustainability: From the Margins to the Mainstream: A Textbook, Routledge
- Rendtorff, J.D., 2019. *Philosophy of Management and Sustainability: Rethinking Business Ethics and Social Responsibility in Sustainable development*. Emerald Group Publishing.

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

GENERIC ELECTIVES (GE-EVS-8): E-WASTES: LEGISLATION, TRADE AND MANAGEMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
E-WASTES: LEGISLATION, TRADE AND MANAGEMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Define and explain e-waste and its category
- Learn effective mechanisms to regulate the generation, collection, storage, transport, import, and export,
- Empower with methods of recycling, treatment, and disposal of e-waste
- Current legislative rules for managing e-waste in the environment

Learning outcomes:

After the course, students will be able to

- Apply various concepts for e-waste management hierarchy with a holistic understanding of the environmental impacts of e-waste
- Decipher the roles of the various national and internal acts and laws applicable for e-waste management
- Evolve plans for handling e-waste to comply with its management proposed under national and global legislation
- Develop a holistic understanding of environmental impacts of e-waste, application of

SYLLABUS OF GE-EVS-8

Theory (02 Credits: 30 lectures)

UNIT – I E-waste Composition, Generation and Management (8 Hours)

Definition, Composition and generation, Global and national perspective, Co-pollutants, Hazardous properties, Effects on human health and environment, Domestic e-waste disposal, E-waste Management: Basic principles, Components, Resource recovery potential, Technologies for recovery of resources, Steps in recycling and recovery of materials-mechanical processing, Occupational and environmental health effects (8 Lectures)

UNIT – II Global trade of E-waste (7 Hours)

Factors in global waste trade economy, Waste trading and electronic recycling, Free trade agreements as a means of waste trading. Import of hazardous e-waste in India; India's stand on liberalizing import rules, E-waste economy in the organized and unorganized sector, Production and recycling of e-wastes in Indian metro cities.

UNIT – III Control measures (7 Hours)
Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.

UNIT – IV Relevant legislation (8 Hours)
Hazardous Waste Rules, 2008, E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. The international legislation: The Basel Convention; The Bamako Convention. The Rotterdam Convention. Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union, Restrictions of Hazardous Substances (RoHS) Directive. (8 Lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Prepare inventory and estimate the magnitude of electrical and electronic waste from the home, college, or the selected site (hospitals/company/manufacturing facilities) (example, air conditioners, heaters, microwaves, batteries, digital cameras, calculators, circuit boards, monitors, VCRs/DVD players, telephone equipment, etc.)
2. Categorize e-waste into different types as per international and national guidelines
3. Prepare a list of certified electronics recyclers in your city and transport e-waste to it, and have an interactive session to learn from the processes being followed.
4. Find out the composition of e-waste and segregate it from the given materials. Recommend the internationally acceptable shredding processes for each type of e-waste.
5. Prepare a poster showing salient features of the e-waste management act of India
6. Sort electronics and prepare a list of valuables that can be extracted from electronics, such as fluorescent light and toner cartridges (metals, plastics, glass, compounds, and other elements). Identify and remove e-waste that may carry hazardous materials (like cathode ray tubes) before sending the objects for recycling.
7. Visit a nearby e-waste handling facility and learn about the dismantling of e-waste and the handling process
8. Discuss with students in groups the plausible ways and implementation of e-waste reduction at the source and how regulatory mechanisms can be utilized in the management of e-waste in educational institutions.
9. Evaluate the status of e-waste handling at your institution. Suggest potential solutions as per the existing norms of E-Waste (Management) Rules, 2016 and beyond.
10. Decipher the methods of dust extractions, magnetic and water separation, purification, and preparation for sale. Identify the material that can be repurposed.
11. Study the evolutionary history of e-waste management rules and their implementation- Hazardous Waste Rules, 2008; E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016
12. Compare and analyze international laws on e-waste management- the international legislations: The Basel Convention; The Bamako Convention; The Rotterdam

Convention; Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union; Restrictions of Hazardous Substances (RoHS) Directive

13. Develop an understanding and itinerary of the process for procuring e-waste import permissions and inventory of the e-waste disposal mechanisms.

Essential/recommended readings

- Hester, R.E. and Harrison, R.M., 2009. Electronic Waste Management: Design. Analysis and Application. Royal Society of Chemistry Publishing. Cambridge, UK.
- Fowler, B.A., 2017. Electronic Waste: Toxicology and Public Health Issues. Academic Press.
- Eduljee, G.H. and Harrison, R.M. eds., 2019. Electronic Waste Management. Royal Society of Chemistry.

Suggested readings

- Janyasuthiwong, S., 2020. Metal Removal and Recovery from Mining Wastewater and E-waste Leachate. CRC Press.
- Gaidajis, G., Angelakoglou, K. and Aktsoglou, D., 2010. E-waste: environmental problems and current management. Journal of Engineering Science and Technology Review, 3(1), pp.193-199.

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

DEPARTMENT OF HOME SCIENCE

Category I

B.Sc. (Hons.) Home Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE

DISCIPLINE SPECIFIC CORE COURSE – 4 (DSC HS 204): FASHION STUDIES

COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FASHION STUDIES DSC HS 204	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To understand the basics of fashion and the fashion industry.
2. To impart knowledge about functions and theories of clothing.
3. To develop sensitivity towards selection of garments and garment design.

Learning Outcomes

The student will be able to:

1. Identify the role and functions of clothing and recognize the factors affecting the selection and evaluation of clothing.
2. Explain the concept of fashion, its terminology, sources and factors affecting it.
3. Being aware of global fashion centres.
4. Apply the knowledge of elements and principles in design interpretation.

SYLLABUS OF DSC-4

Unit I: Clothes and us **(12 Hours)**

This unit introduces the student to key concepts of how and why people started to wear clothes, and what factors are at play in the current times for selecting clothing for the individual.

- Clothing functions and theories of origin
- Clothing terminology
- Individuality and conformity, conspicuous consumption and emulation
- Body shapes
- Selection and Evaluation of quality of ready-made garments
- Selection of clothes for self

Unit II: Understanding fashion (12 Hours)

This unit will deal with the basic concepts in understanding fashion, from key terms to the why and how of fashion and more contemporary knowledge of fast and slow fashions.

- Fashion cycle
- Terminology
- Theories of fashion adoption
- Sources of fashion research
- Factors favoring and retarding fashion
- Role of a Designer
- Fast Fashion: Characteristics of Fast Fashion, Fast Fashion and Consumer
- Slow Fashion: Characteristics, Slow Fashion as a process, importance of changing from fast to slow fashion

Unit III: Design in Garments **(09 Hours)**

This unit orients the student from a design perspective in garments; the various elements that comprise a garment and the various principles that govern and guide in developing a good design.

- Structural and Decorative Design
- Elements of Design
- Principles of Design

Unit IV: Fashion **(12 Hours)**

This unit will apprise the student on the forecasting process for fashions, functioning of the industry and various garment categories for production.

- Structure and Functioning of Fashion Industry
- Forecasting: Fashion seasons
- Garment Categories
- Fashion Centers
- Careers in Fashion

ESSENTIAL READINGS

- Brown, Patty, Rice J., 1998, *Ready to Wear Apparel Analysis*. Prentice Hall.
- Marshall S G, Jackson H O, Stanley MS, Kefgen M & Specht T, 2009, *Individuality in Clothing & Personal Appearance, 6th Edition*, Pearson Education, USA.
- Tate S.L., Edwards M.S., 1982, *The Complete Book of Fashion Design*, Harper and Row Publications, New York.
- Fringes G.S., 1994, *Fashion From Concept to Consumer, 6th edition*, Prentice Hall, New Jersey.

SUGGESTED READINGS:

- R. Andrew, 2018, Key Concepts for Fashion Industry, Bloomsbury Publishing, India

PRACTICAL
(30 Hours)

Unit I: Hand stitches **(14 Hours)**

This unit will impart hands-on skill for making small products using upcycling of used articles of clothing or home textiles and how value addition may be achieved in garments by using popular embroidery stitches.

- Prepare samples of –
  - Basic hand stitches for creating a seam and edge finishing.
  - Decorative Hand Stitches
- Develop an upcycled product

Unit II: Elements & Principles of Design **(16 Hours)**

This unit will train the students to identify the various elements of a design that a garment uses and the principles that are creating an aesthetic design. Eventually a student will be able to effectively use these elements and principles of design to create well designed garments.

- Create a collection of garments for analysis from print and visual media.
- Analyze the various elements that comprise the garments.
  Identify the various principles of design used in the selected garments

Essential Readings

- Fringes G.S., 1994, *Fashion From Concept to Consumer, 6th edition*, Prentice Hall, New Jersey.
- Marshall S G, Jackson H O, Stanley MS, Kefgen M & Specht T, 2009, *Individuality in Clothing & Personal Appearance, 6th Edition*, Pearson Education, USA.

Suggested Readings:

- Reader's Digest (Eds.). 2002, New Complete Guide to Sewing, (Canada) Ltd. Montreal.

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

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC HS 205): FUNDAMENTALS OF RESOURCE MAMAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FUNDAMENTALS OF RESOURCE MANAGEMENT **DSC HS 205**	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To enable students to understand the fundamentals of resource management in changing scenario and available resources, their uses and conservation.
2. To understand the processes of management in a scientific manner for the judicious use of resources.

Learning Outcomes

Students will be able to:

1. Comprehend the fundamentals of resource management in the changing scenario.
2. Familiarize with the available resources, their uses and conservation.
3. Utilize resources optimally in a prudent manner.
4. Understand the processes of management in a scientific manner for the use of resources.

THEORY

Unit I: Introduction to management **(12 Hours)**

Unit Description: The focus of this unit would be on understanding the concept of management, scope and approaches of management in context to changing scenario.

Subtopics:

- Concept, nature, universality and scope of management
- Theories and Approaches to management.
- Ethics in management
- Motivation in management

UNIT II: Understanding resources **(09 Hours)**

Unit Description: This unit attempts to acquaint the students with the available resources, their uses and conservation approaches.

Subtopics:

- Meaning, classification and characteristics of resources.
- Resource conservation- maximizing use of resources, factors
- affecting utilization of resources.
- Family life cycle in context to resource use: Time, energy, money.

Unit III: Functions of management: An overview **(12 Hours)**

Unit Description: This unit will orient the students in understanding the functions and processes of management in a scientific manner for the optimization of resources.

- Decision Making: Concept, significance and steps involved in decision-making process.
- Planning: Nature and characteristics, classification of plans & steps in planning.
- Organizing: Concept, significance and steps involved in organizing process.
- Supervision: Types of supervision (directing & guiding), factors of effective supervision.
- Controlling: Types of control, steps in controlling, requirements of effective control.
- Evaluation: Types and steps of evaluation.

Unit IV: Management of time and energy resources **(12 Hours)**

This unit will familiarize students with effective management of time and energy resources and their functional use in day-to-day life.

- Time Management: Concept, tools of time management, types of time plans, steps in making a time plan.
- Energy Management: Concept, principles of body mechanics, types of fatigue.
- Work Simplification: Techniques, Classes of Change.

PRACTICAL -30 Hours

Unit I: Identification and Development of managerial competencies **(14 Hours)**

Activities:

- Micro Lab and Who am I
- SWOC analysis
  - Self
  - Case studies: Individuals
  - Case studies: Organizations
- Building Decision making abilities
- Team building management games
- Decision Making: Case Analysis

Unit II: Management of Time and Energy **(16 Hours)**

Activities:

- Time Management:
  - Evaluation of time plans through case analysis:
    - Case Study-1
    - Case Study-2
  - Analysis of time use pattern of self
    - Preparation and evaluation of time plans
- Work improvement using time and motion study techniques
  - pathway chart or travel chart / process chart - observe, record, and analyze an activity.
  - pathway chart or travel chart / process chart - observe, record, and analyze an activity with improvement.

Essential Readings

- Combe, C. (2014). *Introduction to management.* Oxford University Press.
- Drucker, P. F. (2007). *Management: Tasks, responsibilities, practices.* Transaction Pub, ISBN-13: 978-0750643894.
- Goel, S. Ed. (2016). *Management of resources for sustainable development.* New Delhi: Orient Blackswan Pvt. Ltd, ISBN: 9788125063490, 9788125063490.
- Griffin, R. W. (2013). *Management: Principles and practices (11th ed.)*. South-Western Cengage Learning, ISBN: 9788131530917, 8131530914.
- Hill, C. W., & Stevenane. (2006). *Principles of management (1st ed.).* McGraw-Hill/Irwin. ISBN: 9780073530123.
- Koontz, H., & O' Donnel, C. (2005). *Management: A systems and contingency analysis of managerial functions.* New York: McGraw-Hill Book Company, ISBN-13: 978-0070853775.
- Moore, T. J. (2021). *Family resource management* (4th ed.). ISBN-13: 978-1544370620.
- Rao, V.S.P. (2008). *Principles & practice of management*. Konark Publishers Pvt. Ltd, ISBN-13: 978-8122000283.

For Practicals

- Goel, S. Ed. (2016). *Management of resources for sustainable development.* New Delhi: Orient Blackswan Pvt. Ltd, ISBN: 9788125063490, 9788125063490.
- Arora, R., Magu, P., Singh, P., Meghna, Gupta, S. (2013). *Resource Management: An Introductory Manual.* R. Gangadharan of Elite Publishing House Pvt. Ltd., Daryaganj, ISBN No: 978-81-88-901-50-0.
- Drucker, P. F. (2007). *Management: Tasks, responsibilities, practices.* Transaction Pub, ISBN-13: 978-0750643894

Suggested Readings:

- Jyoti, A. (2009). *Principles of management*. Gennext Publication. ISBN-13: 9789380222127.
- Kreitner, R. (2009). *Management*. Canada: Houghton Miffin Harcourt Publishing Company.
- Nickel, D. (2002). *Management in family living,* 4e (4th ed.), ISBN-13: 978-8123908519.
- Robbin, S.P. (2009). *Fundamentals of management,* 11th edition, Pearson Education.
- Steidl, R. & Bratton, E. (1968). *Work in the Home.* USA: John Wiley & Sons, Inc, ISBN-13: 9780471820857.

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

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC HS 206): LIFE SCIENCE FOR HOME SCIENCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LIFE SCIENCE FOR HOME SCIENCE DSC HS 206	4	2	0	2	12th Pass	NIL

Learning Objectives

- To impart the basic knowledge of animal diversity, plant diversity and its significance for human life.
- To make students aware of the fundamental process of plant growth and its regulation.
- To enable students to learn about methods of sustainable agriculture, plant conservation and propagation.
- To make students aware of immunology, genetics and biotechnology.

Learning Outcomes

- The students would be able to identify and appreciate some common plant and animal diversity in their vicinity.
- The students would understand the fundamentals of genetics and its significance in human life.
- The students would gain hands-on experience and training on gardening and plant propagation techniques along with the artificial methods of vegetative propagation.
- The students would acquire the basic knowledge of biotechnology along with recent trends and its applications in agriculture, animal husbandry and human welfare and associated ethical and social issues.
- The students would acquire knowledge about various zoonotic diseases, pandemics and learn about its control and management.
- The students would understand the importance prenatal screening and natal health.

THEORY

Section A – Botany

Unit I: Introduction to Plant Kingdom (08 Hours)

Plant kingdom, plant growth and regulation, Economically Important Plants

- Introduction to Plant Diversity
- Economic importance of Microbes (Industrial &Household Products, Sewage treatment, Biogas production, Biocontrol agents, Bio-fertilizers)
- Angiosperm plants: Morphology (Parts of plants with modifications and Life cycle)
- Plant Nutrition and Soil: Essential Elements and Functions, Nutrient cycles, Human Impact on nutrient cycles and effects of pollution
- Plant growth and Development- Regulation and control (Hormones)
- Enzymes: principles and biotechnological applications
- Introduction to Economically important plants: Food Crops, Fibre Crops, Medicinal Plants, Oil Crops, Timber Plants

Unit II: Propagation, Gardening and Conservation of Plants (06 Hours)

Plant propagation methods, Sustainable Agriculture, Biotechnology in Agriculture

- Seed Propagation
- Vegetative Propagation: Cuttings – stem leaf and root, Layering, Grafting, Tissue Culture
- Gardening: Concept and Types with example of Kitchen Garden, Green Roofs, Maintenance of plants
- Sustainable Agriculture: Concept of Organic farming, IPM, Biopesticides, Climate smart agriculture, Seed bank, Urban Agriculture
- Concept of Sustainable development with Sustainability Indicators
- Role of Plants in Air Pollution Control
- Principles and Applications of biotechnology in agricultural crops

Section B – Zoology

Unit III: Animal Diversity and Human Needs (08 Hours)

Animal diversity and its importance to humans

- Types, Structure and Function of Animal Cell and its components (Chromosomes and Nucleus)
- Animal diversity and its distribution
- Animals and their ecosystem services: role of animals in soil health, pollination, biological control of pests, food security
- Threatened species of animals and their conservation
- Zoonotic and Parasitic diseases- Life cycle, pathogenesis and control. (*Plasmodium*, *Giardia*, *Entamoeba*, *Taenia*, *Ascaris, Covid-19, malaria, tuberculosis*)
- Animals as economic resources: sericulture, apiculture, aquaponics (concept and applications)

Unit IV: Immunity, Genetics and Biotechnology (08 Hours)

Basics of human immunity, Pandemics, genetic diseases, application of biotechnology, developmental biology

- Basics of Human Immunity: introduction to humoral and cell mediated immunity; Vaccination
- Introduction to Pandemics and its management
- Genetic diseases and importance of Genetic counselling
- Birth defects and its causes (genetic and environmental factors)
- Application of biotechnology: Stem cells, cloning and animal improvements

PRACTICAL – 60 Hours

SECTION A- BOTANY

1. Preparation of soil mixture, potting and re-potting
2. Raising of healthy seedlings in a nursery bed
3. Assessment of soil quality: determination of soil pH, test for nitrates, nitrites
4. Propagation of plants through stem cutting, air layering and underground layering
5. Propagation of plants by approach grafting and veneer grafting
6. Identification and classification of economically important Food crops, Medicinal plants
7. Identification and classification of economically important plants: Fibre crops, Timber plants and Oil crops
8. Identification, Care and maintenance of important plants in controlling air pollution
9. A visit to Home Garden/ Organic farm/ Tissue culture Lab
10. Demonstration of Urban Home Gardens/ Kitchen Garden / Nutrition Garden
11. Study of techniques of biotechnology through audio visual aids

SECTION B- ZOOLOGY

1. Study of cell Structure through temporary slides: Blood Cells
2. Study of cell Structure through temporary slides: Neurons
3. Study of cell cycle stages through permanent slides: Mitosis
4. Study of cell cycle stages through permanent slides: Meiosis
5. Identification of few common animals and birds in the human environment
6. Estimation of species richness and abundance of animal/ birds in the human environment using point count method
7. Estimation of species richness and abundance of animal/ birds in the human environment using transect method
8. Soil biomonitoring using Burlese-Tullgren method: concept and importance of micro and macrofauna in soil health
9. Detection of chromosomal abnormalities: concepts and interpretation of diagnostic tests: Karyotyping
10. Detection of chromosomal abnormalities: concepts and interpretation of diagnostic tests: Dual marker test
11. Visit to any one of the following: Aquaponic facility/organic farm/ bee farm
12. Case study of a zoonotic/ parasitic disease: COVID-19 pandemics/ bird flu

Essential Readings

- Jordan E. L. and Verma P. S., 2009. Invertebrate Zoology, S. Chand and Co. Ltd, New Delhi.
- Park K., 2016. Textbook of preventive and social medicine. Banarsidas Bhanot Publishers.
- Raven P. and Johnson G., 2010. Biology. Tata McGraw Hill Publication, New Delhi.
- Singh J. S, Singh S. P. and Gupta S. R., 2017. Ecology, Environment Science and Resource Conservation. S. Chand (G/L) & Company Ltd, India.
- Soni N. K. and Soni V., 2010. Fundamentals of Botany. Tata McGraw Hill Publication, New Delhi.

Suggested Readings

- Chadha K. L.2012. Handbook of Horticulture. ICAR Publication, New Delhi.
- Gopalaswamiianger K.S. 1991. Complete gardening in India, Messers Nagaraj and Co., Madras.
- Gupta R. 2015. Fundamentals of Zoology: Theory and Practice. Elite Publishing House Pvt. Ltd., New Delhi.
- Hartman H.T and Kester D. 1986. Plant Propagation: Principles and Practices Prentice Hall of India Pvt. Ltd., New Delhi.
- Kotpal R. L. 2000. Modern Textbook of Zoology, Rastogi Publications, Meerut.
- Magurran, A. E. 1988. Ecological Diversity and Measurement. Croom Helm Limited, Australia.
- Upadhyay R. 2017. Elements of Plant Science, Elite Publishing House, New Delhi.

Vij, U. and Gupta, R. 2011. Applied Zoology Phoenix Publishing House, New Delhi

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

Category-II
B.Sc (Prog.) Home Science

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC HP 204) –: Lifespan Development I: Prenatal and Early Years

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Lifespan Development I: Prenatal and Early Years	4	3	0	1	12^{th} Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquire an understanding of lifespan development as a discipline
- To appreciate the role of heredity, context, family and community in Lifespan development
- To understand developmental progression across stages and domains of the lifespan

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will develop an understanding about the discipline of Lifespan development
- The student will appreciate principles of growth and development
- The student will understand the concept of stages and domains in lifespan development
- The student will become aware of optimal practices in child rearing and child stimulation

SYLLABUS OF DSC HP 204

Unit I: Understanding Lifespan Approaches and Perspectives – 09 Hours

The unit provides a foundational view on Life Span development.
Subtopics:

- Definitions, nature, scope and multidisciplinary nature of Lifespan Development
- Developmental stages and domains
- Principles of growth and development
- Optimizing development in early years

Unit II: Pregnancy, Birth and the Neonate – 12 Hours

The unit focuses on pregnancy and safe motherhood, understanding prenatal development and birthing techniques and the newborn.
Subtopics:

- Stages of prenatal development
- Influences on prenatal development and safe motherhood
- Birthing process and the high-risk newborns
- Newborn capacities and care

Unit III: Development during Infancy – 12 Hours

Understanding the period of infancy through the framework of developmental domains
Subtopics:

- Developmental Norms and Milestones
- Physical- motor development
- Sensory Perceptual development
- Cognitive development
- Language development
- Social development

Unit IV: Development during Preschool – 12 Hours

Understanding the domains of language, cognitive and socio-emotional development preschool period. Interlinkages between developmental domains for strong foundations.
Subtopics:

- Developmental Norms and Milestones during preschool
- Physical and motor development
- Language development
- Cognitive development
- Social and emotional development: Family, Play and Learning

PRACTICAL -30 Hours

- Introduction to research methods in Lifespan development
- Documentation of methods: Interview, Observation and Narrative
- Prepare interviews to explore cultural practices and conceptions related to pregnancy, infancy and early childhood
- Conduct early childhood observations using specimen description and checklist in *any two* domains of development
- Using audio and video resources to study prenatal development, infancy and early childhood
- Preparation of activities and learning aids for parents using locally available materials
- Mapping resources in children's ecology by community survey
- Psychological tests- Developmental assessment of Indian children, WPPSI

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Essential Readings

- Berk, L. (2013). Child development. 9th ed. Boston: Pearson.
- Rice, F. P. (1998). Human Development: A Life-span Approach. New Jersey: Prentice Hall.
- Santrock, J. W. (2011). Life-span development. New York: McGraw-Hill.
- Singh, A. (Ed.) 2015. Foundations of Human Development. New Delhi: Tata McGraw-Hill.
- Snow, C. W., & McGaha, C. G. (2003). Infant development (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Suggested Readings

- Childhood in south Asia: A critical look at issues, policies and programmes. Conn.USA:Information Age.
- Hospital walls. In T.S. Saraswathi (Ed.). Culture, socialization and human development. New Delhi: Sage.
- Singhi, P. (1999). Child health & well-being: Psychological care within & beyond
- Sriram, R. (2004). Ensuring infant and maternal health in India. In J. Pattnaik (Ed.).
- Verma, P, Srivastava, D.N. and Singh, A. (1996). Bal *manovigyan and bal vikas.* Agra: Chapter 3: Indian women: Traditional and modern: pages 52-70.

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

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC HP 205): Foundation of Food Science and Nutrition

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Foundation of Food Science and Nutrition	4	3	0	1	12^{th} Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand functions of food and the relationship between food, nutrition and health.
- To describe the functions of various nutrients, their sources and clinical manifestations of excess/ deficiency of nutrients.
- To learn about various methods of cooking and to understand the selection, nutritional contribution of and effect of cooking on different food groups.
- To describe ways of reducing nutrient losses during cooking.
- To be able to prepare dishes using principles of food science.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Comprehend the relationship between food, nutrition and health.
- Understand the selection, nutritional contribution and changes during cooking of the commonly consumed foods.
- Understand the importance of various nutrients and their dietary sources.
- Develop understanding about the methods of preparing food with better nutrient retention and improving quality of diets.

SYLLABUS OF DSC HP 205

Unit I: Basic Concepts in Food and Nutrition -12 Hours

Basic terminology used in the sciences of food and nutrition and understanding the relationship between what we eat and health.

Subtopics

- Basic terms used in study of food and nutrition
- Understanding relationship between food, nutrition and health

- Functions of food-Physiological, psychological and social

Unit II: Nutrients -12 Hours
Functions, dietary sources and clinical manifestations of deficiency/ excess of the nutrients
Subtopics
- Energy, carbohydrates, lipids and proteins
- Fat soluble vitamins
- Water soluble vitamins
- Minerals

Unit III: Food Groups – 12 Hours
Selection, nutritional contribution and changes during cooking of various food groups.
Subtopics
- Cereals and pulses
- Fruits and vegetables
- Milk & milk products
- Eggs
- Meat, poultry and fish
- Fats and oils

Unit IV: Methods of Cooking and Preventing Nutrient Losses- 09 Hours
Different methods of cooking and how nutrients can be retained
Subtopics
- Dry, moist, frying and microwave cooking
- Advantages, disadvantages and the effect of various methods of cooking on nutrients
- Minimize nutrient losses

Practical -30 Hours

- Weights and measures; preparing market order and table setting
- Food preparation, understanding the principles involved, nutritional quality and portion size

- Cereals: Boiled rice, pulao, chapati, paratha-plain/stuffed, poori, pastas
- Pulses: Whole, dehusked, pulse curry
- Vegetables: Dry preparation, vegetable curry
- Milk preparations: Kheer, porridge, custard
- Egg preparations: Boiled, poached, fried, scrambled, omelettes, egg pudding
- Soups: Plain and cream soups
- Baked products: cakes, biscuits/cookies
- Snacks and Breakfast Cereals: pakoras, cutlets, samosas, cheela, upma/poha, sandwiches
- Salads: salads and salad dressings

Essential Readings

1. Chadha R and Mathur P (eds)(2015). Nutrition: A Lifecycle Approach. Hyderabad: Orient Blackswan.
2. Khanna K, Gupta S, Seth R, Mahna R, Rekhi T (2004). The Art and Science of Cooking: A Practical Manual, Revised Edition. New Delhi: Elite Publishing House Pvt Ltd.
3. Raina U, Kashyap S, Narula V, Thomas S, Suvira, Vir S, Chopra S (2010). Basic Food Preparation: A Complete Manual, Fourth Edition. Hyderabad: Orient Black Swan.
4. Rekhi T and Yadav H (2014). Fundamentals of Food and Nutrition. New Delhi: Elite Publishing House Pvt Ltd.
5. Srilakshmi B (2014). Food Science, 6th Edition. Delhi: New Age International Ltd.

Suggested Readings

1. Bamji MS, Krishnaswamy K, Brahmam GNV (2016). Textbook of Human Nutrition, 4th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J. (2013). Wardlaw's Perspectives in Nutrition, International Edition, 9th edition, New York: McGraw- Hill.
3. Sethi P, Lakra P. Aahar Vigyan, Poshan evam Suraksha (Hindi); First Ed; 2015; Delhi: Elite Publishing House (P) Ltd.

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

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC HP 206): Fundamentals of 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		
Fundamentals of Communication	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the concept, nature, and scope of communication.
- To understand the process of communication with the help of theories, models, and elements of communication.
- To recognize and appreciate the role of Perception, Empathy, Persuasion, Culture and listening in communication.
- To be able to comprehend the various communication transactions and their role in day-to-day life with special reference to public communication.
- To understand the relationship between culture and communication and its applications in real life settings.

Learning outcomes

The Learning Outcomes of this course are as follows:
The students would be able to:

- Develop a clear understanding of the concepts of human communication.
- Comprehend the elements and models governing the process of effective communication.
- Gain understanding about the related concepts of communication such as Perception, Empathy, Persuasion and Listening
- Understand the various communication transactions as well as the qualities and skills required of an effective public speaker.
- Appreciate the role and application of factors for effective communication.

SYLLABUS OF DSC HP 206

Unit I: Communication: Core Concepts-12 Hours

The Unit explores the fundamentals of Human Communication tracing the history of communication from the olden times to the present times. It highlights the concept, nature, types, scope, and postulates of communication and discusses the functions performed through communication.

Subtopics:

- Historical background, concept, nature, functions, and scope of communication
- Types of Communication – Formal and informal communication; Verbal and Non-verbal communication; Digital and Non-digital communication
- Verbal communication- Principles, types, effective use of verbal messages for communication
- Non-verbal communication- functions, types, skills, channels of non-verbal communication, inter-relationship between culture and non-verbal skills
- Elements of communication - Source, Message, Channel, Receiver, Feedback, Context, Noise & Effects

Unit II: Communication Models and Theories- 09 Hours

The Unit emphasizes the models and theories of the communication process. The further delves on the importance of these models and theories for understanding the effectiveness of communication as a process.

Subtopics:

- Models of Communication: Types of models- Linear, Interaction and Transaction models, (Models by Aristotle, Harold Laswell, Shannon &Weaver, Charles Osgood, Wilbur Schramm, Helical model)
- Theories of Communication: Mass Society, Propaganda, Limited Effects, Individual Difference and Personal Influence

Unit III: Factors for Effective Communication – 12 Hours

The Unit delves with intricate concepts such as Empathy, Persuasion, Perception and Listening that are associated with communication. The unit also discusses the relationship between culture and communication.

- Factors for effective communication: Definitions, goals and principles of Empathy, Perception, and Persuasion
- Empathy: Concept and Theories
- Perception: Concept and Theories
- Listening in Human Communication-Listening process, significance of good listening, styles of listening, barriers to listening, culture and listening, listening theories
- Culture and communication- Relationship between culture and communication, signs, symbols and codes in communication

Unit IV: Communication Transactions and Learning – 12 Hours

The Unit III elucidates upon the various levels of communication transactions. This Unit in particular lays thrust on the Public communication and 'need and importance' of communication for learning. The unit also highlights the concept of communication for development.

Subtopics:

- Levels of communication transactions
- Public communication- Concept, types, techniques and skills in public speaking, qualities of an effective public speaker, overcoming speaker apprehension
- Communication, and Learning: Learning as Communication Process, Domains of Learning. Theories of learning
- Audio-Visual Aids in communication- definitions, functions, classification including Edgar Dale's Cone of Experience
- Communication for Development- Concept and approaches

PRACTICAL – 30 Hours

- Exercises to understand visual communication: Elements of Art and Principles of Design
- Exercises to explore dimensions of non-verbal communication
- Hands on practice with different types of public speaking
- Exercises in effective listening skills
- Exercises on building empathy for effective communication
- Analysis and designing of IEC materials

ESSENTIAL READINGS

Devito, J. (2012). *Human Communication*. New York: Harper & Row.

Barker, L. (1990). *Communication*, New Jersey: Prentice Hall, Inc; 171.

Anand, S. & Kumar, A. (2016). *Dynamics of Human Communication*. New Delhi: Orient Black Swan.

Vivian, J. (1991). *The Media of Mass Communication.* Pearson College Div; 11th edition (19 March 2012).

SUGGESTED READINGS:

Patri, V. R. and Patri, N. (2002). *Essentials of Communication*. Greenspan Publications

Baran, S. (2014). *Mass Communication Theory*. Wadsworth Publishing.

Stevenson, D. (2002). *Understanding Media Studies: Social Theory and Mass Communication*, Sage Publications.

McQuail, D. (2000). *Mass Communication Theories*. London: Sage Publications.

Zeuschner, R. (1997). *Communicating Today*. California State University, USA.

PRACTICAL WORK:

Punhani & Aggarwal (2014). *Media for Effective Communication*. Elite Publishers, New Delhi.

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

BSC. (HONS.) FOOD TECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PRINCIPLES OF FOOD PROCESSING	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand freezer, dryer types and functioning
- To understand the material handling, separation processes and thermal processing

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand cold preservation, Freezer types and functioning
- Understand Dehydration, Dryer types and functioning
- Understand the material handling in food industry, conveyer types, separation processes by distillation, extraction, filtration
- Understand thermal processing and fundamentals of thermal process calculations

SYLLABUSOF DSC-04

Unit1: Cold Preservation and Freezers (12 Hours)

- Refrigeration and Freezing: requirements of refrigerated storage - controlled low temperature, air circulation and humidity, modified gas atmosphere. Changes in food during refrigerated and frozen storage, Refrigeration load, factors determining freezing rate: food composition and non-compositional.
- Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

Unit2: Dehydration **(12 Hours)**

Changes in food during drying, drying methods and equipments air convection dryer, tray dryer, tunnel dryer, continuous belt dryer , fluidized bed dryer, spray dryer, drum dryer, vacuum dryer, freeze drying ,foam mat drying.

Unit3: Thermal processing **(9 Hours)**

Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept, characterization of heat penetration data, Thermal process Calculations, Aseptic processing of food

Unit4: Material handling and Separation processes (12 Hours)

Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.

Distillation principles and methods: steam, batch, continuous distillation with rectification and stripping.

Extraction : Hildebrandt, Bollman, SCF extraction Filtration : Plate and frame , pressure leaf, continuous rotary vacuum ,batch and continuous filtration

Practical Exercises: 30 Hours

The learners are required to:

- Preservation of food by freezing
- Drying of food using Tray dryer/other dryers
- Preservation of food by canning (Fruit/Vegetable/meat)
- Cut-out analysis of canned food
- Osmotic dehydration
- Minimal Processing
- Perform distillation of any food sample/by product
- Processing of ready to eat frozen products
- Study of Thawing Characteristics of frozen food

Essential/recommended readings

- Potter,N.N.and Hotchkiss,J.H.(2007). Food Science 5th Ed. New York: Chapman & Hall
- Ramaswamy, H. and Marcott, M. (2006). Food Processing Principles and Applications. CRC Press.
- Rao, P.G. (2010). Fundamentals of Food Engineering. New Delhi: PHI Learning Pvt Ltd .
- Desrosier, N.W. and Desrosier, J.N. (1998). The Technology of Food Preservation. New Delhi: CBS Publication.
- Toledo, Romeo T. (2007). Fundamentals of Food Process Engineering. Aspen Publishers.

- **Note: Learners are advised to use the latest edition of readings.**

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

DSC 05 : TECHNOLOGY OF FOOD PRESERVATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
TECHNOLOGY OF FOOD PRESERVATION	**4**	**3**	0	**1**	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn science behind various preservation/processing technologies.
- Technological application of concepts on conventional Indian foods.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understanding of the concept of different processing and preservation technologies
- Appreciate significance of various preservation methods used in food industries.

SYLLABUS OF DSC-05

Unit1: Introduction to Technology of Food Preservation (6 Hours)

Introduction to historical evolution to food preservation techniques- Conventional to recent technologies Classification of foods based on pH, concept of shelf life, perishable foods, semi perishable foods, shelf stable foods.

Unit2:Food Preservation by Low temperature (14 Hours)

Introduction to refrigeration, chilling, freezing as a means of preservation, cold storage Principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, Introduction to thawing, changes during thawing and its effect on food

Unit3: Food Preservation by Thermal Processing and Irradiation (10 Hours)

Introduction to Thermal Processing- Blanching, pasteurization, sterilization, commercial sterilization. Introduction, units of radiation, concept of cold sterilization, kinds of ionizing radiations, application in food industry.

Unit4: Food Preservation by Moisture control (15 Hours)

Introduction to Drying and Dehydration -Drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), normal drying curve, heat and mass transfer, factors affecting rate of drying and its application in food industry.
Introduction to Evaporation as a means of preservation – Definition, factors affecting evaporation, and its application in food industry.

Practical Exercises: 30 Hours

The learners are required to:

- To study methods of sampling.
- To study the concept of shelf life of different foods.
- To perform blanching of plant foods.
- To study the concept of sterilization
- To perform pasteurization of fluids- juices/ milk/ squashes etc using different methods.
- To determine the pH of different foods.
- To evaluate the quality characteristics of foods preserved by solar drying/ dehydration/ freezing.

Essential/recommended readings

- Potter, N. N., & Hotchkiss, J. H. (2012). Food Science. Springer Science & Business Media.
- Fellows, P. J. (2009). Food Processing Technology: Principles and Practice. Elsevier.
- Bawa. A.S., Chauhan, O.P, Raju. P.S. (2013) ed. Food Science. New India Publishing agency.
- Stewart, G.F., & Amerine, M.A. (2012). Introduction to Food Science and Technology.Elsevier, 2nd Edition.
- Rao, E.S. (2019) Fundamentals of Food Technology and Preservation, Variety Books, New Delhi.
- Frazier, W.C. & West Hoff, D.C. 2004. Food Microbiology. TMH Publication, New Delhi,.
- Rao, D.G. 2010. Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi,

- **Note: Learners are advised to use the latest edition of readings.**

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

DSC 06 : FRUITS, VEGETABLES & PLANTATION CROPS PROCESSING TECHNOLOGYDSC 04 PRINCIPLES OF FOOD PROCESSING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FRUITS, VEGETABLES & PLANTATION CROPS PROCESSING TECHNOLOGY	**4**	**3**	0	**1**	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart knowledge of different methods of fruits and vegetables processing.
- To learn about processing of various spices, tea, coffee and cocoa.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the concept of quality of fruits and vegetables for developing good quality end products.
- Understand the processing and preservation of fruits and vegetables using various techniques.
- Understand processing of plantation crops.

SYLLABUS OF DSC-06

Unit1: Introduction to Fruits and Vegetables (6 Hours)

Importance of Fruits & Vegetables
History & need of preservation
Reasons of spoilage, method of preservation (Short & Long Term)
Post harvest physiological & biochemical changes in fruits &vegetables

Unit2: Canning & Dehydration (11 Hours)

Process of canning, factors affecting the process- time and temperature
Containers of packing, lacquering, syrups and brines for canning.
Spoilage in canned foods.
Sun drying & mechanical dehydration
Process variation for fruits and vegetables packing and storage. Case hardening

Unit3:Fruits Beverages & Tomato Products (13 Hours)

Introduction & Processing of fruit juices (selection, juice extraction, deaeration, straining, filtration and clarification)

Preservation of fruit juices (pasteurization, preservation with chemical, sugar & salt, freezing, drying, tetra-packing, carbonation)
Processing of squashes, cordials, nectars, concentrates and powder
Tomato Products : processing of tomato juice, tomato puree, paste, ketchup, sauce and soup

Unit4: Products preserved with class I & class II preservatives (7 Hours)

Processing & Technology of Jam, Jelly, Marmalade & Pickles (Essential constituents, Role of pectin), Theory of jelly formation, defects in jelly,
Marmalade - Types, defects.
Pickles-- Processing , Types, Causes of spoilage in pickling

Unit5: Technology of Plantation Crops (8 Hours)

Spices
Processing and properties of major and minor spices
Essential oils & oleoresins, adulteration Tea, Coffee and Cocoa
Processing, Variety and Products

Practical Exercises: 30 Hours

The learners are required to:

- Estimation of total soluble solids (TSS), pH, acidity of various products.
- Estimation of brix: acidity ratio of various products.
- Estimation of ascorbic acid and effect of heat treatment on it.
- To study the steps of can making process.
- Preparation & evaluation of pectin based product. (Jam)
- Preparation & evaluation of tomato puree.
- Dehydration of fruits and vegetables
- Rehydration of fruits and vegetables
- Extraction & estimation of polyphenols from fruit & Vegetable wastes.

Essential/recommended readings

- Girdharilal., Siddappaa, G.S and Tandon, G.L.(2009). Preservation of fruits & vegetables. ICAR, New Delhi.
- Thompson, A.K., (2003). Fruits and vegetables; Harvesting, handling and storage. Blackwell Publishing.
- Verma L.R. & Joshi VK. 2000. Post Harvest Technology of Fruits & Vegetables. Indus Publication.
- Crusess, W.B. (2004). Commercial Unit and Vegetable Products. W.V. Special Indian Edition. Agrobios India.
- Manay, S. and Shadaksharaswami, M. (2004). Foods: Facts and Principles. New Age Publishers.
- Ranganna S.(2007). Handbook of analysis and quality control for fruits and vegetable products. Tata Mc Graw-Hill publishing company limited, Second edition.
- Srivastava, R.P. and Kumar, S. (2006). Fruits and Vegetables Preservation- Principles and Practices. 3rd Ed. International Book Distributing Co.
- Somogyi, L.P., Ramaswamy, H.S. and Hui, Y.H. (1996). Biology, Principles and Applications. Volume 1. Technomic Publishing Company, Inc.

- **Note: Learners are advised to use the latest edition of readings.**
- **Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

GE 02: CHEMISTRY OF FOOD

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CHEMISTRY OF FOOD	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the chemistry of foods - composition of food, role of each component
- To understand the different macromolecules and micro molecules in food
- To understand how food components contribute to overall quality of foods

Learning outcomes

The Learning Outcomes of this course are as follows:

- To understand the chemistry of foods - composition of food
- To understand the role of each component, their properties and reactions in food
- To comprehend how dietary components influence total food quality

SYLLABUS OF GE 02

Unit1: Introduction to chemistry of Food (5 Hours)

Introduction to Food Chemistry

Brief composition of food (Carbohydrates, fats, proteins, vitamins, minerals and pigments)

Unit2: Chemistry of Macromolecules (20 Hours)

Water: Definition of water in food, Structure of water and ice, Types of water, Role of water activity in shelf life and packaging Carbohydrates: Introduction, Classification, and Chemical reactions of carbohydrates Protein: Introduction, classification and structure, types of food protein (meat, egg, milk and wheat)

Lipids: Introduction, classification and structure of triglycerides, types of fatty acid, deterioration of fats and oils. (Autooxidation and lipolysis)

Unit3: Chemistry of Micro molecules (10 Hours)

Vitamins: Introduction, types (water soluble and fat soluble vitamins)

Minerals: Introduction, major and minor minerals, Toxic minerals in food

Unit4: Flavors and Pigments (10 Hours)

Definition and basic tastes

Description of some common food flavors

Introduction and classification of pigments

Practical Exercises: 30 Hours

The learners are required to:

- Preparation of primary and secondary solutions
- Estimation of moisture content
- Determination of gelatinization temperature range (GTR) of different starches
- Determination of effect of additives on GTR of starches
- Estimation of total nitrogen content by Kjeldahl method
- Estimation of fat
- Estimation of total ash and acid insoluble ash
- Estimation of reducing sugar

Essential/recommended readings

- DeMan, John M. (1995). Principles of Food Chemistry. 3rd Ed., Springer.
- Fennema, Owen R. (2008). Fennema's Food Chemistry-CRC Press (2008) - 4th Edition.
- Potter,N.N.and Hotchkiss,J.H.(2007). Food Science 5th Ed. New York: Chapman & Hall.
- Richard Owusu-Apenten. (2002) Introduction to Food Chemistry. CRC press
- Hans-Dieter Belitz, Werner Grosch, Peter Schieberle. (2009) Food Chemistry. Springer link

- **Note: Learners are advised to use the latest edition of readings.**

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

B.A (Prog.) with Nutrition and Health Education (NHE) as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-NHE: DIET PLANNING THROUGH THE LIFE SPAN

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Diet Planning Through the Life Span	4	3	0	1	Class XII Pass	DSC-1-NHE and DSC-2-NHE

Learning Objectives:

1. To introduce students to the basic concepts of meal planning.
2. To equip them with knowledge of physiological changes, nutritional requirements, nutritional concerns and healthy food choices during the life cycle.

Learning Outcomes:

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

1. Describe physiological changes and nutritional requirements across the lifespan.
2. Understand the factors affecting meal planning.
3. Understand the importance of food exchange list and use them for meal planning.
4. Plan and prepare balanced meals and nutritious snacks for various age groups.

SYLLABUS OF DSC-3

Theory:

Unit 1: Nutrient Requirements and Recommendations (5 Hours)

- *Unit Description*: This unit will introduce the concept of dietary reference intake.

- *Subtopics:*
    - Nutrient requirement - concept and background
    - Dietary reference intake
    - EAR and RDA
    - Reference man and reference woman

Unit 2: Fundamentals of Menu Planning (6 Hours)

- *Unit Description:* This unit will introduce essential requirements for planning of meals.

- *Subtopics:*
  - Introduction and use of food exchange list
  - Concept and importance of meal planning
  - Factors affecting meal planning

Unit 3: Nutrition during Childhood (16 Hours)

- *Unit Description:* This unit will introduce nutritional requirement, physiological changes, nutritional concerns and healthy eating practices during childhood.
- *Subtopics:*
  - Infancy
  - Preschoolers
  - School- going children
  - Adolescents

Unit 4: Nutrition during Adulthood and Old Age (18 Hours)

- *Unit Description*: This unit will introduce nutritional requirement, physiological changes, nutritional concerns and healthy food choices during adulthood and old age.
- *Subtopics:*
  - Adulthood
  - Pregnancy
  - Lactation
  - Old age

Practical: 30 Hours

Unit 1: Introduction to Meal Planning (10 Hours)

- *Subtopics:*
  - Use of comprehensive food exchange list in meal planning
  - Meal distribution and menu planning
  - Nutrient calculations

Unit 2: Planning and Preparation of Diets/Dishes/Snacks (20 Hours)

- *Subtopics:*
  - Infant- complementary feeding
  - Preschooler child

- School aged child
- Adolescent
- Adult
- Pregnant and lactating woman
- Elderly

Essential/recommended readings:

1. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
2. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.
3. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6^{th} ed.). Delhi: New Age International (P) Ltd.
4. Siddhu, A., Bhatia, N., Singh, K., Gupta, S. (Eds.). (2017). *Lady Irwin College Technical series 6: Compilation of food exchange list.* Delhi: Global books organisation.
5. Puri, S. et al (2020). *Food exchange list- A tool for meal planning.* New Delhi: Elite publishing house.
6. Longvah, T. et al (2017). *Indian food composition tables.* Hyderabad, Telangana: National Institute of Nutrition.

Suggested readings:

1. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11^{th} ed.). New York, NY: McGraw Hill.
2. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5^{th} ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Edelstein, S., & Sharlin, J. (Eds). (2009). *Life cycle nutrition – an evidence based approach* Burlington, MA: Jones and Barlett Publishers.

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

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-NHE: DIETARY GOALS AND GUIDELINES FOR INDIANS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Dietary Goals and Guidelines for Indians	4	3	1	0	Class XII Pass	NIL

Learning Objectives:

1. To introduce the concept of nutritionally adequate diets and healthy lifestyles from conception till old age.
2. To equip the students with the knowledge of dietary goals and guidelines for Indians relating to nutritional requirements, deficiency diseases and chronic diet-related disorders.

Learning Outcomes:

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

1. Describe food groups, food pyramid and the concept of a balanced diet.
2. Understand the physiological changes throughout the lifespan.
3. Acquaint themselves with the dietary goals and dietary guidelines for Indians across the life cycle.

SYLLABUS OF DSC-4

Theory:

Unit 1: Basic Concepts of Food (9 Hours)

- *Unit Description:* This unit will introduce various food groups, concept of balanced diet, food pyramid and other aspects regarding diet.
- *Subtopics:*
  - Food groups: basic classification and nutritional contribution
  - Food pyramid
  - Balanced diet and My food plate
  - Food facts, fads and fallacies

Unit 2: Dietary Guidelines I (15 Hours)

- *Unit Description:* This unit will introduce basic dietary goals for healthy living and dietary guidelines.
- *Subtopics:*
    - Dietary goals
    - Guidelines to ensure nutritional adequacy and prevent deficiency diseases
    - Guidelines related to various stages of life

Unit 3: Dietary Guidelines II (13 Hours)

- *Unit Description:* This unit will introduce dietary guidelines to deal with health concerns and healthy food practices.
- *Subtopics:*
    - Guidelines to maintain an ideal body weight and prevent chronic diet-related disorders
    - Guidelines regarding food-related practices

Unit 4: Practical Application of Dietary Guidelines (8 Hours)

- *Unit Description:* This unit will introduce practical aspects with suitable examples to attain all dietary guidelines for Indians.
- *Subtopics:*
  Sample eating patterns/ menus for the following meals/ snacks:
    - Breakfast
    - Lunch/packed lunch
    - Dinner
    - Snacks

Essential/recommended readings:

1. Damyanthi, K. et al. (2011). *Dietary guidelines for Indians- A manual.* (2nd ed.) Hyderabad. National Institute of Nutrition.
2. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
4. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.

Suggested readings:

1. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6^{th} ed.). Delhi: New Age International (P) Ltd.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11^{th} ed.). New York, NY: McGraw Hill.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5th ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.

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

B.A (Prog.) with Nutrition and Health Education (NHE) as Non-Major

Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-NHE: DIETARY GOALS AND GUIDELINES FOR INDIANS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Dietary Goals and Guidelines for Indians	4	3	1	0	Class XII Pass	NIL

Learning Objectives:

1. To introduce the concept of nutritionally adequate diets and healthy lifestyles from conception till old age.
2. To equip the students with the knowledge of dietary goals and guidelines for Indians relating to nutritional requirements, deficiency diseases and chronic diet-related disorders.

Learning Outcomes:

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

1. Describe food groups, food pyramid and the concept of a balanced diet.
2. Understand the physiological changes throughout the lifespan.
3. Acquaint themselves with the dietary goals and dietary guidelines for Indians across the life cycle.

SYLLABUS OF DSC-2

Theory:

Unit 1: Basic Concepts of Food (9 Hours)

- *Unit Description:* This unit will introduce various food groups, concept of balanced diet, food pyramid and other aspects regarding diet.
- *Subtopics:*
    - Food groups: basic classification and nutritional contribution

- Food pyramid
- Balanced diet and My food plate
- Food facts, fads and fallacies

Unit 2: Dietary Guidelines I (15 Hours)

- *Unit Description:* This unit will introduce basic dietary goals for healthy living and dietary guidelines.
- *Subtopics:*
  - Dietary goals
  - Guidelines to ensure nutritional adequacy and prevent deficiency diseases
  - Guidelines related to various stages of life

Unit 3: Dietary Guidelines II (13 Hours)

- *Unit Description:* This unit will introduce dietary guidelines to deal with health concerns and healthy food practices.
- *Subtopics:*
  - Guidelines to maintain an ideal body weight and prevent chronic diet-related disorders
  - Guidelines regarding food-related practices

Unit 4: Practical Application of Dietary Guidelines (8 Hours)

- *Unit Description:* This unit will introduce practical aspects with suitable examples to attain all dietary guidelines for Indians.
- *Subtopics:*
  Sample eating patterns/ menus for the following meals/ snacks:
  - Breakfast
  - Lunch/packed lunch
  - Dinner
  - Snacks

Essential/recommended readings:

1. Damyanthi, K. et al. (2011). *Dietary guidelines for Indians- A manual.* (2nd ed.) Hyderabad. National Institute of Nutrition.
2. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.

4. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.

Suggested readings:

1. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6^{th} ed.). Delhi: New Age International (P) Ltd.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11^{th} ed.). New York, NY: McGraw Hill.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5th ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.

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CATEGORY-II
B.A (Prog.) with Human Development and Family Empowerment (HDFE) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-HDFE: ADULTHOOD AND AGEING THROUGH A LIFE SPAN PERSPECTIVE

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Adulthood and Ageing through a Lifespan perspective	**4**	**2**	0	**2**	Class XII Pass	DSC-1-HDFE and DSC-2-HDFE (both as Major)

Learning Objectives:
1. To understand the developmental patterns in early, middle and late adulthood.
2. To understand the needs and challenges of the older adults.
3. To use research tools to investigate the ageing process and develop critical thinking skills, necessary to do research in the field of ageing.

Learning Outcomes:

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

1. Understand the characteristics of Adulthood and old age.
2. Understand the challenges of adulthood and ageing and the coping strategies.
3. Students will develop awareness about the developmental patterns in adulthood.
4. Sensitizing students towards the concerns of adulthood and ageing.

THEORY
(Credits:2, Periods: 30)

Unit 1: Adulthood and Ageing (10 hours)

- *Unit Description*: This unit will introduce the concept of adulthood and ageing
- *Subtopics:*
    - Understand definition
    - Concept and scope of ageing as a field of study

- Theoretical perspectives on ageing
- Developmental Tasks of Adulthood

Unit 2: Early & Middle Adulthood (10 hours)

- *Unit Description*: This unit will introduce the concept of early and middle adulthood.
- *Subtopics:*
  - Characteristics
  - Developmental milestones - Physical, cognitive, social and emotional development

Unit 3: Late Adulthood (10 hours)

- *Unit Description*: This unit will introduce the concept of Late adulthood.

- *Subtopics:*
  - Definition
  - Characteristics
  - Developmental milestones
  - Physical changes in males and females
  - Psychological implications of physical changes. Social – Emotional Development. Cognitive Development

PRACTICAL
(Credits: 2, Periods: 60)

- **Unit 1: Conduct Case profile of a senior citizen (30 hours)**
- **Unit 2: Visit to a senior citizen home and /or Movie review (30 hours)**

Essential / recommended readings:

1. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
2. Rice, F.P. (1998). *Human Development: A Life-span Approach* (3rd edition). US: Prentice Hall.
3. Santrock, J. W. (2011). *Life-span development* (13th ed.). McGraw-Hill Education.
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication

Suggested Readings:

1. Patrick, J.H., Hayslip Jr. B., Sawyer, L.H. (2000). *Adult Development and aging: Growth, longevity and challenges* (1st edition). Sage Publications
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. Hyderabad: Orient Blackswan Pvt.
3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan

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

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-HDFE: INTRODUCTION TO HUMAN DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Human Development	**4**	**2**	0	**2**	Class XII Pass	DSC-1-HDFE and DSC-2-HDFE (both as Major)

Learning Objectives:

1. To create an understanding of various stages of lifespan development.
2. To understand developmental changes occurring during infancy, childhood, adolescence.
3. To understand the conflicts during various stages of lifespan development and ways to deal with it.

Learning Outcomes:

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

1. Understand developmental changes occurring during the lifespan with respect to infancy, childhood, adolescence
2. Understand various stages of lifespan development with respect to conflicts and ways to deal with it.
3. Learn the basic skills of research and documentation and apply the knowledge of methods of data collection in real life situations.

THEORY
(Credits: 2; Periods: 30)

Unit 1: Development in early years: The new-born and stage of infancy (10 Hours)

- *Unit Description:* This unit will discuss about the development in early years
- *Subtopics:*
    - New-born: Characteristics.
    - Reflexes
    - Infant developmental milestones

Unit 2: Childhood- Early & Middle (10 Hours)

- *Unit Description:* This unit will introduce all domains of development with regard to early and middle childhood period.
- *Subtopics:*
    - Physical Development.
    - Socio-emotional Development.
    - Cognitive and Language Development

Unit 3: Adolescence (10 Hours)

- *Unit Description:* This unit will introduce regarding adolescent age group
- *Subtopics:*
  - Definition.
  - Characteristics.
  - Developmental milestones.
  - Physical changes in males and females.
  - Psychological implications of physical changes.
  - Social – Emotional Development.
  - Cognitive Development.

PRACTICAL
(Credit: 2, Periods: 60)

Unit 1: Understand Methods and techniques of child study. (15 hours)

Unit 2: Conduct any 2 interviews. (30 hours)

Unit 3: Conduct any 1 observation. (15 hours)

Essential / recommended readings:

1. Bee, H. L (2011). *The developing child*. London: Pearson.
2. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
3. Santrock, J. W. (1996). *Child development*. New York: Tata McGraw Hill
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.

Suugested readings:

1. Papilla, D.E., Olds, S. W. and Feldman, R. D (2004). *Human development*. New York: Mcgraw Hill.
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. London: Orient Longman.

3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.
4. Sapra, R. (2007). *Manav vikas: Ek parichaya*. New Delhi: Vishwa Bharti Publications. Chapter 1, pg 1-6

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

CATEGORY-III

B.A (Prog.) with Human Development and Family Empowerment (HDFE) as Non-Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-HDFE: INTRODUCTION TO HUMAN DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Human Development	**4**	**2**	0	**2**	Class XII Pass	DSC-2-HDFE (Non-Major)

Learning Objectives:

1. To create an understanding of various stages of lifespan development.
2. To understand developmental changes occurring during infancy, childhood, adolescence.
3. To understand the conflicts during various stages of lifespan development and ways to deal with it.

Learning Outcomes:

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

1. Understand developmental changes occurring during the lifespan with respect to infancy, childhood, adolescence
2. Understand various stages of lifespan development with respect to conflicts and ways to deal with it.
3. Learn the basic skills of research and documentation and apply the knowledge of methods of data collection in real life situations.

THEORY
(Credits: 2; Periods: 30)

Unit 1: Development in early years: The new-born and stage of infancy (10 Hours)

- *Unit Description:* This unit will discuss about the development in early years
- *Subtopics:*
  - New-born: Characteristics.
  - Reflexes
  - Infant developmental milestones

Unit 2: Childhood- Early & Middle (10 Hours)

- *Unit Description:* This unit will introduce all domains of development with regard to early and middle childhood period.
- *Subtopics:*
    - Physical Development.
    - Socio-emotional Development.
    - Cognitive and Language Development

Unit 3: Adolescence (10 Hours)

- *Unit Description:* This unit will introduce regarding adolescent age group
- *Subtopics:*
    - Definition.
    - Characteristics.
    - Developmental milestones.
    - Physical changes in males and females.
    - Psychological implications of physical changes.
    - Social – Emotional Development.
    - Cognitive Development.

PRACTICAL
(Credit: 2, Periods:60)

Unit 1: Understand Methods and techniques of child study. (15 hours)

Unit 2: Conduct any 2 interviews. (30 hours)

Unit 3: Conduct any 1 observation. (15 hours)

Essential / recommended readings:

1. Bee, H. L (2011). *The developing child*. London: Pearson.
2. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
3. Santrock, J. W. (1996). *Child development*. New York: Tata McGraw Hill
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.

Suugested readings:

1. Papilla, D.E., Olds, S. W. and Feldman, R. D (2004). *Human development*. New York: Mcgraw Hill.
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. London: Orient Longman.
3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.

4. Sapra, R. (2007). *Manav vikas: Ek parichaya*. New Delhi: Vishwa Bharti Publications. Chapter 1, pg 1-6

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

Category-II

B.A (Prog.) with Apparel Design and Construction (ADC) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-ADC: GARMENT DETAILING

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Garment Detailing	4	2	0	2	Class XII Pass	DSC-1-ADC and DSC-2-ADC

Learning Objectives:

1. To impart basic knowledge required for layout planning on fabrics requiring special attention
2. To familiarise the students about the concepts related to the handling of special fabrics
3. To create an understanding of designing clothes for people with special needs.
4. To develop pattern making and construction skills for various garments and their components
5. To impart skills for developing design variations through dart manipulations

Learning Outcomes:

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

1. Plan pattern layout on fabrics with special requirements
2. Calculate the fabric requirement per garment
3. Make use of different marker making methods
4. Use design variations of garment components in garment construction
5. Carry out dart manipulation according to design variations
6. Handle special fabrics during pattern layout and sewing
7. Design clothes for people with special needs

SYLLABUS OF DSC-3

Theory:

Unit 1: Layout planning **(8 Hours)**

- *Unit Description:* This unit deals with planning on special fabrics, assessing fabric requirement per garment and marker making.

- *Sub Topics:*
    - Pattern Layouts on special fabrics- unidirectional, bold and large prints, stripes and checks, border design, irregular design fabric, napped fabric
    - Calculation of material requirement for garment construction
    - Marker Making – Factors influencing marker making, Methods of marker making.

Unit 2: Design variations in Garment Components (12 Hours)

- *Unit Description:* This unit focuses on the study of garment components and their design variations. It also covers dart manipulation and creating design variations.

- *Sub Topics:*
    - Study of Garment components – terms, types and Styles, evaluation criteria – Necklines, Collars, Sleeves, Cuff, Yokes, Pockets, Plackets
    - Design variations in bodice, skirts, silhouettes, trousers
    - Dart manipulation: Definition, Principles, Methods, dart equivalents

Unit 3: Handling of Special Fabrics (10 Hours)

- *Unit Description:* This unit provides the basic knowledge relating to special fabrics and their handling. It also deals with the concepts and requirements of self-help garments and maternity wear.

- *Sub Topics:*
    - Definition and features of Special fabrics
    - Handling of fabrics with reference to designing, layout, marking, cutting, stitching, needle sizes, stitch sizes, threads used, seams and other special considerations – Sheer and slippery fabrics, napped and pile fabrics, lace, silk & crepe, velvet, wool, knits, plaids and stripes. Preparation of a sample file.
    - Garment designing for special needs: basic principles and design requirements – Self-help, maternity wear

Practical:

Unit 1: Basic Blocks and Dart Manipulation (20 Hours)

- *Sub Topics:*
    - Dart manipulation techniques - Single and double dart series, style lines, Yokes, adding fullness
    - Hip length/ Torso Draft
    - Trousers Block
    - Men's Bodice Block

Unit 2: Construction of Garments and their Components (40 Hours)

- *Sub Topics:*

- Preparation of Samples of any three styles of Sleeves
- Preparation of Samples of any three styles of Collars
- Preparation of Samples of any three styles of pockets
- Preparation of Samples of Plackets - continuous bound, even hem, zipper, tailored placket
- Designing and stitching of one upper and one lower garment

Essential/ Recommended Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York
3. Macdonald Nora M., (2009), Principles of Flat-Pattern Design, Fairchild Books, New York.
4. Shaeffer Claire, (2003), Sew any Fabric, Krause Publications

Suggested Readings:

1. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
2. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
3. Mansfield, E. A. & Lucas, E. L., (1974), Clothing Construction, Houghton Mifflin
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, US

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

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-ADC: BASIC PATTERN MAKING AND CLOTHING CONSTRUCTION

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basic Pattern Making and Clothing Construction	4	2	0	2	Class XII Pass	Nil

Learning Objectives:

1. To introduce students to basic concepts of Body measurements and pattern making
2. To equip the students with the knowledge of pattern layout, fabric cutting, garment sewing and assessing fit in a garment.

Learning Outcomes:

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

1. Take measurements from body and garments accurately.
2. Create patterns of simple women's clothes and apply the pattern information correctly.
3. Operate a sewing machine for simple sewing tasks using the correct thread, needle and stitch length for various fabrics.
4. Use various types of seams and seam techniques during garment construction
5. Apply concept of fit, evaluate garment fit and do pattern alterations as necessary.

SYLLABUS OF DSC-4

Theory:

Unit 1: Body Measurements and Pattern Making (10 Hours)

- *Unit Description:* This unit introduces the students to the process of taking measurements from body or garment and developing basic blocks for creating garment patterns. It also provides an understanding of the different types of patterns as well as using the symbols and markings mentioned on a pattern correctly.

- *Sub Topics:*
  - Importance of Body measurements, Body Landmarks, Correct procedure of taking body measurements, size charts, Taking measurements from Garments
  - Garment Ease - type and amount in different garments

- Basic Blocks and their importance
- Methods of pattern development: Drafting, Flat pattern making, Draping
- Types of paper pattern - Commercial pattern, Graded pattern, Production pattern
- Pattern information and marking symbols and their importance

Unit 2: Sewing Machines **(8 Hours)**

- *Unit Description:* This unit provides the essential knowledge required for operating and maintaining a sewing machine for garment construction.

- *Sub Topics:*
  - Classification of Sewing machines
  - Components of a Basic Sewing machine and their functions
  - Introduction to Industrial sewing machines- single needle lock stitch, overlock, blind stitching, button hole and button stitching, bartacking
  - Sewing defects and remedies
  - Care and maintenance of a sewing machine, precautions while working on a sewing machine
  - Selection of threads, needles and stitch length for various fabrics

Unit 3: Sewing Techniques and Garment Fit **(12 Hours)**

- *Unit Description:* This unit imparts knowledge of seam categories and seam techniques. It also deals with the concept of garment fit and correcting fitting problems through pattern alteration.

- *Sub Topics:*
  - Garment Support Fabrics (Lining, Underlining, Interlining, Interfacing) – their use and selection
  - Basic seam categories- super imposed seam, lapped seam, bound seam, flat seam, decorative seam, ridge seam
  - Additional seam techniques: clipping, notching, grading, trimming, easing, under stitching, stay stitching, trimming a corner
  - Finishing of straight & curved edges- self finish, crossway strips, bias facing, bias binding, shaped facing, self-finishing, casings and finishing with trims
  - Elements of Fit: line, ease, grain, set and balance
  - Fit evaluation, Common fitting problems and pattern correction

Practical: 60 Hours

Unit 1: Development of Basic Blocks and design variations **(20 Hours)**

- *Subtopics:*
  - Adult women's bodice block, sleeve block, skirt block
  - Developing design variations in adult skirt- A-line, flared, wrap-around, pleated, skirt with yoke

Unit 2: Seams and Garment Construction **(40 Hours)**

- *Subtopics:*

- Samples of Seams – Plain Seam, French seam, Run-n-fell seam, Lapped seam, Top stitching, Bound/Piped seam, Slot seam, Curved and Corner seam
- Necklines and their finishing: bias facing, bias binding, shaped facing
- Adaptation of basic blocks to construct Saree blouse, Kurti/Kameez, Skirt
- Construction of lower garments: Salwar/ Churidar, Palazzo

Essential Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
3. Colton V. (1995). Reader's Digest- Complete Guide to Sewing. New York: The Reader's Digest Association, Inc.
4. Knowles A. (2006). Patternmaking for Fashion Designers. New York: Fairchild Publications Inc.
5. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York

Suggested Readings:

1. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
2. Kindersley D. (1996). The Complete Book of Sewing. London: Dorling Kindersley Limited.
3. MacDonald M. (2009). Principles of Flat Pattern Design (4th Edition). New York: Fairchild Publications Inc
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, America

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

Category-III

B.A (Prog.) with Apparel Design and Construction (ADC) as Non-Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-ADC: BASIC PATTERN MAKING AND CLOTHING CONSTRUCTION

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basic Pattern Making and Clothing Construction	4	2	0	2	Class XII Pass	NIL

Learning Objectives:

1. To introduce students to basic concepts of Body measurements and pattern making
2. To equip the students with the knowledge of pattern layout, fabric cutting, garment sewing and assessing fit in a garment.

Learning Outcomes:

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

1. Take measurements from body and garments accurately.
2. Create patterns of simple women's clothes and apply the pattern information correctly.
3. Operate a sewing machine for simple sewing tasks using the correct thread, needle and stitch length for various fabrics.
4. Use various types of seams and seam techniques during garment construction
5. Apply concept of fit, evaluate garment fit and do pattern alterations as necessary.

SYLLABUS OF DSC-2

Theory:

Unit 1: Body Measurements and Pattern Making (10 Hours)

- *Unit Description:* This unit introduces the students to the process of taking measurements from body or garment and developing basic blocks for creating garment patterns. It also provides an understanding of the different types of patterns as well as using the symbols and markings mentioned on a pattern correctly.

- *Sub Topics:*
    - Importance of Body measurements, Body Landmarks, Correct procedure of taking body measurements, size charts, Taking measurements from Garments
    - Garment Ease - type and amount in different garments
    - Basic Blocks and their importance
    - Methods of pattern development: Drafting, Flat pattern making, Draping
    - Types of paper pattern - Commercial pattern, Graded pattern, Production pattern
    - Pattern information and marking symbols and their importance

Unit 2: Sewing Machines (8 Hours)

- *Unit Description:* This unit provides the essential knowledge required for operating and maintaining a sewing machine for garment construction.

- *Sub Topics:*
    - Classification of Sewing machines
    - Components of a Basic Sewing machine and their functions
    - Introduction to Industrial sewing machines- single needle lock stitch, overlock, blind stitching, button hole and button stitching, bartacking
    - Sewing defects and remedies
    - Care and maintenance of a sewing machine, precautions while working on a sewing machine
    - Selection of threads, needles and stitch length for various fabrics

Unit 3: Sewing Techniques and Garment Fit (12 Hours)

- *Unit Description:* This unit imparts knowledge of seam categories and seam techniques. It also deals with the concept of garment fit and correcting fitting problems through pattern alteration.
- *Sub Topics:*
    - Garment Support Fabrics (Lining, Underlining, Interlining, Interfacing) – their use and selection
    - Basic seam categories- super imposed seam, lapped seam, bound seam, flat seam, decorative seam, ridge seam
    - Additional seam techniques: clipping, notching, grading, trimming, easing, under stitching, stay stitching, trimming a corner
    - Finishing of straight & curved edges- self finish, crossway strips, bias facing, bias binding, shaped facing, self-finishing, casings and finishing with trims
    - Elements of Fit: line, ease, grain, set and balance
    - Fit evaluation, Common fitting problems and pattern correction

Practical: 60 Hours

Unit 1: Development of Basic Blocks and design variations (20 Hours)

- *Subtopics:*
    - Adult women’s bodice block, sleeve block, skirt block

- Developing design variations in adult skirt- A-line, flared, wrap-around, pleated, skirt with yoke

Unit 2: Seams and Garment Construction (40 Hours)

- *Subtopics:*
  - Samples of Seams – Plain Seam, French seam, Run-n-fell seam, Lapped seam, Top stitching, Bound/Piped seam, Slot seam, Curved and Corner seam
  - Necklines and their finishing: bias facing, bias binding, shaped facing
  - Adaptation of basic blocks to construct Saree blouse, Kurti/Kameez, Skirt
  - Construction of lower garments: Salwar/ Churidar, Palazzo

Essential Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
3. Colton V. (1995). Reader's Digest- Complete Guide to Sewing. New York: The Reader's Digest Association, Inc.
4. Knowles A. (2006). Patternmaking for Fashion Designers. New York: Fairchild Publications Inc.
5. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York

Suggested Readings:

1. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
2. Kindersley D. (1996). The Complete Book of Sewing. London: Dorling Kindersley Limited.
3. MacDonald M. (2009). Principles of Flat Pattern Design (4th Edition). New York: Fairchild Publications Inc
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, America

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

Category-II

B.A. (Prog.) with Food Technology (FT) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-FT: NUTRITION AND WELL BEING FOR LIFESPAN

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF 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 Well Being for Lifespan	4	3	0	1	Class XII Pass	DSC-1-FT

LEARNING OBJECTIVES:

1. To make students understand the concept of wellbeing, good health, dietary guidelines and lifestyle management.
2. To familiarize students with the salient physiological changes and nutrition related health concerns during various stages of lifespan.
3. To familiarize students with the dietary guidelines and lifestyle practices which would support overall wellbeing and good health
4. Make students plan and prepare nutritious meals for self, family and the community.

LEARNING OUTCOMES:

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

1. Appreciate the role of dietary guidelines and lifestyle management in promoting health and well being
2. Adopt a healthy and active lifestyle suitable to each physiological stage in lifespan
3. Enhance ability to make healthy food choices for self, family and the community
4. Develop educational aids to impart nutrition knowledge.

SYLLABUS OF DSC-3-FT

THEORY:

UNIT I: Maternal and Infant Nutrition **(12 Hours)**

- *Unit Description:* This unit will focus on basic concepts of wellbeing, dietary guidelines as well as maternal and infant nutrition.

- *Subtopics:*
    - Basic concepts: well-being, nutritional status, dietary guidelines and lifestyle management
    - Pregnancy - physiological changes during pregnancy, dietary guidelines, the role of nutrition in the developmental origins of disease
    - Lactation - factors affecting nutritional requirements, dietary guidelines, breast feeding practices
    - Infancy - growth and development, growth monitoring, dietary guidelines (advantages of mother's milk, complimentary feeding)

UNIT II: Child and Adolescent Nutrition (12 Hours)

- *Unit Description:* This unit will focus on dietary guidelines and lifestyle management of children and adolescents.
- *Subtopics:*
    - Childhood Years: growth and development, dietary guidelines during early, middle and late childhood years, common nutrition concerns.
    - Adolescence: growth and development, eating behaviour, dietary guidelines, common health problems during adolescence, eating disorders, lifestyle management.

UNIT III: Nutrition during Adulthood (12 Hours)

- *Unit Description:* This unit will focus and reference man as well as woman and nutritional needs of adults.
- *Subtopics:*
    - Reference Man and Reference Woman, dietary guidelines, role of nutrition in adulthood in the prevention and development of chronic diseases
    - Lifestyle management: healthy eating behaviour, physical activity, stress management, sleep pattern.

Unit IV: Nutrition for the Elderly (9 Hours)

- *Unit Description:* This unit will focus on nutritional needs, lifestyle management, longevity and care for elderly.
- *Subtopics:*
    - Introduction to Geriatrics, physiological changes, nutrition and longevity, nutritional concerns, dietary guidelines, Nutrition and chronic Degenerative Diseases, Nutrient-Drug Interactions (basic concept).

PRACTICAL: 30 Hours

No. of Students per Practical Class Group: 10-15

1. Develop a poster/chart on dietary guidelines or lifestyle management for adults (sedentary, moderate, heavy workers) or pregnant woman. (4 Hours)
2. Develop a digital educational aid on importance of colostrum/mother's milk/food behaviour/lifestyle management (2 Hours)
3. Develop a questionnaire on common nutrition/health concerns (2 Hours)
4. Learn to fill growth chart for under five years children (case study) (2 Hours)
5. Plan and prepare nutritious snack for Pregnant women (iron and folic acid rich) (2 Hours)
6. Plan and prepare nutritious snack Lactating mother (protein and calcium rich) (2 Hours)
7. Plan and prepare nutritious snack Pre-schooler (Vitamin A rich) (2 Hours)
8. Plan and prepare nutritious tiffin for School going child (energy and protein rich) (2 Hours)
9. Plan and prepare nutritious snack for adolescents (energy and protein rich) (2 Hours)
10. Plan and prepare nutritious snack for Elderly (easy to prepare, protein and micro-nutrient rich) (2 Hours)
11. Plan and prepare premix or complimentary food for infants (2 Hours)
12. Plan and organize a health awareness activity in college for college students (exhibition of model snacks/tiffins/one dish 2meals) OR Plan and play a skit on the concept of longevity for elderly in a nearby slum or community center or college event (Group activity) (6 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Chadha, R., & Mathur, P. (Eds.). (2015). Textbook Nutrition: A Lifecycle Approach. Orient Blackswan. ISBN978-8125059301
2. Khanna, K., Gupta, S., Passi, S. J., Seth, R., Mahna, R., & Puri, S. (2013). Textbook of Nutrition and -Dietetics (2nd ed.). Elite Publishing House Pvt. Ltd. ISBN: 978-81- 88901-53-1
3. Srilakshmi, B. (2006). Dietetics. New Age International (P) Limited Publishers. ISBN 81-224-1611-X
4. Wardlaw, G. M., & Smith, A. M. (2015). Contemporary Nutrition (9th ed.). McGraw Hill Education (India) Private Limited.

SUGGESTED READINGS:

1. Evans, S. (2009). Nutrition: A Lifespan Approach, Wiley-Blackwell. ISBN:978-1-405- 17878-5.
2. Shubhangini A Joshi, S. (2021). Nutrition and Dietetics (5th ed.). McGraw Hill Education (India) Private Limited. ISBN:978-93-90727-82-7.
3. Bernstein, M. & McMahon, K. (2018). Nutrition Across Life Stages, Jones & Bartlett Publishers. ISBN: 9781284102161
4. Katz, D., Yeh, M. and Levitt, J. (2022). Wolters Kluwer Publishers. ISBN: 9781975161491

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

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-FT: FOOD SCIENCE PART-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		
Food Science Part-II	4	3	0	1	Class XII Pass	DSC-2-FT

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LEARNING OBJECTIVES:

1. To familiarize the students with the composition and processing of milk, egg, sugars, fats and miscellaneous food.
2. To impart concept of properties of fats and oil, sugar, egg foam stages and emulsions.

LEARNING OUTCOMES:

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

1. Describe the composition and nutritive value of milk, egg, sugar and fats and their role in food processing.
2. Develop understanding about basic processing of milk and eggs.
3. Illustrate the behaviour of sugar at various temperatures.
4. Describe spoilage of fat scientifically, determine the smoke point of different fats and illustrate the ways to prevent rancidity of fats.

THEORY:

UNIT I: MILK (9 Hours)

- *Unit Description:* This unit is about milk, its nutritive value, processing, types and effect of processing on milk quality.
- *Subtopics:*
    - Nutritive value
    - Introduction to liquid milk technology (clarification, pasteurization, homogenization, fortification, sterilization)
    - Types of milk
    - Effect of processing on milk

UNIT II: EGGS (12 Hours)

- *Unit Description:* This unit is about eggs its composition and nutritive value, structure, quality, foam formation and effect of heat on egg proteins.
- *Subtopics:*
  - Composition and nutritive value
  - Structure of an egg
  - Egg quality and deterioration
  - Effect of heat on egg proteins: Green ring formation in boiled egg
  - Storage and preservation of eggs
  - Egg foams – stages of preparation and factors affecting them

UNIT III: FATS AND OILS (12 Hours)

- *Unit Description:* This unit is about types of fats and oils, their functions, spoilage, precautions to be taken while using, emulsions and RUCO.
- *Subtopics:*
  - Definitions, types of fats and oils and their functions
  - Rancidity in fat and its prevention
  - Care of fat used for frying (smoke, flash and fire points)
  - Emulsions
  - Repurpose used cooking oil (RUCO).

UNIT IV: MISCELLANEOUS FOOD PRODUCTS (12 Hours)

- *Unit Description:* This unit is about miscellaneous food items like sugar and its properties and behaviour during cooking, tea and coffee processing and flavouring compounds in spices
- *Subtopics:*
  - Sugar: Properties, sugar behaviour during cooking.
  - Tea and Coffee: Types of tea and coffee, basic processing of tea and coffee.
  - Spices and Herbs: Types and flavouring components

PRACTICAL:30 Hours

No. of Students per Practical Class Group: 10-15

1. Determination of pH of different foods. (2 Hours)
2. Selection and purchase criteria of raw materials (cereal, pulses, vegetables, fruits and eggs) (2 Hours)
3. Effect of heat on milk processing. (2 Hours)
4. Effect of acid and alkali on milk processing. (2 Hours)

5. Egg white foam formation (2 Hours)
6. Factors affecting egg white foam stability (4 Hours)
7. Green ring formation in boiled eggs and its prevention (2 Hours)
8. Determination of the quality of an egg (2 Hours)
9. Behaviour of sugar at various temperatures (4 Hours)
10. Preparation of crystalline candies (2 Hours)
11. Preparation of non-crystalline candies (2 Hours)
12. Determination of smoke point of different fats and oil (2 Hours)
13. Preparation of emulsions – mayonnaise (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Suri, S. & Malhotra, A. (2014). *Food Science Nutrition and Safety*. Delhi: Pearson India Ltd.
   i. Online Question Bank and student E Resources:https://wps.pearsoned.co.in/suri_fsns_1/
   ii. Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
2. Sethi, P. &Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt.Ltd.
3. Srilakshmi, B. (2018). *Food Science*. Delhi: New Age International Pvt.Ltd.
4. Potter, N. & Hotchkiss, J.H. (2007). *Food Science.* 5th Edition. Delhi: CBSPublishers.
5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt.Ltd.
6. Sharma, A. (2010). *Textbook of Food Science and Technology*. 2nd Edition. Delhi:IBDC Publishers

SUGGESTED READINGS:

1. Manay, N. S. &Shadakashraswamy. (2020). Foods: Facts and Principles. 3rd Edition. New Age International Pvt Ltd.
2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Roday, S. (2018). Food Science and Nutrition. 3rd Edition. Delhi: Oxford University Press.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer

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

B.A. (Prog.) with Food Technology (FT) as Non-Major
Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2A-FT: FOOD SCIENCE PART-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		
Food Science Part-II	4	3	0	1	Class XII Pass	DSC-1A-FT

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LEARNING OBJECTIVES:

1. To familiarize the students with the composition and processing of milk, egg, sugars, fats and miscellaneous food.
2. To impart concept of properties of fats and oil, sugar, egg foam stages and emulsions.

LEARNING OUTCOMES:

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

1. Describe the composition and nutritive value of milk, egg, sugar and fats and their role in food processing.
2. Develop understanding about basic processing of milk and eggs.
3. Illustrate the behaviour of sugar at various temperatures.
4. Describe spoilage of fat scientifically, determine the smoke point of different fats and illustrate the ways to prevent rancidity of fats.

THEORY:

UNIT I: MILK (9 Hours)

- *Unit Description:* This unit is about milk, its nutritive value, processing, types and effect of processing on milk quality.
- *Subtopics:*
  - Nutritive value
  - Introduction to liquid milk technology (clarification, pasteurization, homogenization, fortification, sterilization)
  - Types of milk
  - Effect of processing on milk

UNIT II: EGGS **(12 Hours)**

- *Unit Description:* This unit is about eggs its composition and nutritive value, structure, quality, foam formation and effect of heat on egg proteins.
- *Subtopics:*
    - Composition and nutritive value
    - Structure of an egg
    - Egg quality and deterioration
    - Effect of heat on egg proteins: Green ring formation in boiled egg
    - Storage and preservation of eggs
    - Egg foams – stages of preparation and factors affecting them

UNIT III: FATS AND OILS **(12 Hours)**

- *Unit Description:* This unit is about types of fats and oils, their functions, spoilage, precautions to be taken while using, emulsions and RUCO.
- *Subtopics:*
    - Definitions, types of fats and oils and their functions
    - Rancidity in fat and its prevention
    - Care of fat used for frying (smoke, flash and fire points)
    - Emulsions
    - Repurpose used cooking oil (RUCO).

UNIT IV: MISCELLANEOUS FOOD PRODUCTS **(12 Hours)**

- *Unit Description:* This unit is about miscellaneous food items like sugar and its
properties and behaviour during cooking, tea and coffee processing and flavouring compounds in spices
- *Subtopics:*
    - Sugar: Properties, sugar behaviour during cooking.
    - Tea and Coffee: Types of tea and coffee, basic processing of tea and coffee.
    - Spices and Herbs: Types and flavouring components

PRACTICAL: 30 Hours

No. of Students per Practical Class Group: 10-15

1. Determination of pH of different foods. (2 Hours)
2. Selection and purchase criteria of raw materials (cereal, pulses, vegetables, fruits and eggs) (2 Hours)
3. Effect of heat on milk processing. (2 Hours)

4. Effect of acid and alkali on milk processing. (2 Hours)
5. Egg white foam formation (2 Hours)
6. Factors affecting egg white foam stability (4 Hours)
7. Green ring formation in boiled eggs and its prevention (2 Hours)
8. Determination of the quality of an egg (2 Hours)
9. Behaviour of sugar at various temperatures (4 Hours)
10. Preparation of crystalline candies (2 Hours)
11. Preparation of non-crystalline candies (2 Hours)
12. Determination of smoke point of different fats and oil (2 Hours)
13. Preparation of emulsions – mayonnaise (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Suri, S. & Malhotra, A. (2014). *Food Science Nutrition and Safety*. Delhi: Pearson India Ltd.
    a. Online Question Bank and student E Resources:https://wps.pearsoned.co.in/suri_fsns_1/
    b. Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
2. Sethi, P. &Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt.Ltd.
3. Srilakshmi, B. (2018). *Food Science*. Delhi: New Age International Pvt.Ltd.
4. Potter, N. & Hotchkiss, J.H. (2007). *Food Science.* 5th Edition. Delhi: CBSPublishers.
5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt.Ltd.
6. Sharma, A. (2010). *Textbook of Food Science and Technology*. 2nd Edition. Delhi:IBDC Publishers

SUGGESTED READINGS:

1. Manay, N. S. &Shadakashraswamy. (2020). Foods: Facts and Principles. 3rd Edition. New Age International Pvt Ltd.
2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Roday, S. (2018). Food Science and Nutrition. 3rd Edition. Delhi: Oxford University Press.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer

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

Category-IV

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

GENERIC ELECTIVES (GE HS 002): SELF DEVELOPMENT AND WELLBEING

Credit 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		
Self Development and Wellbeing	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the concepts of self-development and wellbeing
- To study theoretical perspectives and stages of self-development
- To understand framework and dimensions of wellbeing
- To understand the context and significance of managing emotions and wellbeing
- To study and understand activities for enhancing self-development and wellbeing

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will be able to understand the concept of self-development and parameters of wellbeing
- The student will be able to understand the theoretical perspectives on self-development and wellbeing
- The students will be able to demonstrate skills in developing and using contextually appropriate methods to promote well-being
- The student will be able to enhance their self-development and wellbeing through reflection and introspection

SYLLABUS OF GE HS 002

Unit I: Understanding the self (12 Hours)

To introduce various approaches and theories of self.
Subtopics:

- Definitions and concepts of self
- Perspectives on self
- Phases of self-development
- Theories of self-development

Unit II: Components of self-development (09 Hours)

To understand various aspects of self-development.
Subtopics:

- Components of Self- An integrated approach
- Self-concept and self esteem
- Social self and development
- Factors influencing self

Unit III: Concept, approaches and importance of wellbeing (12 Hours)

To understand basic definitions and concepts of wellbeing and interlink these with self-development.
Subtopics:

- Definitions and concept of Wellbeing
- Frameworks and dimensions of wellbeing
- Health and Wellbeing
- Happiness and Wellbeing

Unit IV: Promoting self-development and wellbeing (12 Hours)

To understand significance of activities related to wellbeing.
Subtopics:

- Managing relationships and emotions
- Happiness and emotional wellbeing
- Mindfulness and decision making
- Academics and Work-life balance
-

Practical component (if any)

PRACTICAL: 30 Hours

- An activity on self-reflection from early childhood to adolescence.
- Focused group discussion on self and wellbeing.
- Narrative analysis/: biographies and autobiographies/ Diagrammatic representation of the self)

- Selected exercises to promote wellbeing: Music, dance, literature, poetry, art, yoga, meditation, play, and theatre
- Psychometric tests- on self and wellbeing
- Session on basics of counselling
- Profile an organisation work in sector of counselling

Essential Readings

1. Burkitt, I. (2008). Social selves: Theories of self and society. Sage
2. Emmons, R. A., & Shelton, C. M. (2002). Gratitude and the science of positive psychology. Handbook of positive psychology, 18, 459-471.
3. Kakar, S. (1978). The inner world. Delhi: Oxford University Press.
4. Kakar, S. and Kakar, K. (2007). The Indian: The portraits of a people. London: Penguin/Viking.
5. Mathews, G., & Izquierdo, C. (Eds.). (2008). Pursuits of happiness: Well-being in anthropological perspective. Berghahn books.
6. Rice, F. P. (2007). Adolescent: Development, Relationship and Culture.
7. Sabharwal, N., Ranganathan, N., Singh, I. V., & Basu, S. (2017). Unit-1 Dimensions of Self: An Integrated Approach.
8. Santrock, J. (2010). LifeSpan Development: A Topical Approach, New Delhi: Tata McGraw Hill.
9. Snyder, C. R., Lopez, S. J., Edwards, L. M., & Marques, S. C. (Eds.). (2020). The Oxford handbook of positive psychology. Oxford university press.
10. Snyder, C.R., & Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage.
11. Winnicott, D. W. (2012). The family and individual development. Routledge.
12. Gough, I., & McGregor, J. A. (Eds.). (2007). Wellbeing in developing countries: from theory to research. Cambridge University Press.

Suggested Readings

1. Synder, C.R., Lopez, S.J., Pedrotti, J.T. (2011). Positive psychology: The scientific and
2. Practical explorations of human strengths. New Delhi: Sage.
3. Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books. Peterson, C. A. (2006). A Primer in Positive Psychology, Oxford University Press.
4. Nettle, D.S. (2006). Happiness: The Science Behind Your Smile, Oxford University Press.
5. Lyubomirsky, S. (2013). The Myths of Happiness: What Should Make You Happy, but Doesn't, What Shouldn't Make You Happy, but Does, Penguin.

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

GENERIC ELECTIVES (GE HS 006): NUTRITION FOR THE FAMILY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nutrition for the Family	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable students in understanding the principles of planning nutritionally adequate diets.
- To acquire knowledge about the nutritional needs and concerns of an individual throughout the life cycle.
- To make them exercise food choices consonant with good health based on sound knowledge of principles of nutrition.

Learning outcomes

The Learning Outcomes of this course are as follows:

The students will be able:

- The student will be able to comprehend the principles of planning nutritionally adequate diets.
- The student will be able to acquire knowledge about the nutritional needs and concerns of an individual throughout the life cycle.
- The student will be able to exercise food choices consonant with good health based on sound knowledge of principles of nutrition.

SYLLABUS OF GE HS 006

Unit I: Basics of nutrients requirements (06 Hours)

Concepts of estimated average requirements, recommended allowances and methods of assessing nutrient requirements in general for Indians
Subtopics:

- Concept of EAR, RDA and TUL
- Methods of assessment of nutrient requirements

Unit II: Principles of Meal Planning (06 Hours)

Concepts of food groups and food exchange lists for meal planning, factors affecting meal planning will be dealt with. Students will also be introduced to dietary guidelines for Indians.
Subtopics:

- Food groups
- Food exchange list
- Factors affecting meal planning and food related behaviour
- Dietary guidelines for Indians

Unit III: Nutrition during adulthood (18 Hours)

Physiological influence on nutrient requirements during adulthood (EAR/RDA), energy balance in adulthood, nutritional concerns and changes in requirements during pregnancy, lactation, and old age will be dealt with.
Subtopics:

- Adult men and women
- Pregnant women
- Lactating mothers
- Elderly

Unit IV: Nutrition during childhood (15 Hours)

Physiological changes during infancy, childhood and adolescence – growth and development; and their influence on nutrient requirements (EAR/RDA), concepts of nutrient requirements during these ages and nutrition concerns keeping in mind the changing food habits and importance of physical activity will be dealt with.
Subtopics:

- Infants
- Preschool children
- School children
- Adolescents

Practical component (if any)

PRACTICAL: 30 Hours

Introduction to meal planning:

- Rich sources of nutrients
- Use of food exchange lists

Planning nutritious diets for:

- Adult (Male and Female)
- Pregnant and Lactating woman
- Pre-schooler
- Adolescent
- Elderly

Planning and cooking of nutrient rich snacks/dishes for:

- Infants (Freshly prepared complementary foods)
- Packed tiffin
- Pregnancy/Lactation

Essential Readings

1. Chadha R and Mathur P eds. (2015). Nutrition: A Lifecycle Approach. New Delhi: Orient Blackswan
2. ICMR-NIN (2020). Expert Group on Nutrient Requirements for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR)-2020
3. Khanna K, Gupta S, Seth R, Passi SJ, Mahna R, Puri S (2013). Textbook of Nutrition and Dietetics. Delhi: Elite Publishing House Pvt. Ltd.
4. Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K (2017). Indian Food Composition Tables. National Institute of Nutrition, Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India, Hyderabad.
5. NIN (2011). Dietary Guidelines for Indians-A manual. Second Edition. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad.
6. Puri S, Bhagat A, Aeri, BT, Sharma A (2019). Food Exchange List: A Tool for Meal Planning. New Delhi: Elite Publishing House.
7. Seth V, Singh K, Mathur P (2018). Diet Planning Through the Lifecycle Part I: Normal Nutrition- A Practical Manual. 6th Edition. New Delhi: Elite Publishing House.
8. Siddhu, A, Bhatia, N, Singh, K, Gupta, S (2017). Compilation of Food Exchange List, Technical Series 6, Lady Irwin College, University of Delhi Publ. Global Books Organisation, Delhi.

Suggested Readings

1. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J (2013). Wardlaw"s Perspectives in Nutrition, McGraw- Hill International Edition, 9th edition
2. B Srilakshmi Eighth Edition (2019). Nutrition Science. New Age International Publishers.
3. Punita Sethi, Poonam Lakra (2015). Aahar Vigyan Suraksha evam Poshan.Delhi: Elite Publishing House Pvt.Ltd

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

GENERIC ELECTIVES (GE HS 009): GENDER AND MEDIA STUDIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Gender and Media Studies	4	3	0	1	12th Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the concepts relating to gender and to sensitize the students to the construction of gender.
- To highlight the various aspects in gender and development, and its dimensions, theories and approaches.
- To understand the gender-based issues of equality and equity through a study of development indices and feminist theories and perspectives.
- To learn about the inter-relationships between portrayal of women in media and the status of women as well as the role media can play in empowerment of women.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to understand the concept of gender and socio-cultural practices impacting the construction of gender.
- The student will be able to understand the theories and approaches of feminism.
- The student will be able to comprehend the various aspects in gender and development, and its dimensions, theories
  - and approaches.
- The student will be able to critique the role of the media in promoting gender equity and empowerment.

SYLLABUS OF GE HS 009

Unit I: Social Construction of Gender (12 Hours)

The Unit aims to critically understand the concept of gender and socio-cultural practices impacting the social construction of gender.
Subtopics:

- Concept of gender and sex
- Socialization and construction of gender
- Patriarchal social order and status of women
- Shifts in Status of women – historical and contemporary perspectives on status of women

Unit II: Gender and Development (12 Hours)

The Unit highlights the various aspects in gender and development and focuses on its dimensions, theories and approaches.
Subtopics:

- Concept of Gender, Development and Indicators
- Approaches to women's participation in development
- Invisibility of women's work and economic participation
- Gender differentials in various sectors of development
- Life Cycle Approach to gender studies (violence against women)

Unit III: Feminism, Gender and Media (12 Hours)

This Unit focuses on historical evolution of feminism and perspectives on gender and media.
Subtopics:

- Feminist theories; A short introduction
- Gender and Media; Theoretical perspectives - portrayal and representation
- Theory of Visual Pleasure - Male Gaze (Laura Mulvey);
- Queer Theory (Judith Butler)
- Masculine Hegemony (R.W. Connell)
- Framework for gender responsive media and gender mainstreaming

Unit IV: Gender and Empowerment (09 Hours)

This Unit provides an insight on the concept of empowerment and gender equality.
Subtopics:

- Advocacy of women's rights through media
- Women's Empowerment; Historical and Contemporary Perspectives
- Women's Legal Rights and Redressal System
- Media laws related to women

Practical component (if any)

PRACTICAL: 30 Hours

- Exercises on sex and gender
- Data interpretation on gender-related indicators
- Review and content analysis of various Media: print, films/documentaries on gender issues and their critical analysis.
- Case studies on representation of gender in mainstream media from a gender perspective (print, broadcast and new media)
- Critical analysis of Laura Mulvey's notion of Male Gaze

Essential Readings

- Bhasin, Kamla (2000). Understanding Gender. New Delhi. Kaali for Women.
- Butler, J. (1999). Gender trouble: Feminism and the subversion of identity. New York: Routledge.
- Connell, R. W., & Messerschmidt, J. W. (2005). Hegemonic Masculinity: Rethinking the Concept. Gender & Society, 19(6), 829–859.
- Human Development Reports. (n.d.). Hdr.undp.org. https://hdr.undp.org/en/towards-hdr-2022
- Mulvey, L. (1989). Visual Pleasure and Narrative Cinema. In Visual and other pleasures (pp. 14-26). Palgrave Macmillan, London.

Suggested Readings

- Beauvoir, S. (2015). The Second Sex. London: Vintage Books.
- Chattopadhyay, S (2018). Gender Socialization and the Making of Gender in the Indian Context. New Delhi: Sage Publications.
- Dube, L. (2001). Anthropological Explorations in Gender-Intersecting Fields. New Delhi: Sage Publications.
- Ghadially, R (2007). Urban Women in Contemporary India. New Delhi: sage Publications.
- Goel, A. (2004). Education & Socio-Economic Perspectives of Women Development and Empowerment. New Delhi: Deep & Deep.
- Goel, A. (2004). Organisation & Structure of Women Development and Empowerment. New Delhi: Deep & Deep.
- Goel, A, Kaur, A and Sultana, A (2006). Violence against women: Issues and Perspectives. New Delhi, Deep & Deep Publishers.
- Khanna, S. (2009). Violence against Women and Human Rights. Delhi: Swastik
- Krishna, S. (Ed) (2003) Livelihood and Gender Equality in Community Resource Management. New Delhi: Sage Publications.
- Madhi, V. J et al (2014) Women's Studies in India. New Delhi: Rawat.
- Sohoni, K Neeraja, (1994), Status of Girls in Development Strategies, New Delhi, Har-Anand Publications.

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

GENERIC ELECTIVES (GE HS 014): FABRIC STUDY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Fabric Study	4	3	0	1	12^{th} Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To briefly study the fabric components.
- To enhance awareness of various commercially available fabrics.
- To understand the properties and end uses of the various types of fabrics.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to understand the components of a textile fabric.
- The student will be able to identify the various commercially available fabrics.
- The student will be able to appropriately select fabrics based on their properties, cost and recommended end-use.

SYLLABUS OF GE HS 014

UNIT I: Fabric components (09 Hours)

In this unit, students will be able to understand the basics of fibres, yarns and fabric.

Subtopics:

- Fibres and yarns
- Methods of fabric construction

Fabric finishing- dyeing, printing, aesthetic and functional finishes

Unit II: Commercially important woven fabrics: Identification, properties and end use (21 Hours)

In this unit, students will gain an understanding of various types of woven fabrics

Subtopics:

- **Cotton and other Cellulosic Fabrics**
  - Lightweight fabrics- Mulmul, Voile, Organdy, etc.
  - Medium weight fabrics- Cambric, Poplin, Cotton, Rubia, Denim, Chambray, Seer-sucker, Eyelash dobby, Schiffli, Jute, Linen, etc.
  - Heavy weight fabrics- Canvas, Casement, Gabardine, Damask, Corduroy, Velvet, Terry, etc.
- **Silk and Wool fabrics**
  - Lightweight fabrics- Silk Crepe, De Chine, Georgette, Chiffon, Organza, etc.
  - Medium/Heavy weight fabrics- Flat silk, Satin, Taffeta, Dupion, Shantung, Raw silk, Tussar silk, Habutai silk, Tweed
- **Man-made fibre and blended fabrics**

Art silk, Lizzy-Bizzy, Terivoile, Semi-crepe, Moss crepe, Artificial chiffon, Artificial georgette, Terrycot, Poly-satin, Lycra, Modal, Viscose

Unit III: Commercially Important Knitted and Non-woven fabrics: Identification, properties and end use (09 Hours)

In this unit, students will learn about various types of knitted and non-woven and other types of fabrics

Subtopics:

- Knitted Fabrics- Knitted Terry, Jersey, Rib Knit, Interlock knit, Pique, Velour, Scuba, Fleece, etc.
- Non-wovens- Different types and weights
- Others- Leatherette, Suede, Nets and Laces

Unit IV: Traditional Indian Fabrics: Identification, properties and end use (06 Hours)

In this unit, students will be learn to identify various types of traditional Indian fabrics

Subtopics:

Selected woven, embroidered, painted, printed and dyed traditional Indian textiles.

Practical component (if any)

PRACTICAL: 30 Hours

Unit I: Identification of various types of fibres, yarns, fabrics and weaves

- Learn to identify the different components of a fabric, its construction and other essential properties

Subtopics:

- Identification of common textile fibres
- Identification of textile yarns
- Identification of fabric types: Woven, Knitted, Non-Wovens and others
- Identification of fabric weave
- Identification of various types of woven fabrics in terms of Weight
- Thread Count

Unit II: Collection of swatches for portfolio preparation of woven, knitted, non-woven and traditional Indian fabrics

Learn to recognise various types of commercially available fabrics

Subtopics:

- Preparation of portfolio of commonly available fabrics
- Commercially important Woven Fabrics

Commercially important Knitted, Non-Woven and other fabrics o Traditional Indian Fabrics

Essential Readings

- Corbman P. B., (1989), Textiles- Fibre to Fabric, 6th edition, McGraw Hill, New York.
- Hollen N., Saddler J., Langford A.L., Kadolph S.J., (1988), Textiles, 6 th Edition, Macmillan Publishing Company New York, USA
- Joseph, M.L., (1988) Essentials of Textiles (6th Edition), Holt, Rinehart and Winston Inc., Florida.
- Rastogi, D. (Ed.) and Chopra, S. (Ed.), (2017), Textile Science, Orient Black Swan.
- Sekhri S., (2011) Textbook of Fabric Science: Fundamentals to Finishing, PHI Learning, Delhi.
- Chattopadhyay, K.D., 1995, Handicrafts of India, Wiley Eastern Limited, N Delhi.

Suggested Readings: (Practical)

- Corbman P. B., (1989), Textiles- Fibre to Fabric, 6th edition, McGraw Hill, New York.
- Chelna Desai, 1988, Ikats Textiles of India, Chronicle Books, India.
- Pizzuto's J.J. "Fabric Science", Fairchild Publication, New York.
- Hollen N., Saddler J., Langford A.L., Kadolph S.J., (1988), Textiles, 6th Edition, Macmillan Publishing Company New York, USA
- Das, Shukla, 1992, Fabric Art- Heritage of India, Abhinav Publications, N Delhi.
- Chelna Desai, 1988, Ikats Textiles of India, Chronicle Books, India
- Tholia A., (2013) Understanding Fabrics- A practical Approach, 2nd edition, Sarv

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Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE HS 018): INNOVATIVE DESIGN PRACTICES

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Innovative Design Practices	4	3	0	1	12th Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To sensitize students towards innovation in design to improve the quality of life of users as well as comply with environment protection.
- To stimulate the students to engage in creativity and integrate sustainability in their design endeavours.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to get sensitized towards innovation and creativity through innovative and sustainable design practices and techniques.
- The student will be able to carry out development of product and prototyping from a sustainability perspective.
- The student will be able to brainstorm new product ideas in a systematic manner.

Unit I: Introduction to Innovation in Design (09 Hours)

The focus of this unit would be on understanding the theoretical concepts related to innovation, design and creativity.
Subtopics:

- Concept of Design, Innovation, and Creativity
- Theories and principles of design and innovation
- Challenges to innovation

Unit II: Methods and techniques for Innovation in Design (12 Hours)

This unit focuses on studying the various methods and techniques used for design innovation
Subtopics:

- Understanding disruptions in innovation approaches, case analysis
- Process of creativity and design
- Methods of ideating, creating and implementing innovative design ideas

Unit III: Approaches for Sustainability in Design (12 Hours)

This unit attempts to acquaint the students with contemporary techniques and approaches for integrating concepts of sustainability in design.

Subtopics:

- Role of sustainability in design practice
- Emerging trends and sustainable methods and techniques of design
- Sustainable Materials: reclaimed and eco-friendly composite materials
- Contemporizing traditional designs
- Circular Economy as a pathway to sustainability in design

Unit IV: Design Development and Presentation **(12 Hours)**

This unit will develop competence amongst students towards creating and executing their innovative design ideas.

Subtopics:

- Critical evaluation of existing designs:
  - Products
  - Interiors and Space
- Case study of Innovative design practices related to:
  - Interiors and Space

Product

SYLLABUS OF GE HS 018

Practical component (if any)

PRACTICAL: 30 Hours

Unit I: Brainstorming Methods

Activities:

- Sessions on Tinkering Lab
- Engaging students in a practical setup for brainstorming
- Narration / Documentation of brainstorming sessions
- Workshop/ Field Visits- Contemporary discussion with the artists and designers

Unit II: Project on Innovative Design Idea

Activities:

- Case study on Reuse/ Recycle/ Reclaim products
- Minor project on sustainable materials
- Portfolio on Innovative Design Idea
- Description
- Relevance of the idea in present contextDigital Presentation / Prototype of Innovative Design Idea

Essential Readings

- Brown, T. (2019). Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. ISBN-13: 9780062856623
- Soni, P. (2020) Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving.
- Jones, J. C. Design Methods. ISBN-13: 978-0471284963
- Ashby, M.F, Johnson, K. Materials and Design: The Art and Science of Material Selection in Product Design.
- Allwood, J, Cullen, J. (2011). Sustainable Materials.
- Desai, A, Mital, A. Sustainable Product Design and Development. ISBN: 9780367343217
- William McDonough and Michael Braungart (2002). “Cradle-to-Cradle: Remaking the Way We Make Things”, North Point Press, New York.
- Lance Hosey, (2012). “The Shape of Green: Aesthetics, Ecology, and Design”, Island Press, Washington, D.C.

Suggested Readings

- Norman, A.D. The Design of Everyday Things: Revised and Expanded Edition.
- Kaptelinin, V. Affordances and Design.
- Pivot. From Concept to Product Launch: A guide to Product Development.
- Monto Mani and Prabhu Kandachar (Eds) (2015), “Design for sustainable well-being and empowerment: Selected Papers”, IISc, Bangalore and TU Delft, The Netherlands.
- Papanek, V. (1984), “Design for the Real World”, 2nd Edition, London: Thames & Hudson.
- White Lemon, “365 Days of DIY”, Create Space Independent Publishing Platform, 2016.
- Jaffe, S.B et.al. (2020). Sustainable Design Basics.

REGISTRAR

UNIVERSITY OF DELHI

CNC-II/093/1(28)/2023-24/45

Dated: 18.01.2024

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14-1/-(14-1-6/-) dated 09.06.2023 and 27-1-1/ dated 25.08.2023]

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

Add the following:

Syllabi of Semester-IV of the following programmes in respect of Department of Physics & Astrophysics under Faculty of Science based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23:

SEMESTER-IV: BSc. (H) Physics/ Pool of Discipline Specific Electives/ BSc. Physical Science with Physics as one of the Core Disciplines/ BSc. Physical Science with Physics & Electronics as one of the Core Disciplines/ Common Pool of Generic Electives (GEs) ***(As per Annexure-1)***

18/1/24

REGISTRAR

ANNEXURE-1

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3	**B. Sc. Physical Science with Physics as one of the Core** **DSC** Physics DSC 4: Waves and Optics **DSEs** Physics DSE 14a: Introduction to Numerical Methods Physics DSE 14b: Analog Electronics Physics DSE 14c: Physics of Earth	20-34
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B. SC. (HONOURS) PHYSICS

DISCIPLINE SPECIFIC CORE COURSE – DSC - 10: MODERN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Modern Physics DSC – 10	4	3	0	1	Class XII Pass with PCM	Studied 'DSC-Light and Matter' & Mathematical Physics-I, II & III

LEARNING OBJECTIVES

This course introduces modern development in Physics. Starting from Planck's law, it develops the idea of probability interpretation and then discusses the formulation of Schrodinger equation and its applications to step potential and rectangular potential problems. This paper aims to provide knowledge about atomic physics, hydrogen atoms and X-rays. This paper covers the in-depth knowledge of lasers, its principle and working. It also introduces concepts of nuclear physics and accelerators.

LEARNING OUTCOMES

After getting exposure to this course, the following topics would be learnt.

- Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. Heisenberg's Uncertainty principle and its applications, photoelectric effect and Compton scattering.
- The Schrodinger equation in 1-dimension, wave function, probability and probability current densities, normalization, conditions for physical acceptability of wave functions, position and momentum operators and their expectation values, Commutator of position and momentum operators.
- Time independent Schrodinger equation, derivation by separation of variables, wave packets, particle in a box problem, energy levels. Reflection and transmission across a step and rectangular potential barrier.
- Modification in Bohr's quantum model: Sommerfeld theory of elliptical orbits
- Hydrogen atom energy levels and spectra emission and absorption spectra.
- X-rays: their production and spectra: continuous and characteristic X-rays, Moseley Law.
- Lasers and their working principle, spontaneous and stimulated emissions and absorption, Einstein's A and B coefficients, Metastable states, components of a laser and lasing action in He-Ne lasers and free electron laser.
- Basic properties of nuclei, nuclear binding energy, semi-empirical mass formula, nuclear force and meson theory. Radioactivity.
- Types of Accelerators, Van-de Graaff generator linear accelerator, cyclotron.

SYLLABUS OF DSC – 10

THEORY COMPONENT

Unit – I **(9 Hours)**

Origin of Quantum Theory: Black body radiation and failure of classical theory, Planck's quantum hypothesis, Planck's radiation law, quantitative treatment of photo-electric effect and Compton scattering, Heisenberg's uncertainty principle, Gamma ray microscope thought experiment, position - momentum uncertainty, consequences of uncertainty principle.

Unit – II **(9 Hours)**

The Schrodinger Equation: The Schrodinger equation in one dimension, statistical interpretation of wave function, probability and probability current densities. Normalization, conditions for physical acceptability of wave functions with examples, position and momentum operators and their expectation values. Commutator of position and momentum operators

Unit – III **(9 Hours)**

Time Independent Schrodinger Equation: Demonstration of separation of variable method for time independent Schrodinger equation: Free particle wave function, wave packets, application to energy eigen values and stationary states for particle in a box problem. Reflection and transmission across a step and rectangular potential barrier

Unit - IV **(9 Hours)**

Atomic Physics: Beyond the Bohr's Quantum Model: Sommerfeld theory of elliptical orbits; Hydrogen atom energy levels and spectra, emission and absorption spectra; Correspondence principle; X-rays: Method of production, Continuous and Characteristic X-rays, Moseley's law.

Lasers: Lifetime of excited states, natural and Doppler width of spectral lines, emission (spontaneous and stimulated) and absorption processes, Einstein's A and B coefficients, principle of detailed balancing, metastable states, components of a laser and lasing action, working principle of a 4 level laser, e.g. He-Ne lasers; qualitative idea of X-ray free electron lasers.

Unit - V **(9 Hours)**

Basic Properties of Nuclei: Introduction (notation, a basic idea about nuclear size, mass, angular momentum, spin, parity, isospin), N-Z graph, nuclear binding energy, semi-empirical mass formula, and basic idea about the nuclear force and meson theory.

Radioactivity: Law of radioactivity and secular equilibrium.

Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), linear accelerator, cyclotron (principle, construction, working, advantages and disadvantages), discovery of new elements of the periodic table

References:

Essential Readings:

1) Concepts of Modern Physics, A. Beiser, 2002, McGraw-Hill.
2) Modern Physics, R. A. Serway, C. J. Moses and C. A. Moyer, 2012, Thomson Brooks Cole, Cengage.
3) Schaum's Outline of Modern Physics, R. Gautreau and W. Savin, 2020, McGraw Hill LLC

4) Modern Physics for Scientists and Engineers, S. T. Thornton Rex, 4^{th} edition, 2013, Cengage Learning.
5) Introduction to Modern Physics, F. K. Richtmyer, E. H. Kennard and J. N. Cooper, 2002, Tata McGraw Hill.
6) Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010.
7) Learning Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill.
8) Modern Physics, R. Murugeshan, S Chand & Co. Ltd.
9) Schaum's Outline of Beginning Physics II | Waves, electromagnetism, Optics and Modern Physics, Alvin Halpern, Erich Erlbach, McGraw Hill.
10) Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2^{nd} edition, Tata McGraw-Hill Publishing Co. Ltd.
11) Quantum Physics, Berkeley Physics, Vol.4. E. H. Wichman, 1971, Tata McGraw-Hill
12) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 2004, Macmillan Publishers India Limited.
13) Introduction to Quantum Mechanics, D. J. Griffith, 2005, Pearson Education.
14) Concepts of nuclear physics, B. Cohen, 2003, McGraw-Hill Education.
15) Atomic Physics, Ghoshal, 2019, S. Chand Publishing House.
16) Atomic Physics, J. B. Rajam & foreword by Louis De Broglie, 2010, (S. Chand & Co.
17) Nuclear Physics, S. N. Ghoshal, S. Chand Publishers.
18) Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain, 2^{nd} edition, Pearson
19) Atomic and Molecular Physics, Rajkumar, RBSA Publishers.
20) Atoms, Molecules and Photons, W. Demtroder, 2^{nd} edition, 2010, Springer.
21) Introducing Nuclear Physics, K. S. Krane, 2008, Wiley India.

Additional Readings:

1) Basic Atomic & Molecular Spectroscopy, J. M. Hollas (Royal Society of Chemistry)
2) Molecular Spectra and Molecular Structure, G. Herzberg.
3) Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach (Series in Fundamental and Applied Nuclear Physics), K. Heyde (Institute of Physics Publishing Third Edition.
4) Nuclear Physics: Principles and applications, J. Lilley, 2006, Wiley.
5) Schaum's Outline of Modern Physics, 1999, McGraw-Hill Education.
6) Atomic and molecular Physics, R. Kumar, 2013, Campus Book Int.
7) The Fundamentals of Atomic and Molecular Physics (Undergraduate Lecture Notes in Physics), 2013, Springer.
8) Six Ideas that Shaped Physics: Particles Behave like Waves, T. A. Moore, 2003, McGraw Hill.
9) Thirty years that shook physics: The story of quantum theory, G. Gamow, Garden City, NY: Doubleday, 1966.

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

Mandatory activity:

- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab
- Familiarization with Schuster`s focusing; determination of angle of prism.

<u>At least five experiments to be performed from the following list</u>

1) Measurement of Planck's constant using black body radiation and photo-detector
2) Photo-electric effect: photo current versus intensity and wavelength of light, maximum energy of photo-electrons versus frequency of light
3) To determine the work function of material of filament of directly heated vacuum diode.
4) To determine the Planck's constant using LEDs of at least 4 different colours.
5) To determine the wavelength of the H-alpha emission line of Hydrogen atoms.
6) To determine the ionization potential of mercury.
7) To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8) To show the tunneling effect in tunnel diodes using I-V characteristics.
9) One innovative experiment designed by the teacher relevant to the syllabus.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal.
3) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th edition, reprinted, 1985, Heinemann Educational Publishers.
4) A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal, 1985, Vani Publisher.
5) B.Sc. Practical Physics, H. Singh, S. Chand & Co Ltd.
6) B.Sc. Practical Physics, G. Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC CORE COURSE – DSC - 11: SOLID STATE PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Solid State Physics DSC – 11	4	3	0	1	Class XII Pass with PCM	Studied 'Thermal Physics, Electricity & Magnetism' and Mathematical Physics-I,II & III

LEARNING OBJECTIVES

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon the arrangement of its atomic and molecular constituents. The gained knowledge helps to solve problems in solid state physics using relevant mathematical tools. It also communicates the importance of solid- state physics in modern society.

LEARNING OUTCOMES

On successful completion of the module students should be able to,

- Elucidate the concept of lattice, crystals and symmetry operations
- Understand elementary lattice dynamics and its influence on the properties of materials
- Describe the origin of energy bands, and their influence on electronic behaviour
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids
- Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability
- Understand the basics of superconductivity
- In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor

SYLLABUS OF DSC - 11

THEORY COMPONENT

Unit – I - Crystal Structure **(10 Hours)**

Classification of solids as amorphous and crystalline materials, basic understanding of bonding in crystals, closed packed structure and packing fractions, lattice translation vectors, lattice with a basis, types of lattices, unit cell, symmetry elements, crystal planes and Miller indices, reciprocal lattice and Ewald's construction (geometrical), Brillouin Zones, Diffraction of X-rays: single crystal and powder method. Bragg's Law

Unit – II - Elementary band theory **(6 Hours)**

Brief discussion on free electron model, success and failure of free electron model, Kronig-Penney model, band gap, direct and indirect band gap, effective mass, concept of mobility, Hall effect (Semiconductor).

Unit – III - Elementary Lattice Dynamics (10 Hours)
Lattice Vibrations and Phonons: Linear monoatomic and diatomic chains, acoustic and optical phonons, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

Unit – IV - Magnetic Properties of Matter (9 Hours)
Dia-, Para-, Ferri- and Ferromagnetic Materials, Classical Langevin Theory of dia– and para-magnetism, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains, Curie's law, B-H Curve, hysteresis and energy loss, soft and hard material

Unit – V - Dielectric Properties of Materials (7 Hours)
Polarization, local electric field in solids, depolarization field, electric susceptibility, polarizability, Clausius Mossotti equation, classical theory of electronic polarizability, AC electronic polarizability, normal and anomalous dispersion, complex dielectric constant, basic idea of ferroelectricity and PE Hysteresis loop.

Unit – VI – Superconductivity (3 Hours)
Experimental results, critical temperature, critical magnetic field, Meissner effect, Type I and type II superconductors

References:
Essential Readings:
1) Introduction to Solid State Physics, Charles Kittel, 8th edition, 2004, Wiley India Pvt. Ltd.
2) Elements of Solid State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India.
3) Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4) Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976, Cengage Learning.
5) Solid-state Physics, H. Ibach and H. Luth, 2009, Springer

Additional Readings:
1) Elementary Solid State Physics, M. Ali Omar, 2006, Pearson
2) Solid State Physics, R. John, 2014, McGraw Hill
3) Solid State Physics, M. A. Wahab, 2011, Narosa Publications

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)
- Sessions on the construction and use of specific measurement instruments and experimental apparatus used in the solid state physics laboratory, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the laboratory.

At least four experiments to be performed from the following list

1) Measurement of susceptibility of paramagnetic solution (Quinck's tube method).
2) To measure the magnetic susceptibility of solids.
3) To study the dielectric constant of a material/s (solid/liquid) as a function of temperature and frequency.
4) To determine the complex dielectric constant and plasma frequency of a metal using Surface Plasmon Resonance (SPR) technique.
5) To determine the refractive index of a dielectric material using SPR technique.
6) To study the PE Hysteresis loop of a ferroelectric crystal.
7) To draw the BH curve of iron (Fe) using solenoid and determine the energy loss from hysteresis loop.
8) To measure the resistivity of a semiconductor (Ge) with temperature (up to 150^{o}C) by four-probe method and determine its band gap.
9) To determine the Hall coefficient of a semiconductor sample.
10) Analysis of X-ray diffraction data in terms of unit cell parameters and estimation of particle size.
11) To study magnetoresistance in a semiconductor with magnetic field

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal
3) Elements of Solid State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
4) Practical Physics, G. L. Squires, 4th edition, 2015, Cambridge University Press.
5) Practical Physics, C. L. Arora, 19th edition, 2015, S. Chand

DISCIPLINE SPECIFIC CORE COURSE – DSC - 12: ANALOG ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Analog Electronics DSC – 12	**4**	**2**	**0**	**2**	Class XII Pass with PCM	Studied 'Electrical Circuit Analysis'

LEARNING OBJECTIVES

This course introduces the concept of semiconductor devices and their analog applications. It also emphasizes on understanding of amplifiers, oscillators, operational amplifier and their applications.

LEARNING OUTCOMES

At the end of this course, the following concepts will be learnt.

- To learn about diodes and its uses in rectification
- To gain an insight into working principle of photodiodes, solar cells, LED and zener diode as voltage regulator
- To gain an understanding of construction and working principle of bipolar junction transistors (BJTs), characteristics of different configurations, biasing and analysis of transistor amplifier
- To be able to design and understand use of different types of oscillators
- To learn the fundamentals of operation amplifiers and understand their operations to compare, add, or subtract two or more signals and to differentiate or integrate signals etc.

In the laboratory course, the students will be able to study characteristics of various diodes and BJT. They will be able to design amplifiers, and oscillators. Also different applications using Op-Amp will be designed.

SYLLABUS OF DSC - 12

THEORY COMPONENT

Unit – I - Two-terminal devices and their applications (5 Hours)

IV characteristics of a diode and its application as rectifier (half-wave and full wave rectifier), IV characteristics of a zener diode and its use as voltage regulator, principle, structure and characteristics of (1) LED, (2) Photodiode and (3) Solar Cell

Unit – II - Bipolar junction transistors (4 Hours)

n-p-n and p-n-p transistors, IV characteristics of CB and CE configurations, active, cut-off and saturation regions, current gains α and β, relations between α and β, physical mechanism of current flow

Unit – III – Amplifiers and sinusoidal oscillators (11 Hours)

Load line analysis of transistor, DC load line and Q-point, fixed bias and voltage divider bias,

transistor as 2-port network, h-parameter equivalent circuit of a transistor, analysis of a single-stage CE amplifier using hybrid model (input and output impedance, current and voltage gain)
Sinusoidal Oscillators: General idea of positive and negative feedback, Barkhausen's criterion for self-sustained oscillations, RC phase shift oscillator, determination of frequency, Hartley and Colpitts oscillators

Unit – IV - Operational Amplifiers (Black Box approach) (10 Hours)
Characteristics of an ideal and practical Op-Amp (IC 741), open-loop and closed-loop gain, frequency response, CMRR, slew rate and concept of virtual ground
Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Comparator and Zero crossing detector (7) Wein bridge oscillator

References:
Essential Readings:

1) Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill
2) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall
3) Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
4) Microelectronic circuits, A. S. Sedra, K. C. Smith and A. N. Chandorkar, 6th edition, 2014, Oxford University Press.
5) Semiconductor Devices: Physics and Technology, S. M. Sze, 2nd edition, 2002, Wiley India
6) Electronic Principles, A. Malvino, D. J. Bates, 7th edition, 2018, Tata Mc-Graw Hill Education.
7) Electronic Devices and circuit Theory, R. L. Boylestad and L. D. Nashelsky, 2009, Pearson

Additional Readings:

1) Learning Electronic Devices and circuits, S. Salivahanan and N. S. Kumar, 3rd edition, 2012, Tata Mc-Graw Hill
2) Microelectronic Circuits, M. H. Rashid, 2nd edition, Cengage Learning
3) Microelectronic Devices and Circuits, D. A. Bell, 5th edition, 2015, Oxford University Press
4) Basic Electronics: Principles and Applications, C. Saha, A. Halder and D. Ganguli, 1st edition, 2018, Cambridge University Press
5) Solid State Electronic Devices, B. G.Streetman and S. K. Banerjee, 6th edition, 2009, PHI

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

- Session on the construction and use of specific analogue devices and experimental apparatuses used in the lab, including necessary precautions
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

At least six experiments to be performed from the following list

1) To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2) Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3) To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4) To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
5) To design a Wien bridge oscillator for given frequency using an op-amp.
6) To design an inverting amplifier using Op-amp (741, 351) for dc voltage of given gain
7) To design inverting amplifier using Op-amp (741, 351) and study its frequency response
8) To design non-inverting amplifier using Op-amp (741, 351) and study frequency response
9) To add two dc voltages using Op-amp in inverting and non-inverting mode
10) To study the zero-crossing detector and comparator
11) To investigate the use of an op-amp as an integrator
12) To investigate the use of an op-amp as a differentiator.

References for laboratory work:

1) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino and M. A. Miller, 1994, Mc- Graw Hill
2) Student Manual for The Art of Electronics, T. C. Hayes and P. Horowitz

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 3: ADVANCED MATHEMATICAL PHYSICS I

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Advanced Mathematical Physics I DSE – 3	4	3	1	0	Class XII Pass with PCM	Studied DSC 'Mathematical Physics I, II & Physics III'

LEARNING OBJECTIVES

The objective of the course is to impart the concept of generalized mathematical constructs in terms of algebraic structures mainly vector spaces. Linear algebra studies linear vector spaces, linear transformations, and the matrices and is an important mathematical tool with applications in physics, engineering, machine learning, economics and even life sciences and social sciences. This course is intended to provide a solid foundation in linear algebra as used by physicists and has direct applications in classical and quantum mechanics.

LEARNING OUTCOMES

After completing this course, students will be able to,

- Understand algebraic structures in n-dimension and basic properties of the linear vector spaces.
- Understand the concept of dual spaces and inner product spaces.
- Represent linear transformations as matrices and understand basic properties of matrices.
- Determine the eigenvalues and eigenvectors of matrices and diagonalise the matrices.
- Determine orthogonal basis for a vector space using Gram-Schmidt procedure.

SYLLABUS OF DSE - 3

THEORY COMPONENT

Unit – I **(13 Hours)**

Vector Spaces as Algebraic Structures: Definition and examples of groups, rings, fields and vector spaces. Real and Complex fields, Use of ket notation $|\alpha >$ for vectors. Subspaces, Linear combination of vectors, Linear dependence and independence of vectors, span of a subset of vectors, Bases and dimension of vector space, direct sum of spaces, representation of vectors as column vectors with R^n as example.

Inner Product Spaces: Inner product of vectors ($< \alpha|\beta >$) and norm of a vector, euclidean spaces and unitary spaces. Cauchy-Schwartz inequality, concept of length and distance, metric spaces. Hilbert Space (definition only). Linear functional, dual space, dual basis ($< \alpha|$ notation); Orthogonality of vectors, orthonormal basis, Gram-Schmidt procedure to construct an orthonormal basis.

Unit – II **(8 Hours)**

Linear Transformation: Linear Mappings and Examples, Homomorphism and Isomorphism of vector space, rank and nullity of a linear mapping, Range space and Kernel (null space) of a linear mapping, non-singular transformations, Nilpotent and Idempotent Transformations.

Unit – III **(10 Hours)**

Matrices as Representations: Matrix Representation of a Linear transformations, composition of linear transformations and matrix multiplication, linear algebra. Algebra of matrices, determinant and trace of matrix and their properties. Non-singular matrices. Rank of a matrix and invertibility of matrices. Direct sum and direct product of matrices.

Change of basis transformation, similar matrices, trace and determinant as invariants of basis change. Transpose and adjoint of a linear transformation, self-adjoint operators. Symmetric and hermitian matrices. Preservation of norms by orthogonal and unitary transformations.

Unit – IV **(14 Hours)**

Eigen-values and Eigenvectors: Eigen-values and eigen vectors of a transformation and corresponding matrix representation. Cayley- Hamilton Theorem (Statement only), its applications like inverse and powers of a matrix. Eigensystems of hermitian and unitary matrices. Diagonalization of matrices. Normal matrices. Simultaneous diagonalizability of two matrices.

Use of Matrices in Solving Coupled Linear first order ordinary differential equations with constant coefficients. Minimal Polynomial, Functions of a Matrix.

References:

Essential Readings:

1) Mathematical Methods for Physicists, G. Arfken, H. Weber and F. E. Harris, 7th edition, 2012, Elsevier
2) Introduction to Matrices and Linear Transformations, D. T. Finkbeiner, 2011, Dover Publications
3) Schaum's Outline of Theory and Problems of Linear Algebra, S. Lipschutz and M. Lipson, 2017, McGraw Hill Education
4) Linear Algebra, S. H. Friedberg, A. J. Insel, and L. E. Spence, 2022, Pearson Education
5) Linear Algebra and Applications, D. C. Lay, 2002, Pearson Education India.

Additional Readings:

1) Elementary Linear Algebra with Supplemental Applications, H. Anton and C. Rorres, 2016, Wiley Student Edition
2) A Physicist's Introduction to Algebraic Structures: Vector Spaces, Groups, Topological Spaces and More, P. B. Pal, 2019, Cambridge University Press
3) Matrices and Tensors in Physics: A.W. Joshi, 2017, New Age International Pvt. Ltd.
4) An Introduction to Linear Algebra and Tensors, M. A. Akivis, V. V. Goldberg, Richard and Silverman, 2012, Dover Publications
5) Vector Spaces and Matrices in Physics, M. C. Jain, 2000, Narosa
6) Mathematical Methods for Physics and Engineering, K. F. Riley and M. P. Hobson, 2018, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 4: PHYSICS OF DEVICES

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Devices DSE – 4	**4**	**2**	**0**	**2**	Class XII Pass with PCM	'Mathematical Physics-I', 'Mechanics' and 'Electrical Circuit Analysis'.

LEARNING OBJECTIVES

This paper is based on advanced electronics which covers the devices such as UJT, JFET, MOSFET, CMOS etc. Process of IC fabrication is discussed in detail.

LEARNING OUTCOMES

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

- Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications.
- Understand the operation of devices such as UJT, JFET, MOS, various bias circuits of MOSFET, basics of CMOS and charge coupled devices.
- Learn to analyse MOSFET circuits and develop an understanding of MOSFET I-V characteristics and the allowed frequency limits.
- Learn the IC fabrication technology involving the process of diffusion, implantation, oxidation and etching with an emphasis on photolithography and electron-lithography
- Apply concepts for the regulation of power supply by developing an understanding of various kinds of RC filters classified on the basis of allowed range of frequencies.
- Learn to use semiconductor diode as a clipper and clamper circuit

SYLLABUS OF DSE - 4

THEORY COMPONENT

Unit – I **(7 Hours)**

Semiconductors (P and N type), Energy band diagram, Barrier formation in pn junction diode, Derivation of barrier potential and barrier width, storage and depletion capacitances, current flow mechanism in forward and reverse bias junction, current components in a transistor, tunnel diode, metal-semiconductor contacts, Schottky junction and Ohmic junction

Unit – II **(6 Hours)**

Diode as clipper and clamper circuits, RC Filters: Passive-Low pass and High pass filters, Active (1st order Butterworth)-Low Pass, High Pass, Band Pass, and band reject Filters.

Unit – III **(11 Hours)**

Characteristic and small-signal equivalent circuits of UJT and JFET, introduction to metal oxide semiconductor (MOS) device/MOSFET, MOSFET - their frequency limits, enhancement and depletion mode MOSFETS, basic idea of CMOS and charge coupled devices, importance of power devices: power diode, SCR. Construction and I-V characteristics of DIAC and TRIAC.

Unit – IV **(4 Hours)**
(Basic idea) Basic process flow for IC fabrication, diffusion and implantation of dopants, passivation/oxidation technique for Si, contacts and metallization technique, basic idea of thermal evaporation and sputtering techniques, basic idea of photolithography, electron-lithography, SSI, MSI, LSI, VLSI and USI.

Unit – V **(2 Hours)**
Basic idea about sensors (gas/fire) and piezoelectric transducer

References:
Essential Readings:

1) Physics of Semiconductor Devices, S. M. Sze and K. K. Ng, 3rd edition 2008, John Wiley and Sons
2) Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
3) Electronic communication systems, G. Kennedy, 1999, Tata McGraw Hill.
4) Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill.
5) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
6) Solid State Electronic Devices, B. G. Streetman and S. K. Banerjee, 7th edition
7) Power Electronics, M. D. Singh and K. B. Khanchandani, 2006, Tata Mc-Graw Hill

Additional Readings:

1) Op-Amps and Linear Integrated Circuits, R. A. Gayakwad, 4th edition, 2000, PHI Learning Pvt. Ltd
2) Introduction to Measurements and Instrumentation, A. K. Ghosh, 4th edition, 2017, PHI Learning
3) Semiconductor Physics and Devices, D. A. Neamen, 4th edition, 2011, Tata McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) To design the active low pass and high pass filters of given specification.
2) To design the active filter (wide band pass and band reject) of given specification.
3) To study the output and transfer characteristics of a JFET.
4) To design a common source JFET amplifier and study its frequency response.
5) To study the output characteristics of a MOSFET.
6) To study the characteristics of a UJT and design a simple relaxation oscillator.
7) To study diode as clipper circuit.
8) To study diode as a clamper circuit.
9) Pattern the given structure on silicon wafer by wet chemical etching.

Suggested extra experiment:

1) Deposition of metallic thin films using thermal evaporation technique.
2) Preparation of a pn junction and study its IV characteristics.

References for laboratory work:

1) Advanced PC based instrumentation; Concepts and Practice, N. Mathivanan, 2007, Prentice-Hall of India
2) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller,1994, Mc-Graw Hill
3) Introduction to PSPICE using ORCAD for circuits and Electronics, M. H. Rashid, 2003, PHI Learning.

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 5: PHYSICS OF EARTH

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Earth DSE – 5	**4**	**3**	**1**	**0**	Class XII Pass with PCM	NIL

LEARNING OBJECTIVES

This course familiarizes the students with the origin of earth in the solar system and various processes occurring in atmosphere, oceans and earth's internal structure.

LEARNING OUTCOMES

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

- Have an overview of structure of the earth as well as various dynamical processes occurring on it.
- Develop an understanding of evolution of the earth.
- Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.
- Understand the origin of magnetic field, Geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection.
- Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth.
- Develop the problem solving skills by adding numerical and simulations to clarify the fundamental concepts.

SYLLABUS OF DSE - 5

THEORY COMPONENT

Unit – I **(10 Hours)**

The Earth and the Universe:

a) General characteristics and origin of the Universe. The Big Bang Theory. Estimation of age of the Universe and Hubble constant. Formation of Galaxies. Types of galaxies, Milky Way galaxy, Nebular hypothesis, Solar system, The Terrestrial and Jovian planets (Sizes, Acceleration due to gravity, Obliquity, Flatness, Eccentricity, Density, Temperature, Pressure, Atmosphere, Moons, Exceptions in trends). Titius-Bode law. Asteroid belt. Asteroids: origin types and examples, Meteorites.

b) Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Earth's orbit and spin, the Moon's orbit and spin.

c) Energy and particle fluxes incident on the Earth.

Unit – II **(8 Hours)**

Structure of Earth:

a) Internal structure of Earth: Core, mental, magnetic field. Origin of the Magnetic field. Convection in Earth's core and production of its magnetic field. Dynamo Theory, calculation of magnetic fields, Causes of variation of Magnetic Field and Palaeomagnetism.
b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. Ocean circulations. Oceanic current system and effect of Coriolis forces.
c) The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Unit – III **(8 Hours)**

Dynamical Processes:

a) The Solid Earth: Concept of plate tectonics; types of plate movements, hotspots; sea-floor spreading and continental drift.
b) Earthquake and earthquake belts. Types and properties of Seismic waves, Richter scale, geophones.
c) Volcanoes: types, products and distribution.
d) Concepts of eustasy, air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

Unit – IV **(10 Hours)**

The Atmosphere

a) The Atmosphere: Features of different layers, variation of temperature with altitude; Dry, moist and environmental lapse rate, variation of density and pressure with altitude, Types of clouds and formation.
b) The Atmosphere: Atmospheric circulation. Causes of Atmospheric circulation, Formation of three cells, Easterlies and Westerlies, and ICTZ, Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones, tropical storms, hurricanes and tornadoes.
c) Climate: Earth's temperature and greenhouse effect. Paleoclimate and recent climate changes. The Indian monsoon system.

Unit – V **(9 Hours)**

Disturbing the Earth – Contemporary dilemmas

a) Hydrosphere: Fresh water depletion.
b) Geosphere: Chemical effluents, nuclear waste.
c) Biosphere: Biodiversity loss. Deforestation. Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.
d) Air Pollution: Types of air pollutants, Effects on atmosphere and living organisms. Ozone Hole.

References:

Essential Readings:

1) Planetary Surface Processes, H. J. Melosh, 2011, Cambridge University Press.
2) Holme's Principles of Physical Geology, 1992, Chapman & Hall.
3) Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.
4) Physics of the Earth, F. D. Stacey, P. M. Davis, 2008, Cambridge University Press.
5) Environmental Physics: Sustainable Energy and Climate Change, E. Boecker and R.V. Grondelle, 3rd edition, 2011, Wiley, UK
6) Atmospheric Remote Sensing (Principles and Applications, Editors – S. Tiwari and A. K.

Singh, Chapter-1 (Composition and thermal structure of the Earth's atmosphere, by S. K. Dhaka and V. Kumar), 1st edition, Elsevier

Additional Readings:

1) The Blue Planet: An Introduction to Earth System Science, B. J. Skinner, S. C. Portere, 1994, John Wiley & Sons.
2) Consider a Spherical Cow: A course in environmental problem solving, J. Harte, University Science Books.
3) Fundamentals of Geophysics, W. Lowrie, 1997, Cambridge University Press.
4) The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press.
5) Climate Change: A Very Short Introduction, M. Maslin, 3rd edition, 2014, Oxford University Press.
6) The Atmosphere: A Very Short Introduction, P. I. Palmer, 2017, Oxford University Press.
7) IGNOU Study material: PHE 15 Astronomy and Astrophysics Block 2

Category II

Physical Science Courses
with Physics discipline as one of the Core Disciplines

(B. Sc. Physical Science with Physics as Major discipline)

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 4: WAVES AND OPTICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Waves and Optics PHYSICS DSC – 4	4	2	0	2	Class XII Pass with Science	Studied Mathematical Physics-I, Mechanics

LEARNING OBJECTIVES

This is a core course in Physics curriculum that begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

LEARNING OUTCOMES

On successfully completing the requirements of this course, the students will have the skill and knowledge to,

- Understand simple harmonic oscillation and superposition principle.
- Understand superposition of a range of collinear and mutually perpendicular simple harmonic motions and their applications.
- Understand concept of normal modes in stationary waves: their frequencies and configurations.
- Understand interference as superposition of waves from coherent sources derived from same parent source.
- Demonstrate understanding of interference experiments: Young's double slit, Fresnel's biprism, Llyod's mirror, Newton's rings
- Demonstrate basic concepts of diffraction: Superposition of wavelets diffracted from apertures
- Understand Fraunhoffer diffraction from apertures: single slit, double slit, grating
- Demonstrate fundamental understanding of Fresnel diffraction: Half period zones, diffraction of different apertures
- Laboratory course is designed to understand the principles of measurement and skills in experimental designs.

SYLLABUS OF PHYSICS DSC – 4

THEORY COMPONENT

Unit – I **(11 Hours)**

Superposition of collinear harmonic oscillations: Simple harmonic motion (SHM); linearity and superposition principle; superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (beats).

Superposition of two perpendicular harmonic oscillations: Graphical and analytical methods.

Lissajous figures with equal and unequal frequencies and their uses
Superposition of two harmonic Waves: Standing (stationary) waves in a string; normal modes of stretched strings

Unit – II **(8 Hours)**

Interference: Division of amplitude and division of wavefront; Young's double slit experiment: width and shape of fringes; Fresnel's biprism; Lloyd's mirror; Phase change on reflection: Stokes' treatment; Interference in thin films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger fringes); Fringes of equal thickness (Fizeau Fringes); Newton's rings: Measurement of wavelength and refractive index

Unit – III **(11 Hours)**

Diffraction:
Fraunhofer diffraction: Single slit, double slit, diffraction grating
Fresnel diffraction: Fresnel's assumptions. Fresnel's half-period zones for plane wave. Explanation of rectilinear propagation of light; Fresnel's diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis

References:

Essential Readings:

1) Vibrations and Waves, A. P. French, 1st edition, 2003, CRC press.
2) The Physics of Waves and Oscillations, N. K. Bajaj, 1998, Tata McGraw Hill.
3) Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
4) Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.
5) Optics, A. Ghatak, 6th edition, 2017, McGraw-Hill Education, New Delhi
6) The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

Additional Readings:

1) Principles of Optics, M. Born and E. Wolf, 7th edition, 1999, Pergamon Press.
2) Optics, E. Hecht, 4th edition, 2014, Pearson Education.
3) Fundamentals of Optics, F. A. Jenkins and H. E. White, 1981, McGraw-Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least 7 experiments to be performed from the following list

1) To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2–T law.
2) To study Lissajous figures.
3) Familiarization with Schuster`s focusing and determination of angle of prism.
4) To determine refractive index of the material of a prism using sodium light.
5) To determine the dispersive power and Cauchy's constants of the material of a prism using mercury light.
6) To determine wavelength of sodium light using Fresnel biprism.
7) To determine wavelength of sodium light using Newton's rings.
8) To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped film.

9) To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10) To determine dispersive power and resolving power of a plane diffraction grating.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal
3) Advanced level Physics Practicals, M. Nelson and J. M. Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers
4) A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
5) B.Sc. Practical Physics, G. Sanon, 2019, R. Chand & Co

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 14a: INTRODUCTION TO NUMERICAL METHODS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Introduction to Numerical Methods PHYSICS DSE 14a	4	2	0	2	Class XII Pass with Science	Elementary calculus

LEARNING OBJECTIVES

The main objective of this course is to introduce the students to the field of numerical analysis enabling them to solve a wide range of physics problems. The skills developed during the course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Analyse a physics problem, establish the mathematical model and determine the appropriate numerical techniques to solve it.
- Derive numerical methods for various mathematical tasks such as root finding, interpolation, least squares fitting, numerical differentiation, numerical integration, and solution of initial value problems.
- Analyse and evaluate the accuracy of the numerical methods learned.

In the laboratory course, the students will learn to implement these numerical methods in Python and develop codes to solve various physics problems and interpret the results.

SYLLABUS OF PHYSICS DSE – 14a
THEORY COMPONENT

Unit – I **(7 Hours)**

Approximation and errors in computing: Introduction to numerical computation, Taylor's expansion and mean value theorem; Floating point computation, overflow and underflow; IEEE single and double precision format; Rounding and truncation error, absolute and relative error, error propagation.

Solutions of algebraic and transcendental equations: Basic idea of iteration method, Bisection method, Secant method, Newton Raphson method; comparison of order of convergence.

Unit – II **(7 hours)**

Interpolation: Interpolation and Lagrange polynomial, divided differences, Newton divided-difference form of the interpolating polynomial with equally spaced nodes. Theoretical error in interpolation.

Least Squares Approximation: Least squares linear regression, Least squares regression for exponential and power functions by taking logarithm.

Unit - III **(8 Hours)**

Numerical Differentiation: Using finite difference to approximate derivatives of first and second order using Taylor series and error in this approximation.

Numerical Integration: Newton Cotes quadrature methods; derivation of Trapezoidal and Simpson (1/3 and 3/8) rules from Lagrange interpolating polynomial; error and degree of precision of a quadrature formula; composite formulae for trapezoidal and Simpson methods; Gauss Legendre quadrature method.

Unit - IV **(8 Hours)**

Initial Value Problems: Solution of initial value problems by Euler, modified Euler and Runge Kutta (RK2, RK4) methods; local and global errors, comparison of errors in the Euler and RK methods, system of first order differential equations. Solving higher order initial value problems by converting them into a system of first order equations.

References:

Essential Readings:

1) Introduction to Numerical Analysis, S. S. Sastry, 5th edition, 2012, PHI Learning Pvt. Ltd.
2) Elementary Numerical Analysis, K. E. Atkinson, 3rd edition, 2007, Wiley India Edition.
3) Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyenger and R. K. Jain, 2012, New Age Publishers
4) A Friendly Introduction to Numerical Analysis, B. Bradie, 2007, Pearson India

Additional Readings:

1) Numerical Recipes: The art of scientific computing, W. H. Press, S. A. Teukolsky and W. Vetterling, 3rd edition, 2007, Cambridge University Press
2) Numerical Methods for Scientists and Engineers, R. W. Hamming, 1987, Dover Publications
3) Applied numerical analysis, C. F. Gerald and P. O. Wheatley, 2007, Pearson Education
4) Numerical Analysis, R. L. Burden and J. D. Faires, 2011, Brooks/Cole, Cengage Learning
5) Numerical Methods, V. N. Vedamurthy and N. Ch. S.N. Iyengar, 2011, Vikas Publishing House

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Assessment is to be done not only on the programming but also on the basis of formulating the problem.
- The list of recommended programs is suggestive only. Students should be encouraged to do more physics applications. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods.
- The students should be encouraged to develop and present an independent project.
- **At least 12 programs must be attempted (taking two from each unit). The implementation is to be done in Python. Use of scipy inbuilt functions may be encouraged**

Unit 1

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, formatting in the print statement.

Control Structures: Conditional operations, ***if, if-else, if-elif-else, while*** and ***for*** Loops, indentation, break and continue, List comprehension. Simple programs for practice like solving quadratic equations, temperature conversion etc.

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc. Use of inbuilt functions to generate pseudo random numbers.

Recommended List of Programs

a) Make a function that takes a number N as input and returns the value of factorial of N. Use this function to print the number of ways a set of m red and n blue balls can be arranged.
b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
c) Write functions to convert Cartesian coordinates of a given point to cylindrical and spherical polar coordinates or vice versa.
d) Solve quadratic equations for the three cases of distinct real, double real and complex conjugate roots.

Unit 2

NumPy Fundamentals: Importing *Numpy*, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using *ones(), zeros(), random(), arange(), linspace()*. Basic array operations (*sum, max, min, mean, variance*), 2-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt().

Plotting with Matplotlib: *matplotlib.pyplot* functions, plotting of functions given in closed form as well as in the form of discrete data and making histograms

Recommended List of Programs

(a) To generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.
(b) To plot the displacement-time and velocity-time graph for the undamped, under damped critically damped and over damped oscillator using *matplotlib* (using given formulae).
(c) To generate array of N random numbers drawn from a given distribution (uniform, binomial, poisson and gaussian) and draw histogram using *matplotlib* for increasing N to verify the distribution.
(d) To approximate the elementary functions (e.g. $\exp(x)$, $\sin(x)$, $\cos(x)$, $\ln(1+x)$, etc.) by a finite number of terms of Taylor's series and discuss the truncation error. To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualise the convergence of series.

Unit 3

Root Finding: Implement the algorithms for Bisection, Secant and Newton Raphson methods or their combinations to,

(a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.

(b) Solve transcendental equations like α = tan(α).
(c) Approximate nth root of a number up to a given number of significant digits.

Unit 4
Interpolation and Least Square Fitting:

a) Given a dataset (x, y) with equidistant x values, prepare the Newton's divided difference table. Generate a tabulated data for an elementary function, approximate it by a polynomial and compare with the true function.
b) Given a dataset (x, y) corresponding to a physics problem, use Lagrange and Newton's forms of interpolating polynomials and compare. Determine the value of y at an intermediate value of x not included in the data set. This may be done with equally spaced and non-equally spaced x-values.
c) Make Python function for least square fitting, use it for fitting given data (*x, y*) and estimate the parameters *a, b* as well as uncertainties in the parameters for the following cases :

i. Linear ($y = ax + b$)
ii. Power law ($y = ax^b$) and
iii. Exponential ($y = ae^{bx}$)

The real data taken in physics lab may be used here.

d) Compare the interpolating polynomial for a given dataset (following a known form e.g. exponential) with the approximation obtained by least square fitting.

Unit 5
Differentiation and Integration:

a) To compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative on the same graph. Plot (using *matplotlib)* the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.
b) Use integral definition of error function to compute and plot erf(x) in a given range. Use Trapezoidal, Simpson and Gauss Legendre methods and compare the results for small and large values of x.
c) Verify the degree of precision of each quadrature rule.
d) Approximate the value of π by evaluating the integral $\int_0^\infty \frac{1}{x^2+1} dx$ using Simpson and Gauss Legendre method. More integrals may be evaluated.

Unit 6
Initial Value Problems (IVP):

a) Compare the errors in Euler, RK2 and RK4 by solving a first order IVP with known solution. Reduce the step size to a point where the round off errors takes over.
b) Radioactive decay: With a given number of initial nuclei and decay constant plot the number of nuclei left as a function of time and determine the half life
c) Solve a system of two first order differential equations by Euler, RK2 and RK4 methods. Use it to solve an nth order IVP. Solve a damped free and forced harmonic oscillator problem using this.
d) Solve a physics problem like free fall with air drag or parachute problem using RK method.
e) Obtain the current flowing in a series LCR circuit with constant voltage for a given set of initial conditions.

References for laboratory work:

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, D. Walker, 1st edition, 2015, Scientific International Pvt. Ltd
4) An Introduction to Computational Physics, T. Pang, 2010, Cambridge University Press
5) Python Programming and Numerical Methods - A Guide for Engineers and Scientists, Q. Kong, T. Siauw, A. M. Bayen, 2021, Academic Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 14b: ANALOG ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Analog Electronics PHYSICS DSE – 14b	4	2	0	2	Class XII Pass with Science	NIL

LEARNING OBJECTIVES

This course introduces the concept of semiconductor devices and their analog applications. It also emphasizes on understanding of amplifiers, oscillators, operational amplifier and their applications.

LEARNING OUTCOMES

At the end of this course, the following concepts will be learnt.

- To learn about diodes and its uses in rectification
- To gain an insight into working principle of photodiodes, solar cells, LED and zener diode as voltage regulator
- To gain an understanding of construction and working principle of bipolar junction transistors (BJTs), characteristics of different configurations, biasing and analysis of transistor amplifier
- To be able to design and understand use of different types of oscillators
- To learn the fundamentals of operation amplifiers and understand their operations to compare, add, or subtract two or more signals and to differentiate or integrate signals etc.

In the laboratory course, the students will be able to study characteristics of various diodes and BJT. They will be able to design amplifiers, and oscillators. Also different applications using Op-Amp will be designed.

SYLLABUS OF Physics DSE – 14b

THEORY COMPONENT

Unit – I - Two-terminal devices and their applications (5 Hours)

IV characteristics of a diode and its application as rectifier (half-wave and full wave rectifier), IV characteristics of a zener diode and its use as voltage regulator, principle, structure and characteristics of (1) LED, (2) Photodiode and (3) Solar Cell

Unit – II - Bipolar junction transistors (4 Hours)

n-p-n and p-n-p transistors, IV characteristics of CB and CE configurations, active, cut-off and saturation regions, current gains α and β, relations between α and β, physical mechanism of current flow

Unit – III – Amplifiers and sinusoidal oscillators (11 Hours)

Load line analysis of transistor, DC load line and Q-point, fixed bias and voltage divider bias, transistor as 2-port network, h-parameter equivalent circuit of a transistor, analysis of a

single-stage CE amplifier using hybrid model (input and output impedance, current and voltage gain)
Sinusoidal Oscillators: General idea of positive and negative feedback, Barkhausen's criterion for self-sustained oscillations, RC phase shift oscillator, determination of frequency, Hartley and Colpitts oscillators

Unit – IV - Operational Amplifiers (Black Box approach) (10 Hours)
Characteristics of an ideal and practical Op-Amp (IC 741), open-loop and closed-loop gain, frequency response, CMRR, slew rate and concept of virtual ground
Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Comparator and Zero crossing detector (7) Wein bridge oscillator

References:
Essential Readings:

1) Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill
2) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall
3) Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall
4) Microelectronic circuits, A. S. Sedra, K. C. Smith and A. N. Chandorkar, 6^{th} edition, 2014, Oxford University Press.
5) Semiconductor Devices: Physics and Technology, S. M. Sze, 2^{nd} edition, 2002, Wiley India
6) Electronic Principles, A. Malvino, D. J. Bates, 7^{th} edition, 2018, Tata Mc-Graw Hill Education.
7) Electronic Devices and circuit Theory, R. L. Boylestad and L. D. Nashelsky, 2009, Pearson

Additional Readings:

1) Learning Electronic Devices and circuits, S. Salivahanan and N. S. Kumar, 3^{rd} edition, 2012, Tata Mc-Graw Hill
2) Microelectronic Circuits, M. H. Rashid, 2^{nd} edition, Cengage Learning
3) Microelectronic Devices and Circuits, D. A. Bell, 5^{th} edition, 2015, Oxford University Press
4) Basic Electronics: Principles and Applications, C. Saha, A. Halder and D. Ganguli, 1^{st} edition, 2018, Cambridge University Press
5) Solid State Electronic Devices, B. G.Streetman and S. K. Banerjee, 6^{th} edition, 2009, PHI

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

- Session on the construction and use of specific analogue devices and experimental apparatuses used in the lab, including necessary precautions
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

At least six experiments to be performed from the following list

1) To study the V-I characteristics of a Zener diode and its use as voltage regulator.

2) Study of V-I and power curves of solar cells, and find maximum power point and efficiency.
3) To study the characteristics of a Bipolar Junction Transistor in CE configuration.
4) To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
5) To design a Wien bridge oscillator for given frequency using an op-amp.
6) To design an inverting amplifier using Op-amp (741, 351) for dc voltage of given gain
7) To design inverting amplifier using Op-amp (741, 351) and study its frequency response
8) To design non-inverting amplifier using Op-amp (741, 351) and study frequency response
9) To add two dc voltages using Op-amp in inverting and non-inverting mode
10) To study the zero-crossing detector and comparator
11) To investigate the use of an op-amp as an integrator
12) To investigate the use of an op-amp as a differentiator.

References for laboratory work:

1) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino and M. A. Miller, 1994, Mc- Graw Hill
2) Student Manual for The Art of Electronics, T. C. Hayes and P. Horowitz

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 14c: PHYSICS OF EARTH

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Earth PHYSICS DSE – 14c	4	3	1	0	Class XII Pass with Science	NIL

LEARNING OBJECTIVES
This course familiarizes the students with the origin of earth in the solar system and various processes occurring in atmosphere, oceans and earth's internal structure.

LEARNING OUTCOMES
At the end of this course student will be able to,

- Have an overview of structure of the earth as well as various dynamical processes occurring on it.
- Develop an understanding of evolution of the earth.
- Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.
- Understand the origin of magnetic field, geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top.
- Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth
- Develop the problem solving skills by adding numerical and simulations to clarify the fundamental concepts.

SYLLABUS OF DSE – 14c

THEORY COMPONENT

Unit – I **(10 Hours)**

The Earth and the Universe:

a) General characteristics and origin of the Universe. The Big Bang Theory. Estimation of age of the Universe and Hubble constant. Formation of Galaxies. Types of galaxies, Milky Way galaxy, Nebular hypothesis, Solar system, The Terrestrial and Jovian planets (Sizes, Acceleration due to gravity, Obliquity, Flatness, Eccentricity, Density, Temperature, Pressure, Atmosphere, Moons, Exceptions in trends). Titius-Bode law. Asteroid belt. Asteroids: origin types and examples, Meteorites.

b) Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Earth's orbit and spin, the Moon's orbit and spin.

c) Energy and particle fluxes incident on the Earth.

Unit – II **(8 Hours)**

Structure of Earth:

a) Internal structure of Earth: Core, mental, magnetic field. Origin of the Magnetic field. Convection in Earth's core and production of its magnetic field. Dynamo Theory, calculation of magnetic fields, Causes of variation of Magnetic Field and Palaeomagnetism.
b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. Ocean circulations. Oceanic current system and effect of Coriolis forces.
c) The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Unit – III **(8 Hours)**

Dynamical Processes:

a) The Solid Earth: Concept of plate tectonics; types of plate movements, hotspots; sea-floor spreading and continental drift.
b) Earthquake and earthquake belts. Types and properties of Seismic waves, Richter scale, geophones.
c) Volcanoes: types, products and distribution.
d) Concepts of eustasy, air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

Unit – IV **(10 Hours)**

The Atmosphere

a) The Atmosphere: Features of different layers, variation of temperature with altitude; Dry, moist and environmental lapse rate, variation of density and pressure with altitude, Types of clouds and formation.
b) The Atmosphere: Atmospheric circulation. Causes of Atmospheric circulation, Formation of three cells, Easterlies and Westerlies, and ICTZ, Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones, tropical storms, hurricanes and tornadoes.
c) Climate: Earth's temperature and greenhouse effect. Paleoclimate and recent climate changes. The Indian monsoon system.

Unit – V **(9 Hours)**

Disturbing the Earth – Contemporary dilemmas

a) Hydrosphere: Fresh water depletion.
b) Geosphere: Chemical effluents, nuclear waste.
c) Biosphere: Biodiversity loss. Deforestation. Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.
d) Air Pollution: Types of air pollutants, Effects on atmosphere and living organisms. Ozone Hole.

References:

Essential Readings:

1) Planetary Surface Processes, H. J. Melosh, 2011, Cambridge University Press.
2) Holme's Principles of Physical Geology, 1992, Chapman & Hall.
3) Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.
4) Physics of the Earth, F. D. Stacey, P. M. Davis, 2008, Cambridge University Press.
5) Environmental Physics: Sustainable Energy and Climate Change, E. Boecker and R.V. Grondelle, 3rd edition, 2011, Wiley, UK
6) Atmospheric Remote Sensing (Principles and Applications, Editors – S. Tiwari and A. K.

Singh, Chapter-1 (Composition and thermal structure of the Earth's atmosphere, by S. K. Dhaka and V. Kumar), 1st edition, Elsevier

Additional Readings:

1) The Blue Planet: An Introduction to Earth System Science, B. J. Skinner, S. C. Portere, 1994, John Wiley & Sons.
2) Consider a Spherical Cow: A course in environmental problem solving, J. Harte, University Science Books.
3) Fundamentals of Geophysics, W. Lowrie, 1997, Cambridge University Press.
4) The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press.
5) Climate Change: A Very Short Introduction, M. Maslin, 3rd edition, 2014, Oxford University Press.
6) The Atmosphere: A Very Short Introduction, P. I. Palmer, 2017, Oxford University Press.
7) IGNOU Study material: PHE 15 Astronomy and Astrophysics Block

Category II

Physical Science Courses (with Electronics)
with Physics and Electronics discipline as Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 7: WAVES AND OPTICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Waves and Optics PHYSICS DSC 7	4	2	0	2	Class XII Pass with Science	--

LEARNING OBJECTIVES

This is a core course in Physics curriculum that begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

LEARNING OUTCOMES

On successfully completing the requirements of this course, the students will have the skill and knowledge to,

- Understand simple harmonic oscillation and superposition principle.
- Understand superposition of a range of collinear and mutually perpendicular simple harmonic motions and their applications.
- Understand concept of normal modes in stationary waves: their frequencies and configurations.
- Understand interference as superposition of waves from coherent sources derived from same parent source.
- Demonstrate understanding of interference experiments: Young's double slit, Fresnel's biprism, Llyod's mirror, Newton's rings
- Demonstrate basic concepts of diffraction: Superposition of wavelets diffracted from apertures
- Understand Fraunhoffer diffraction from apertures: single slit, double Slit, grating
- Demonstrate fundamental understanding of Fresnel diffraction: Half period zones, diffraction of different apertures
- Laboratory course is designed to understand the principles of measurement and skills in experimental designs.

SYLLABUS OF PHYSICS DSC – 7

THEORY COMPONENT

Unit – I **(11 Hours)**

Superposition of collinear harmonic oscillations: Simple harmonic motion (SHM); linearity and superposition principle; superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (beats).

Superposition of two perpendicular harmonic oscillations: Graphical and analytical methods. Lissajous figures with equal and unequal frequencies and their uses

Superposition of two harmonic Waves: Standing (stationary) waves in a string; normal modes of stretched strings

Unit – II **(8 Hours)**

Interference: Division of amplitude and division of wavefront; Young's double slit experiment: width and shape of fringes; Fresnel's biprism; Lloyd's mirror; Phase change on reflection: Stokes' treatment; Interference in thin films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger fringes); Fringes of equal thickness (Fizeau Fringes); Newton's rings: Measurement of wavelength and refractive index

Unit – III **(11 Hours)**

Diffraction:

Fraunhofer diffraction: Single slit, double slit, diffraction grating

Fresnel diffraction: Fresnel's assumptions. Fresnel's half-period zones for plane wave. Explanation of rectilinear propagation of light; Fresnel's diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis

References:

Essential Readings:

1) Vibrations and Waves, A. P. French, 1st edition, 2003, CRC press.
2) The Physics of Waves and Oscillations, N. K. Bajaj, 1998, Tata McGraw Hill.
3) Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
4) Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.
5) Optics, A. Ghatak, 6th edition, 2017, McGraw-Hill Education, New Delhi
6) The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

Additional Readings:

1) Principles of Optics, M. Born and E. Wolf, 7th edition, 1999, Pergamon Press.
2) Optics, E. Hecht, 4th edition, 2014, Pearson Education.
3) Fundamentals of Optics, F. A. Jenkins and H. E. White, 1981, McGraw-Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least 7 experiments to be performed from the following list

1) To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2–T law.
2) To study Lissajous figures.
3) Familiarization with Schuster`s focusing and determination of angle of prism.
4) To determine refractive index of the material of a prism using sodium light.
5) To determine the dispersive power and Cauchy's constants of the material of a prism using mercury light.
6) To determine wavelength of sodium light using Fresnel biprism.
7) To determine wavelength of sodium light using Newton's rings.
8) To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.

9) To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10) To determine dispersive power and resolving power of a plane diffraction grating.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal
3) Advanced level Physics Practicals, M. Nelson and J. M. Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers
4) A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.
5) B.Sc. Practical Physics, G. Sanon, 2019, R. Chand & Co

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 8: MICROPROCESSOR AND MICROCONTROLLER

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Microprocessor and Microcontroller PHYSICS DSC – 8	4	2	0	2	Class XII Pass with Science	Basic Electronics

LEARNING OBJECTIVES

This paper introduces the basic concepts of microprocessor and microcontrollers to the undergraduate students. Basic architecture and buildings blocks of a microprocessor and microcontrollers will be discussed in detail. Pin out diagram and the assembly language programming is discussed for both of them. The course is supported by a lab where students will apply the learned concepts and write simple programs to strengthen their classroom learning.

LEARNING OUTCOMES

Upon completion of this course, students will be able to,

- Describe the basic difference between a microprocessor and microcontroller and a general computing system.
- Explain the basic architecture and pin out diagram of 8085 microprocessor and 8051 microcontroller.
- Explain the difference between machine code, mnemonics, assembly language (low level) and high level language.
- Explain the concept of memory, different types of memory available in a system. The concept of memory map and how addresses are assigned to each memory element and peripherals.
- Classify instructions 1-, 2- or 3-byte instructions and into arithmetic, logical types etc.
- Describe the different addressing modes available to perform the same task.
- Write simple programs for 8085 microprocessor and 8051 microcontroller.

SYLLABUS OF PHYSICS DSC - 8

THEORY COMPONENT

Unit – I - Microcomputer organization (4 Hours)

Basic organization of a microcomputer/ microprocessor based system, computer memory, memory classification (RAM and ROM), memory organization and addressing, memory interfacing, memory map

Unit – II - 8085 Microprocessor architecture (4 Hours)

Main features of 8085, pin-out diagram of 8085, data and address buses, registers, ALU, stack pointer, program counter

Unit – III - 8085 Programming **(7 Hours)**
Instruction classification (data transfer, arithmetic, logical, branch, and control instructions), general discussion on 1 byte, 2 bytes and 3 bytes instructions, subroutines, instruction cycle, timing diagram of MOV and MVI, hardware and software interrupts (general discussion).

Unit – IV - 8051 microcontroller **(8 Hours)**
Microcontroller vs microprocessor, block diagram of 8051 microcontroller, 8051 assembly language programming, program counter and ROM memory map, data types and directives, flag bits and program status word (PSW) register, register banks and stack, jump, loop and call instructions

Unit – V - 8051 I/O port programming **(3 Hours)**
Pin out diagram of 8051 microcontroller, introduction of I/O port and their general features, I/O port programming in 8051 (using assembly language)

Unit – VI - 8051 Programming **(4 Hours)**
8051 addressing modes and accessing memory locations using various addressing modes, arithmetic and logic instructions

References:
Essential Readings:
1) Microprocessor Architecture Programming and applications with 8085, R. S. Goankar, 2002, Prentice Hall.
2) Microprocessors and Microcontrollers, K. Kant, 2nd edition, 2016. PHI learning Pvt. Ltd.
3) The 8051 Microcontroller, Ayala, Cengage learning, 3rd edition.
4) The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, 2nd edition, 2007, Pearson Education India.
5) Microprocessor and Microcontrollers, N. Senthil Kumar, 2010, Oxford University Press.
6) 8051 Microcontroller, S. Shah, 2010, Oxford University Press.

Additional Readings:
1) Embedded Systems: Design and Applications, S. F. Barrett, 2008, Pearson Education India.
2) Introduction to embedded system, K. V. Shibu, 1st edition, 2009, McGraw Hill.
3) Embedded Microcomputer systems: Real time interfacing, J. W. Valvano, 2011, Cengage Learning.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

There are two options here:
A. Every Student must perform at least 06 experiments each from Section-A and Section-B
Or
B. Every Student must perform at least 04 experiments each from Section-A and Section-B and a suitable project based on Arduino.

Section-A: Programs using 8085 Microprocessor

1) Addition and subtraction of two 8 bits numbers using direct addressing mode

2) Addition and subtraction of two 8 bits numbers using indirect addressing mode
3) Addition and subtraction of two 16 bits numbers using direct addressing mode
4) Addition and subtraction of two 16 bits numbers using indirect addressing mode
5) Multiplication by repeated addition.
6) Division by repeated subtraction.
7) Handling of 16-bit Numbers.
8) Use of CALL and RETURN Instruction.
9) Block data handling.
10) Parity checking in an 8-bit and 16 bit number.

Section-B: Experiments using 8051 microcontroller:

1) To find that the given numbers is prime or not.
2) To find the factorial of a number.
3) Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4) Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
5) Program to glow the first four LEDs then next four using TIMER application.
6) Program to rotate the contents of the accumulator first right and then left.
7) Program to run a countdown from 9-0 in the seven segment LED display.
8) To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9) To toggle '1234' as '1324' in the seven segments LED display.
10) Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11) Application of embedded systems: Temperature measurement & display on LCD

References for laboratory work:

1) Microprocessor Architecture Programming and applications with 8085, R. S. Goankar, 2002, Prentice Hall.
2) Embedded Systems: Architecture, Programming and Design, R. Kamal, 2008, Tata McGraw Hill.
3) The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, 2nd edition, 2007, Pearson Education India.
4) 8051 microcontrollers, S. Shah, 2010, Oxford University Press.
5) Embedded Microcomputer systems: Real time interfacing, J. W. Valvano, 2011, Cengage Learning

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 11: INTRODUCTION TO NUMERICAL METHODS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Introduction to Numerical Methods PHYSICS DSE 11	4	2	0	2	Class XII Pass with Science	Elementary calculus

LEARNING OBJECTIVES

The main objective of this course is to introduce the students to the field of numerical analysis enabling them to solve a wide range of physics problems. The skills developed during the course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Analyse a physics problem, establish the mathematical model and determine the appropriate numerical techniques to solve it.
- Derive numerical methods for various mathematical tasks such as root finding, interpolation, least squares fitting, numerical differentiation, numerical integration, and solution of initial value problems.
- Analyse and evaluate the accuracy of the numerical methods learned.

In the laboratory course, the students will learn to implement these numerical methods in Python and develop codes to solve various physics problems and interpret the results.

SYLLABUS OF PHYSICS DSE – 11

THEORY COMPONENT

Unit – I **(7 Hours)**

Approximation and errors in computing: Introduction to numerical computation, Taylor's expansion and mean value theorem; Floating point computation, overflow and underflow; IEEE single and double precision format; Rounding and truncation error, absolute and relative error, error propagation.

Solutions of algebraic and transcendental equations: Basic idea of iteration method, Bisection method, Secant method, Newton Raphson method; comparison of order of convergence.

Unit – II **(7 hours)**

Interpolation: Interpolation and Lagrange polynomial, divided differences, Newton divided-difference form of the interpolating polynomial with equally spaced nodes. Theoretical error in interpolation.

Least Squares Approximation: Least squares linear regression, Least squares regression for exponential and power functions by taking logarithm.

Unit - III **(8 Hours)**

Numerical Differentiation: Using finite difference to approximate derivatives of first and second order using Taylor series and error in this approximation.

Numerical Integration: Newton Cotes quadrature methods; derivation of Trapezoidal and Simpson (1/3 and 3/8) rules from Lagrange interpolating polynomial; error and degree of precision of a quadrature formula; composite formulae for trapezoidal and Simpson methods; Gauss Legendre quadrature method.

Unit - IV **(8 Hours)**

Initial Value Problems: Solution of initial value problems by Euler, modified Euler and Runge Kutta (RK2, RK4) methods; local and global errors, comparison of errors in the Euler and RK methods, system of first order differential equations. Solving higher order initial value problems by converting them into a system of first order equations.

References:

Essential Readings:

1) Introduction to Numerical Analysis, S. S. Sastry, 5th edition, 2012, PHI Learning Pvt. Ltd.
2) Elementary Numerical Analysis, K. E. Atkinson, 3rd edition, 2007, Wiley India Edition.
3) Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyenger and R. K. Jain, 2012, New Age Publishers
4) A Friendly Introduction to Numerical Analysis, B. Bradie, 2007, Pearson India

Additional Readings:

1) Numerical Recipes: The art of scientific computing, W. H. Press, S. A. Teukolsky and W. Vetterling, 3rd edition, 2007, Cambridge University Press
2) Numerical Methods for Scientists and Engineers, R. W. Hamming, 1987, Dover Publications
3) Applied numerical analysis, C. F. Gerald and P. O. Wheatley, 2007, Pearson Education
4) Numerical Analysis, R. L. Burden and J. D. Faires, 2011, Brooks/Cole, Cengage Learning
5) Numerical Methods, V. N. Vedamurthy and N. Ch. S.N. Iyengar, 2011, Vikas Publishing House

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Assessment is to be done not only on the programming but also on the basis of formulating the problem.
- The list of recommended programs is suggestive only. Students should be encouraged to do more physics applications. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods.
- The students should be encouraged to develop and present an independent project.
- **At least 12 programs must be attempted (taking two from each unit). The implementation is to be done in Python. Use of scipy inbuilt functions may be encouraged.**

Unit 1

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, formatting in the print statement.

Control Structures: Conditional operations, ***if, if-else, if-elif-else, while*** and ***for*** Loops, indentation, break and continue, List comprehension. Simple programs for practice like solving quadratic equations, temperature conversion etc.

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc. Use of inbuilt functions to generate pseudo random numbers.

Recommended List of Programs

a) Make a function that takes a number *N* as input and returns the value of factorial of *N*. Use this function to print the number of ways a set of *m* red and *n* blue balls can be arranged.
b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
c) Write functions to convert Cartesian coordinates of a given point to cylindrical and spherical polar coordinates or vice versa.
d) Solve quadratic equations for the three cases of distinct real, double real and complex conjugate roots.

Unit 2

NumPy Fundamentals: Importing *Numpy*, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using *ones(), zeros(), random(), arange(), linspace()*. Basic array operations (*sum, max, min, mean, variance*), 2-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt().

Plotting with Matplotlib: *matplotlib.pyplot* functions, plotting of functions given in closed form as well as in the form of discrete data and making histograms

Recommended List of Programs

(a) To generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.
(b) To plot the displacement-time and velocity-time graph for the undamped, under damped critically damped and over damped oscillator using *matplotlib* (using given formulae).
(c) To generate array of N random numbers drawn from a given distribution (uniform, binomial, poisson and gaussian) and draw histogram using *matplotlib* for increasing N to verify the distribution.
(d) To approximate the elementary functions (e.g. exp(x), sin(x), cos(x), ln($1+x$), etc.) by a finite number of terms of Taylor's series and discuss the truncation error. To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualise the convergence of series.

Unit 3

Root Finding: Implement the algorithms for Bisection, Secant and Newton Raphson methods or their combinations to,

(a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.

(b) Solve transcendental equations like α = tan(α).
(c) Approximate nth root of a number up to a given number of significant digits.

Unit 4
Interpolation and Least Square Fitting:

a) Given a dataset (x, y) with equidistant x values, prepare the Newton's divided difference table. Generate a tabulated data for an elementary function, approximate it by a polynomial and compare with the true function.
b) Given a dataset (x, y) corresponding to a physics problem, use Lagrange and Newton's forms of interpolating polynomials and compare. Determine the value of y at an intermediate value of x not included in the data set. This may be done with equally spaced and non-equally spaced x-values.
c) Make Python function for least square fitting, use it for fitting given data (*x, y*) and estimate the parameters *a, b* as well as uncertainties in the parameters for the following cases :
   i. Linear $(y = ax + b)$
   ii. Power law $(y = ax^b)$ and
   iii. Exponential $(y = ae^{bx})$
   The real data taken in physics lab may be used here.
d) Compare the interpolating polynomial for a given dataset (following a known form e.g. exponential) with the approximation obtained by least square fitting.

Unit 5
Differentiation and Integration:

a) To compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative on the same graph. Plot (using *matplotlib)* the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.
b) Use integral definition of error function to compute and plot erf(x) in a given range. Use Trapezoidal, Simpson and Gauss Legendre methods and compare the results for small and large values of x.
c) Verify the degree of precision of each quadrature rule.
d) Approximate the value of π by evaluating the integral $\int_0^\infty \frac{1}{x^2+1} dx$ using Simpson and Gauss Legendre method. More integrals may be evaluated.

Unit 6
Initial Value Problems (IVP):

a) Compare the errors in Euler, RK2 and RK4 by solving a first order IVP with known solution. Reduce the step size to a point where the round off errors takes over.
b) Radioactive decay: With a given number of initial nuclei and decay constant plot the number of nuclei left as a function of time and determine the half life
c) Solve a system of two first order differential equations by Euler, RK2 and RK4 methods. Use it to solve an nth order IVP. Solve a damped free and forced harmonic oscillator problem using this.
d) Solve a physics problem like free fall with air drag or parachute problem using RK method.
e) Obtain the current flowing in a series LCR circuit with constant voltage for a given set of initial conditions.

References for laboratory work:

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, D. Walker, 1st edition, 2015, Scientific International Pvt. Ltd
4) An Introduction to Computational Physics, T. Pang, 2010, Cambridge University Press
5) Python Programming and Numerical Methods - A Guide for Engineers and Scientists, Q. Kong, T. Siauw, A. M. Bayen, 2021, Academic Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 12: PHYSICS OF EARTH

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Earth Physics DSE 12	**4**	**3**	**1**	**0**	Class XII Pass with Science	--

LEARNING OBJECTIVES

This course familiarizes the students with the origin of earth in the solar system and various processes occurring in atmosphere, oceans and earth's internal structure.

LEARNING OUTCOMES

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

- Have an overview of structure of the earth as well as various dynamical processes occurring on it.
- Develop an understanding of evolution of the earth.
- Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.
- Understand the origin of magnetic field, geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top.
- Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth
- Develop the problem solving skills by adding numerical and simulations to clarify the fundamental concepts.

SYLLABUS OF DSE – 12

THEORY COMPONENT

Unit – I **(10 Hours)**

The Earth and the Universe:

a) General characteristics and origin of the Universe. The Big Bang Theory. Estimation of age of the Universe and Hubble constant. Formation of Galaxies. Types of galaxies, Milky Way galaxy, Nebular hypothesis, Solar system, The Terrestrial and Jovian planets (Sizes, Acceleration due to gravity, Obliquity, Flatness, Eccentricity, Density, Temperature, Pressure, Atmosphere, Moons, Exceptions in trends). Titius-Bode law. Asteroid belt. Asteroids: origin types and examples, Meteorites.

b) Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Earth's orbit and spin, the Moon's orbit and spin.

c) Energy and particle fluxes incident on the Earth.

Unit – II **(8 Hours)**

Structure of Earth:

a) Internal structure of Earth: Core, mental, magnetic field. Origin of the Magnetic field. Convection in Earth's core and production of its magnetic field. Dynamo Theory, calculation of magnetic fields, Causes of variation of Magnetic Field and Palaeomagnetism.
b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. Ocean circulations. Oceanic current system and effect of Coriolis forces.
c) The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Unit – III **(8 Hours)**

Dynamical Processes:

a) The Solid Earth: Concept of plate tectonics; types of plate movements, hotspots; sea-floor spreading and continental drift.
b) Earthquake and earthquake belts. Types and properties of Seismic waves, Richter scale, geophones.
c) Volcanoes: types, products and distribution.
d) Concepts of eustasy, air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

Unit – IV **(10 Hours)**

The Atmosphere

a) The Atmosphere: Features of different layers, variation of temperature with altitude; Dry, moist and environmental lapse rate, variation of density and pressure with altitude, Types of clouds and formation.
b) The Atmosphere: Atmospheric circulation. Causes of Atmospheric circulation, Formation of three cells, Easterlies and Westerlies, and ICTZ, Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones, tropical storms, hurricanes and tornadoes.
c) Climate: Earth's temperature and greenhouse effect. Paleoclimate and recent climate changes. The Indian monsoon system.

Unit – V **(9 Hours)**

Disturbing the Earth – Contemporary dilemmas

a) Hydrosphere: Fresh water depletion.
b) Geosphere: Chemical effluents, nuclear waste.
c) Biosphere: Biodiversity loss. Deforestation. Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.
d) Air Pollution: Types of air pollutants, Effects on atmosphere and living organisms. Ozone Hole.

References:

Essential Readings:

1) Planetary Surface Processes, H. J. Melosh, 2011, Cambridge University Press.
2) Holme's Principles of Physical Geology, 1992, Chapman & Hall.
3) Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.
4) Physics of the Earth, F. D. Stacey, P. M. Davis, 2008, Cambridge University Press.
5) Environmental Physics: Sustainable Energy and Climate Change, E. Boecker and R.V. Grondelle, 3rd edition, 2011, Wiley, UK
6) Atmospheric Remote Sensing (Principles and Applications, Editors – S. Tiwari and A. K.

Singh, Chapter-1 (Composition and thermal structure of the Earth's atmosphere, by S. K. Dhaka and V. Kumar), 1st edition, Elsevier

Additional Readings:

1) The Blue Planet: An Introduction to Earth System Science, B. J. Skinner, S. C. Portere, 1994, John Wiley & Sons.
2) Consider a Spherical Cow: A course in environmental problem solving, J. Harte, University Science Books.
3) Fundamentals of Geophysics, W. Lowrie, 1997, Cambridge University Press.
4) The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press.
5) Climate Change: A Very Short Introduction, M. Maslin, 3rd edition, 2014, Oxford University Press.
6) The Atmosphere: A Very Short Introduction, P. I. Palmer, 2017, Oxford University Press.
7) IGNOU Study material: PHE 15 Astronomy and Astrophysics Block

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVE (GE – 15): QUANTUM MECHANICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Quantum Mechanics GE – 15	4	3	1	0	Class XII Pass with Science	GE Modern Physics of this course or its equivalent

LEARNING OBJECTIVES

The development of quantum mechanics has revolutionized the human life. In this course, the students will be exposed to the probabilistic concepts of basic non-relativistic quantum mechanics and its applications to understand the sub atomic world.

LEARNING OUTCOMES

After completing this course, the students will be able to,

- Learn the methods to solve time-dependent and time-independent Schrödinger equation.
- Characteristics of an acceptable wave function for any sub atomic particle in various potentials.
- Applications of the Schrodinger equation to different cases of potentials namely infinite and finite potential well, step potential, rectangular potential barrier, harmonic oscillator potential.
- Solve the Schrodinger equation in 3-D.
- Understand the spectrum and eigen functions for hydrogen atom

SYLLABUS OF GE - 15

THEORY COMPONENT

Unit – I **(10 Hours)**

Review of Schrodinger wave equation, applicability of operator, eigenvalues, eigenfunction, normalisation, expectation value to various kinds of potential, Superposition Principle, linearity of Schrodinger equation, General solution as a linear combination of discrete stationary states, Observables as operators, Commutator of position and momentum operators, Ehrenfest’s theorem. Applicability to various kinds of wave functions

Unit – II **(15 Hours)**

General discussion of bound states in an arbitrary potential: Continuity of wave function, boundary conditions and emergence of discrete energy levels. Application to energy eigen states for a particle in a finite square potential well, reflection and transmission across step potential and rectangular potential barrier. Fourier transforms and momentum space wave function, time evolution of Gaussian wave packets, Uncertainty principle

Unit – III **(10 Hours)**

Harmonic oscillator: Energy eigen values and eigen states of a 1-D harmonic oscillator using algebraic method (ladder operators) and using Hermite polynomials. Zero point energy and uncertainty principle. Applications to various kinds of wave functions

Unit – IV **(10 Hours)**

Schrödinger Equation in three dimensions: Probability and probability densities in 3D. Schrödinger equation in spherical polar coordinates, its solution for Hydrogen atom solution using separation of angular and radial variables, Angular momentum operator, quantum numbers and spherical harmonics. Radial wave functions from Frobenius method, Orbital angular momentum quantum numbers l and ml, s, p, d shells

References:

Essential Readings:

1) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 6^{th} edition, 2019, Laxmi Publications, New Delhi.
2) Introduction to Quantum Mechanics, D. J. Griffith, 2^{nd} edition, 2005, Pearson Education.
3) A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2^{nd} edition, 2010, McGraw Hill.
4) Quantum Mechanics, B. H. Bransden and C. J. Joachain, 2^{nd} edition, 2000, Prentice Hall
5) Quantum Mechanics: Concepts and Applications, 2^{nd} edition, N. Zettili, A John Wiley and Sons, Ltd., Publication
6) Atomic Physics, S. N. Ghoshal, 2010, S. Chand and Company

Additional Readings:

1) Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008, Cambridge University Press.
2) Introduction to Quantum Mechanics, R. H. Dicke and J. P. Wittke, 1966, Addison-Wesley Publications
3) Quantum Mechanics, L. I. Schiff, 3^{rd} edition, 2010, Tata McGraw Hill.
4) Quantum Mechanics, R. Eisberg and R. Resnick, 2^{nd} edition, 2002, Wiley
5) Quantum Mechanics, B. C. Reed, 2008, Jones and Bartlett Learning.
6) Quantum Mechanics, W. Greiner, 4^{th} edition, 2001, Springer.
7) Introductory Quantum Mechanics, R. L. Liboff, 4^{th} edition, 2003, Addison Wesley

GENERIC ELECTIVE (GE – 16) INTRODUCTION TO EMBEDDED SYSTEM DESIGN

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Introduction to Embedded System Design GE – 16	4	2	0	2	Class XII Pass with Science	NIL

LEARNING OBJECTIVES

This paper aims to introduce the basic concepts or fundamentals of embedded system design to students not majoring in physics. The course covers the comprehensive introduction to embedded systems, their role and application areas in our daily life. Basic elements needed to design a typical embedded system are discussed to provide the students a broader perspective. Specific applications of embedded systems which are a part of our daily life were discussed. In the end Arduino Uno is introduced.

LEARNING OUTCOMES

Upon completion of this course, students will be able to,

- Learn about an embedded system and how it is different than a general purpose computing system like computer or laptop etc.
- The student should be able to identify various embedded systems available around us in our daily life.
- Classify embedded systems based on generation, complexity and performance, major applications areas etc.
- Explain the domains and areas of applications of embedded systems. The students should be able to get a broader perspective of different embedded systems available in industry, telecom, photography, homes, automobile, aviation and ship industry etc.
- Explain the roles and uses of various components like microcontroller, memory, sensors and actuators, interface types etc. of embedded systems.
- Know the basic characteristics and quality attributes that any typical embedded system must possess.
- This paper is designed in such a way that the students will be able to connect the textbook knowledge with basic design and working of the various embedded systems present in our daily life. By the end of this course the student will have a fairly good idea of embedded systems and the gained knowledge will be helpful in predicting the possible design and working of an unknown system. Arduino Uno is introduced so that students can learn how to use different sensors to control different processes.

SYLLABUS OF GE - 16

THEORY COMPONENT

UNIT – I - Introduction to Embedded Systems (3 Hours)
Embedded systems, historical background, difference between an embedded systems and general computing systems, classification of embedded systems based on generation, complexity and performance, major applications areas, purpose of embedded systems like in data collection/storage/representation, data communication, data/signal processing, monitoring, control, application specific user interface.

Unit – II - Elements of Embedded System (6 Hours)
Core of the embedded system: General purpose and domain specific processors like microprocessors, microcontrollers and digital signal processors, application specific integrated circuits (ASICs), programmable logic devices (PLDs), commercial off-the-shelf components (COTS), reduced instruction set computing (RISC) and complex instruction set computing (CISC), Harvard vs Von-Neumann architecture, different types of memory (RAM, ROM, Storage etc) their classification and different versions, reset circuit, oscillator unit

Unit – III - Peripheral devices, sensors and actuators (6 Hours)
General discussion on light emitting dodes (LEDs), 7-segment LED display, piezo buzzer, push button switch, keypad or keyboard (discuss design using push button switches), relay (single pole single throw), LDR, thermistor, IR sensor, ultrasonic sensor, opto-coupler, DC motors, servo motor, stepper motor (unipolar and bipolar)

Unit – IV - Communication Interface (2 Hours)
Serial and parallel interface, universal serial bus (USB), Infra-red data transfer, bluetooth (BT), Wi-Fi, general packet radio Service (GPRS), 3G, 4G, LTE

Unit – V - Characteristics and quality attributes of an embedded systems (3 Hours)
Characteristics: Application and domain specific, reactive and real time, operation under harsh environments, distributed or stand alone, size and weight, power consumption
Operational and non-operational attributes: response time, throughput, reliability, maintainability, security, safety, testability and debug-ability, evolvability, portability, cost and revenue

Unit – VI - Applications of Embedded Systems (4 Hours)
General discussion on the design and working of washing machine, refrigerator, microwave oven, automobiles, mobile phones, hearing aid device, electrocardiogram (ECG), AC or TV remote control system, smart watch, digital camera and laser printers etc.

Unit – VII - Introduction to Arduino (6 Hours)
Pin diagram and description of Arduino UNO, basic programming and applications

References:
Essential Readings:

1) Introduction to embedded system, K. V. Shibu, 1st edition, 2009, McGraw Hill
2) Embedded Systems: Architecture, Programming and Design, R. Kamal, 2008, Tata McGraw Hill
3) Embedded Systems and Robots, S. Ghoshal, 2009, Cengage Learning.
4) Embedded Microcomputer systems: Real time interfacing, J. W. Valvano, 2011, Cengage Learning
5) Embedded System, B. K. Rao, 2011, PHI Learning Pvt. Ltd.
6) Programming Arduino: Getting Started with Sketches, S. Monk, 2nd edition, McGraw Hill

7) Arduino: Getting Started With Arduino and Basic Programming with Projects by E. Leclerc

Additional Readings:

1) The 8051 Microcontroller and Embedded Systems Using Assembly and C, M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, 2nd edition, 2007, Pearson Education
2) Microprocessors and Microcontrollers, K. Kant, 2nd edition, 2016, PHI learning Pvt. Ltd.
3) The 8051 Microcontroller, Ayala, 3rd edition, Cengage learning

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

- Every student must perform at least six experiments from the following list
- Mandatory exercise for all students: Familiarization with power supply, function generator, CRO/DSO, multimeter, bread board etc. Measure the frequency and amplitude (pp or rms) of a given signal using CRO/DSO. (The purpose is to acquaint the students with these instruments so that they can have a basic understanding of these instruments).

ARDUINO based Experiments:

1) Flashing LEDs ON/OFF after a given delay.
2) Design a simple transmitter and receiver circuit using IR LED and a detector and use it for obstacle detection.
3) Interface a simple relay circuit to switch ON and OFF a dc motor/LED.
4) Interface DC motor to Arduin Uno and rotate it clockwise and anticlockwise.
5) Interface Servo motor to Arduin Uno and rotate it clockwise and anticlockwise for a given angle.
6) Interface an ADC and read the output of the LDR sensor. Display the value on the serial monitor.
7) To design an alarm system using an Ultrasonic sensor.
8) To design a counter/Motion sensor alarm using IR Led and Detector
9) To design a circuit to control ON/OFF of LED light using LDR.
10) To design a circuit to control ON/OFF of a process using a thermistor.
11) To design a thermistor based thermometer.
12) Control the speed of the DC motor using LDR.

References for laboratory work:

1) Arduino Programming: 3 books in 1 - The Ultimate Beginners, Intermediate and Expert Guide to Master Arduino Programming, R. Turner
2) Arduino: Getting Started With Arduino and Basic Programming with Projects, E. Leclerc
3) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino, M. A. Miller, 1994, McGraw Hill.
4) Electronic Devices and circuit theory, R. L. Boylestad and L. D. Nashelsky, 2009, Pearson
5) Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.
6) Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning.

GENERIC ELECTIVE (GE - 17) NANO PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Nano Physics GE – 17	4	2	0	2	Class XII Pass with Science	NIL

LEARNING OBJECTIVES

The syllabus introduces the basic concepts of nanomaterials, their synthesis, properties exhibited by them and finally few applications. Various nanomaterial synthesis/growth methods and characterizations techniques are discussed to explore the field in detail. The effect of dimensional confinement of charge carries on the electrical, optical and structural properties will be discussed. Interesting experiments which shape this filed like conductance quantization in 2DEG (Integer Quantum Hall Effect) and coulomb blockade are introduced. The concept of micro- and nano-electro mechanical systems (MEMS and NEMS) and important applications areas of nanomaterials are discussed.

LEARNING OUTCOMES

On successful completion of the course students should be able to,

- Explain the difference between nanomaterials and bulk materials and their property difference.
- Explain various methods for the synthesis/growth of nanomaterials.
- Explain the role of confinement on the density of state function and so on the various properties exhibited by nanomaterials compared to bulk materials.
- Explain the concept of quasi-particles such as excitons and how they influence the optical properties.
- Explain the direct and indirect band gap semiconductors, radiative and non-radiative processes and the concept of luminescence.
- Explain the structure of 2DEG system and its importance in quantum transport experiments, like integer quantum Hall effect and conductance quantization.
- Explain the conductance quantization in 1D structure and its difference from the 2DEG system.
- Explain the necessary and sufficient conditions required to observe coulomb blockade, single electron transistor and the scope of these devices.
- Explain how MEMS and NEMS devices are produced and their applications.

SYLLABUS OF GE - 17

THEORY COMPONENT

Unit – I – Introduction **(3 Hours)**

Basic introduction to nano-science and technology - Implications on nanoscience on fields like Physics, Chemistry, Biology and Engineering, Classifications of nanostructured materials as quantum dots (0D), nanowires (1D), Thin films (2D) and Multilayered materials or super lattices; introduction to properties like mechanical, electronic, optical, magnetic and thermal properties and how they change at nano scale dimensions to motivate students (qualitative only).

Unit – II - Nanoscale Systems (8 Hours)

Brief review of Schrodinger equation and its applications in- Infinite potential well, potential step and potential box problems, band structure and density of states of 3D and 2D systems in detail and qualitatively for 1D and 0D, confinement of charges in nanostructures their consequences on electronic and optical properties.

Unit – III - Properties of Nano Scale systems (10 Hours)

Time and length scales (diffusion, elastic and inelastic lengths etc.) of electrons in nanostructured materials, Carrier transport in nanostructures: diffusive and ballistic transport

2D naomaterials: Conductance quantization in 2DEG in GaAs and integer quantum hall effect (semi-classical treatment)

1D nanomaterials: Conductance quantization in 1D structures using split gate in 2DEG system (Qualitative)

0D nanomaterials: Charging effect, Coulomb Blockade effect, Single Electron Transfer (SET) device

Basic understanding of excitons in semiconductors and their consequence on optical properties of the material

Unit – IV - Synthesis of Nanomaterials (Qualitative) (5 Hours)

Top down and Bottom up approach, Ball milling, Spin Coating

Vacuum deposition: Physical vapor deposition (PVD): Thermal evaporation, Sputtering, Chemical vapor deposition (CVD).

Preparation of colloidal solutions of Metals, Metal Oxide nanoparticles

Unit – V - Applications (Qualitative) (4 Hours)

Micro Electromechanical Systems (MEMS), Nano-electromechanical Systems (NEMS), Applications of nanomaterials as probes in medical diagnostics and targeted drug delivery, sunscreen, lotions, and paints and other examples to give broader perspective of applications of nanomaterials

References:

Essential Readings:

1) Introduction to Nanotechnology, C. P. Poole and Jr. Frank J. Owens, 1st edition, 2003, Wiley India Pvt. Ltd.
2) Nanotechnology: Principles and Practices, S. K. Kulkarni, 2nd edition, 2011, Capital Publishing Company
3) Introduction to Nanoscience and Technology, K. K. Chattopadhyay and A. N. Banerjee, 2009, PHI Learning Private Limited
4) Introduction to Nanoelectronics, V. V. Mitin, V. A. Kochelap and M. A. Stroscio, 2011, Cambridge University Press
5) Nanotechnology for Dummies, R. Booker and E. Boysen, 2005, Wiley Publishing Inc.
6) Introductory Nanoscience, M. Kuno, 2012, Garland science Taylor and Francis Group
7) Electronic transport in mesoscopic systems, S. Datta, 1997, Cambridge University Press.
8) Fundamentals of molecular spectroscopy, C. N. Banwell and E. M. McCash, 4th edition, McGrawHill

Additional Readings:

1) Quantum Transport in semiconductor nanostructures, C. Beenakker and H. Van Houten, 1991, available at arXiv: cond-mat/0412664) Open Source
2) Ph.D. thesis, S. Cronewett, 2001, Available as Arxiv
3) Solid State Physics, J. R. Hall and H. E. Hall, 2^{nd} edition, 2014, Wiley

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Synthesis of metal (e.g. Au/Ag) nanoparticles by chemical route and study its optical absorption properties.
2) Synthesis of semiconductor (CdS/ZnO/TiO_2/Fe_2O_3 etc) nanoparticles and study its XRD and optical absorption properties as a function of ageing time.
3) Surface Plasmon study of metal nanoparticles as a function of size by UV-Visible spectrophotometer.
4) Analysis of XRD pattern of given nanomaterial and estimate lattice parameters and particle size.
5) To study the effect of the size nanoparticles on its color.
6) To prepare composite of CNTs with other materials and study their optical absorption/Transmission properties.
7) Growth of metallic thin films using thermal evaporation technique.
8) Prepare a ceramic disc of a given compound and study its XRD/I-V characteristics/ measure its dielectric constant or any other property.
9) Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study its XRD and transmittance spectra in UV-Visible region.
10) Prepare thin film capacitor and measure capacitance as a function of temperature or frequency.
11) Fabricate a pn junction diode by diffusing Al over the surface of N-type Si/Ge and study its V-I characteristic.
12) Fabricate thin films (polymer, metal oxide) using electro-deposition
13) To study variation of resistivity or sheet resistance with temperature of the fabricated thin films using four probe method.

References for laboratory work:

1) Introduction to Nanotechnology, C. P. Poole and Jr. Frank J. Owens, 1^{st} edition, 2003, Wiley India Pvt. Ltd.
2) Nanotechnology: Principles and Practices, S. K. Kulkarni, 2^{nd} edition, 2011, Capital Publishing Company
3) Introduction to Nanoscience and Technology, K. K. Chattopadhyay and A. N. Banerjee, 2009, PHI Learning Private Limited
4) Nanotechnology for Dummies, R. Booker and E. Boysen, 2005, Wiley Publishing Inc.

GENERIC ELECTIVE (GE - 18): PHYSICS OF DETECTORS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Detectors GE – 18	4	3	1	0	Class XII Pass with Science	GE Modern Physics of this course or its equivalent

LEARNING OBJECTIVES

A detector is necessary for every physical measurement, and experimental physicists must be proficient in detector physics. The course will provide an overview of radiation and particle detectors, as well as how to use them in various experimental physics settings and application fields. The course covers the theory of detectors, their design and operation including electronic readout systems and signal processing. The fundamental physics processes for detecting radiation and particles are covered in the course, which include the photoelectric effect, Compton scattering, pair creation, excitation, ionization, bremsstrahlung, Cherenkov radiation, nuclear reactions, and secondary emissions.

LEARNING OUTCOMES

After completion of this course, students are expected to be able to,

- Understand the different types underlying fundamental physical processes for the detection of radiation and particles
- Acquire knowledge of design principles and characteristics of different types of detector
- Acquire knowledge of electronic readout systems and signal processing
- Assess the applicability of different types of detectors and detector systems in various fields of physics and applied sciences.

SYLLABUS OF GE - 18

THEORY COMPONENT

Unit – I **(12 Hours)**

Interaction of Radiation with matter: Interaction of radiation with matter (e.m. charged particles); detection of charged particles in magnetic field and measurement of charge to mass ratio; energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation; gamma ray interaction through matter (photoelectric effect, Compton scattering, pair production); Dependence of electron and photon energy spectrum on materials (increasing Z); neutron interaction with matter

Unit – II **(8 Hours)**

Introduction to detectors: Basic principle of detector operation and its modes of operation, pulse height spectra, various detector performance parameters: response time, energy resolution, fano factor, efficiency: intrinsic and extrinsic, dead time.

Unit – III **(16 Hours)**

Detectors:

Gas detectors: Detector gases, gas detector characteristics, different types of detectors: gas filled ionization detectors (ionization chamber), bubble and cloud chambers, proportional counters, multi wire proportional counters (MWPC), Geiger Mueller (GM) counters and avalanche counters, gaseous multiplication detector.

Scintillation detectors: General characteristics, organic scintillators (anthracene and plastic), inorganic crystals (NaI(Tl), CsI(Tl)), Charge Coupled Devices (CCD)

Photomultipliers: Basic construction and operation, time response and resolution, noise, gain stability; scintillation counter operation

Semiconductor detectors: Doped semiconductors, np semiconductor junction, depletion depth, detector characteristics of semiconductors. silicon and germanium detectors

Neutron detectors (gas-filled, scintillation, and semiconducting): slow and fast neutron detectors

Bolometric detectors: Working principle, characteristics and use of infrared detectors

Unit - IV **(5 Hours)**

Electronics, signal processing and techniques for data acquisition and analysis: Basic idea of analog and digital signal processing, noise and its types; instrumentation standards for nuclear instruments: NIM, ECL; TTL standards

Data acquisition system: VME and Digital pulse processing system.

Unit - V **(4 Hours)**

Application of detectors: for particle physics experiments, for nuclear physics, for astrophysics and cosmology, medical physics and imaging, by giving two examples each.

References:

Essential Readings:

1) Radiation detection and measurement, G. F. Knoll, 2010, John Wiley and Sons
2) Principles of radiation interaction in matter and detection, C. Leroy and P. G. Rancoita, 3rd edition, 2011, World Scientific
3) Techniques for Nuclear and Particle Physics experiments, W. R. Leo, 1994, Springer
4) Nuclear Radiation Detectors, S. S. Kapoor and V. S. Ramamurthy, 1st edition, John Wiley and Sons.
5) Physics and Engineering of Radiation Detection, S. N. Ahmed, 2007, Academic Press Elsevier
6) Semiconductor detectors: New developments, E. Gatti and P. Rehak, 2002, Springer

Additional Readings:

1) Radiation Detection for Nuclear Physics Methods and industrial applications, D. Jenkins
2) Advanced Nuclear Radiation Detectors Materials, processing, properties and applications, A. K. Batra, IOP Publishing
3) Measurement and Detection of Radiation, N. Tsoulfanidis et al., 4th edition, T and F CRC
4) Principles of nuclear radiation detection, G. G. Eichholz and J. W. Poston, CRC
5) Introduction to Nuclear Radiation Detectors: 2, Laboratory Instrumentation and Techniques, P. Ouseph, Springer
6) Detectors for Particle Radiation, K. Kleinknecht, Cambridge
7) Particle Detectors, C. Grupen, Cambridge
8) Handbook of Particle Detection and Imaging, C. Grupen and I. Buvat

GENERIC ELECTIVE (GE - 19): NUCLEAR AND PARTICLE PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Nuclear and Particle Physics GE – 19	4	3	1	0	Class XII Pass with Science	NIL	Physics and Astrophysics

LEARNING OBJECTIVES
This course imparts the understanding of the sub atomic particles and their properties; introduces various nuclear phenomena and their applications, interactions of basic building blocks of matter through fundamental forces, the inherent discrete symmetries of particles and complements each and every topic with applications and problems.

LEARNING OUTCOMES
After completion of this course, students are expected to have an understanding of,

- Nuclear charge and mass density, size, magnetic and electric moments
- Theoretical principles and experimental evidences towards modelling the nucleus
- Kinematics of nuclear reactions and decays
- Energy loss of radiation during propagation in medium
- Principles of nuclear detection technique
- Classification of fundamental forces based on their range, time-scale and mediator mass.
- Scattering cross-sections of 2 to 2 processes and their inherent symmetries.
- Angular and energy distributions for three body decay process.
- Discrete symmetries of nature and associated conservation laws
- Colour triplet quarks and anti-quarks as constituents of observed colour singlet baryons and mesons.

SYLLABUS OF GE 19

THEORY COMPONENT

Unit – I **(5 Hours)**
General properties of nuclei: Constituents of nucleus and their Intrinsic properties: quantitative facts about mass, radii, charge density, matter density, binding energy, N/Z plot, angular momentum, parity, magnetic moment, electric moments.

Unit – II **(5 Hours)**
Nuclear models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, evidence for nuclear shell structure and the basic assumptions of shell model, magic numbers.

Unit – III **(7 Hours)**

Radioactivity decay: Decay rate and equilibrium (secular and transient)
(a) Alpha decay: basics of α-decay processes, Gamow factor, Geiger Nuttall law, α-decay spectroscopy, decay Chains.
(b) β-decay: energy kinematics for β-decay, β-spectrum, positron emission, electron capture, neutrino hypothesis.
(c) Gamma decay: Gamma ray emission from the excited state of the nucleus and kinematics, internal conversion.

Unit – IV **(5 Hours)**
Nuclear reactions: Kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, Coulomb scattering (Rutherford scattering).

Unit – V **(8 Hours)**
Interaction of nuclear radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation; Gamma ray interaction through matter Detector for nuclear radiations: Basics of types of detectors: gas detectors, scintillation detector, semiconductor detector (principle, schematics of construction and working)

Unit – VI **(15 Hours)**
Particle Physics: Overview of particle spectrum and their interactions in the Standard Model; range, time-scale and relative strength of interactions; interactions at a distance mediated by virtual particles (Exchange Force)
Kinematics for 2 -> 2 scattering processes and crossing symmetries of scattering amplitudes; angular and energy distributions of decaying particles in 1 -> 3 decay processes (muon decay/beta decay); identification of invisibles (neutrinos) from energy and transverse momentum distributions
Lepton and Baryon quantum numbers; isospin, strangeness and hypercharge; Gell-Mann-Nishijima formula; parity and charge conjugation of a particle state; time reversal and general CPT theorem
Valence quark model of Murray Gell-Mann and Yuval Ne'eman, current and constituent masses of quarks, flavor symmetry isospin triplets, baryon octet, decuplet and meson octet; existence of Δ^{++} baryon as a clue for necessity of colour quantum number; evidence for colour triplet quarks from e^+e^- annihilation experiment; confinement of quarks, antiquarks and gluons in hadrons
High energy scattering experiments at linear and circular colliders, inelastic collisions at hadron colliders; elastic and inelastic neutrino-nucleus scattering experiments

References:
Essential Readings:
(A) For Nuclear Physics
1) Basic ideas and concepts in nuclear physics: An introductory approach, K. Heyde, 3rd edition, 1999, IOP Publication
2) Introductory Nuclear Physics, K. S. Krane, 2008, Wiley-India Publication
3) Nuclear Physics, S. N. Ghoshal, 1st edition, 2010, S. Chand Publication
4) Nuclear Physics: Principles and applications, J. Lilley, 2006, Wiley Publication
5) Concepts of Nuclear Physics, B. L. Cohen, 1974, Tata McGraw Hill Publication
6) Radiation detection and measurement, G. F. Knoll, 2010, John Wiley and Sons

(B) For Particle Physics
1) Modern Particle Physics, M. Thompson, 2013, Cambridge University Press

2) Particles and Nuclei: An Introduction to the Physical Concepts, B. Povh, K. Rith, C. Scholz, F. Zetsche and W. Rodejohann, 2015, Springer-Verlag
3) An Introductory Course of Particle Physics, P. B. Pal, 2015, CRC Press
4) Introduction to High Energy Physics, D. H. Perkins, 4^{th} edition, 2000, Cambridge University Press
5) Introduction to elementary particles, D. J. Griffiths, 2008, Wiley
6) Quarks and Leptons, F. Halzen and A. D. Martin, 1984, John Wiley

Additional Readings:
References for Tutorial

1) Problems and Solutions in Nuclear and Particle Physics, S. Petreta, 2019, Springer
2) Schaum's Outline of Modern Physics, 1999, McGraw-Hill
3) Schaum's Outline of College Physics, E. Hecht, 11^{th} edition, 2009, McGraw Hill
4) Problems and Solutions on Atomic, Nuclear and Particle Physics, Yung-Kuo Lim, 2000, World Scientific
5) Nuclear Physics "Problem-based Approach" including MATLAB, H. M. Aggarwal, 2016, PHI Learning Pvt. Ltd

GENERIC ELECTIVE (GE – 20): ATOMIC AND MOLECULAR PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Atomic and Molecular Physics GE – 20	4	3	1	0	Class XII Pass with Science	GE Modern Physics and GE Quantum Mechanics of this course or their equivalent

LEARNING OBJECTIVES
This course introduces the basic concepts of atomic, molecular and nuclear physics to an undergraduate student. Advanced mathematics is avoided and the results of quantum mechanics are attempts to explain, or even to predict, the experimental observations of spectroscopy. The student will be able to visualize an atom or molecule as a physical entity rather than a series of mathematical equations.

LEARNING OUTCOMES
On successful completion of the module students should be able to elucidate the following main features.

- Stern-Gerlach experiment, electron spin, spin magnetic moments
- Space quantization and Zeeman effect
- Spectral notations for atomic and molecular states and corresponding term symbols
- Understanding of atomic spectra and molecular spectra
- Basic principle of Raman spectroscopy and Franck Condon principle
- To complete scientific potential lies on the way we are able to interpret the fundamental astrophysical and nuclear data. This acquired knowledge will be a common base for the areas of astrophysics, nuclear, medical, geology and other inter-disciplinary fields of Physics, Chemistry and Biology. Special skills required for the different fields will be enhanced.

SYLLABUS OF GE 20

THEORY COMPONENT

Unit – I – Atomic Physics **(23 Hours)**

One-electron atoms: Degeneracy of energy levels and selection rules, modes of relaxation of an excited atomic state, line intensities and the lifetimes of excited states, line shapes and widths

Fine structure of hydrogenic atoms: Shifting of energy levels, splitting of spectral lines, relativistic correction to kinetic energy, spin-orbit term, Darwin term, fine structure spectral lines, Lamb shift (qualitative idea)

Atoms in external magnetic fields: Larmor's theorem, Stern-Gerlach experiment, normal Zeeman effect, Paschen Back effect, and anomalous Zeeman effect, g-factors

Two and multi-electron systems: Spin multiplicity, singlet and triplet states and selection rules in helium atom, central field approximation, Aufbau and Pauli exclusion principle,

Slater determinant, LS and JJ coupling scheme (equivalent and non-equivalent electrons), term symbols and Hund's rule, Lande' interval rule
Qualitative Discussion of: Lamb shift and Auger effect.

Unit – II - Molecular Physics (22 Hours)

Electronic states of diatomic molecules: Linear combination of atomic orbitals (LCAO), bonding and antibonding orbitals; 'gerade', 'ungerade', molecular orbitals and the ground state electronic configurations for homo and hetero-nuclear diatomic molecules, classification of molecular excited states of diatomic molecule, Vector representation of Orbital and electron spin angular momenta in a diatomic molecule, The Born-Oppenheimer approximation, Concept of Potential energy curve for a diatomic molecule, Morse potential. The Franck-Condon principle

Molecular Spectra of diatomic molecule: Rotational Spectra (rigid and non-rigid rotor), Vibrational Spectra (harmonic and anharmonic), Vibration-Rotation Spectrum of a diatomic molecule, Isotope effect, Intensity of spectral lines

Raman Effect: Classical Theory (with derivation) of Raman effect, pure rotational Raman Lines, Stoke's and Anti-Stoke's Lines, comparison with Rayleigh scattering

Idea of spin resonance spectroscopy (Nuclear Magnetic Resonance, Electron Spin Resonance) with few examples, estimation of magnetic field of the Sun.

References:

Essential Readings:

1) Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain, 2nd edition, Pearson
2) Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, 1994, Tata McGraw – Hill
3) Atomic physics, J. B. Rajam and foreword by Louis De Broglie, 2010, S. Chand and Co.
4) Atoms, Molecules and Photons, W. Demtroder, 2nd edition, 2010, Springer
5) Atomic, Nuclear and. Particle Physics. Compiled by. The Physics Coaching Class. University of science and Technology of China, edited By Yung-Kuo Lim. World scientific.
6) Atomic Physics, S. N. Ghoshal, 2019, S. Chand Publication
7) Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman, G. A. Kriz and J. R. Vyvyan, 5th edition, 2014, Brookes/Cole

Additional Readings:

1) Basic Atomic and Molecular Spectroscopy, J. M. Hollas, Royal Society of Chemistry
2) Molecular Spectra and Molecular Structure, G. Herzberg
3) Introduction to elementary particles, D. J Griffiths, 2008, Wiley
4) Atomic and molecular Physics, R. Kumar, 2013, Campus Book Int.
5) The Fundamentals of Atomic and Molecular Physics, Undergraduate Lecture Notes in Physics, 2013, Springer

UNIVERSITY OF DELHI

CNC-II/093/1(28)/2024-25/

Dated: 15.05.2024

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 14-1/-(14-1-6/-) dated 09.06.2023 and 27-1-1/ dated 25.08.2023]

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- V and VI in respect of Department of Physics & Astrophysics under Faculty of Science based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23:

(i) **SEMESTER-V**: BSc. (H) Physics/ Pool of DSEs/ BSc. Physical Science with Physics as one of the Core Disciplines/ BSc. Physical Science with Physics & Electronics as one of the Core Disciplines/ Common Pool of GEs ***(As per Annexure-1)***

(ii) **SEMESTER-VI**: BSc. (H) Physics/ Pool of DSEs/ BSc. Physical Science with Physics as one of the Core Disciplines/ BSc. Physical Science with Physics & Electronics as one of the Core Disciplines/ Common Pool of GEs ***(As per Annexure-2)***

REGISTRAR

ANNEXURE-1

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DEPARTMENT OF PHYSICS AND ASTROPHYSICS
Semester-V

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B. SC. (HONOURS) PHYSICS

DISCIPLINE SPECIFIC CORE COURSE – DSC - 13: ELECTROMAGNETIC THEORY

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electromagnetic Theory DSC – 13	4	3	0	1	Class XII pass with Physics and Mathematics as main subjects	Mathematical Physics I, II; Waves and Oscillation; Electricity and Magnetism papers of this course or their equivalents

LEARNING OBJECTIVES

This core course develops further the concepts learnt in the electricity and magnetism course to understand the properties of electromagnetic waves in vacuum and different media.

LEARNING OUTCOMES

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

- Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density
- Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma
- Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at plane interface in bounded media
- Understand polarization of electromagnetic waves: Linear, circular and elliptical polarization. Production as well as detection of waves in laboratory
- Learn the features of planar optical wave guide
- In the laboratory course, the students will get an opportunity to perform experiments with polarimeter, Babinet compensator, ultrasonic grating and simple dipole antenna. Also, to study phenomena of interference, refraction, diffraction and polarization

SYLLABUS OF DSC – 13

THEORY COMPONENT

Unit - I **(6 Hours)**

Review of Maxwell's equations; Coulomb gauge and Lorentz gauge; Poynting's theorem and Poynting's vector; electromagnetic (em) energy density; physical concept of electromagnetic field energy density

Unit – II **(10 Hours)**

EM wave propagation in unbounded media: Plane em waves through vacuum and isotropic dielectric medium: transverse nature, refractive index, dielectric constant, wave impedance. Plane em waves through conducting medium: relaxation time, skin depth, attenuation constant;

Wave propagation through dilute plasma: electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth.

Unit – III **(9 Hours)**

EM waves in bounded media: Boundary conditions at a plane interface between two media; reflection and refraction of plane em waves at plane interface between two dielectric media - Laws of reflection and refraction; Fresnel's formulae for perpendicular and parallel polarization, Brewster's law; reflection and transmission coefficients; total internal reflection, evanescent waves; metallic reflection (normal incidence)

Unit – IV **(13 Hours)**

Polarization of EM waves: Propagation of em waves in an anisotropic media; symmetric nature of dielectric tensor; Fresnel's formula; uniaxial and biaxial crystals; light propagation in uniaxial crystal; double refraction; polarization by double refraction; Nicol prism; ordinary and extraordinary refractive indices; production and detection of plane, circular and elliptically polarized light; phase retardation plates: quarter wave and half wave plates

Optical rotation; Biot's laws for rotatory polarization; Fresnel's theory of optical rotation; specific rotation

Unit – V **(7 Hours)**

Wave guides: Planar optical wave guides; planar dielectric wave guide ($-d/2 < x < d/2$); condition of continuity at interface; phase shift on total reflection; Eigenvalue equations; phase and group velocity of guided waves; field energy and power transmission (TE mode only)

References:

Essential Readings:

1) Introduction to Electrodynamics, D. J. Griffiths, 3rd edition, 1998, Benjamin Cummings.
2) Electromagnetic Field and Waves, P. Lorrain and D. Corson, 2nd edition, 2003, CBS Publisher
3) Classical Electrodynamics, J. D. Jackson, 3rd edition, 2010, Wiley
4) Principle of Optics, M. Born and E. Wolf, 6th edition, 1980, Pergamon Press
5) Optics, A. Ghatak, 6th edition, 2017, McGraw-Hill Education, New Delhi

Additional Readings:

1) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan, and S. R. Choudhary, 2017, TMH
2) Principles of Electromagnetic Theory, C. Jain, 2017, Narosa Publishing House
3) Elements of Electromagnetics, M. N. O. Sadiku, 2001, Oxford University Press.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Problems and solution in Electromagnetics, A. Ghatak, K. Thyagarajan and Ravi Varshney, 2015
6) Electromagnetic field Theory, R. S. Kshetrimayun, 2012, Cengage Learning
7) Engineering Electromagnetic, W. H. Hayt, 8th edition, 2012, McGraw Hill.
8) Electromagnetics, J. A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
9) 2008+ Solved Problems in Electromagnetics, S. A. Nasar, 2001, SciTech

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

- Mandatory sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the lab, including necessary precautions.
- Mandatory sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

<u>At least six experiments to be performed from the following list</u>

1) To verify the law of Malus for plane polarized light.
2) To determine the specific rotation of sugar solution using polarimeter.
3) To analyse elliptically polarized light by using a Babinet's compensator.
4) To study the elliptical polarized light using Fresnel rhomb.
5) To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6) To study the reflection and refraction of microwaves
7) To study polarization and double slit interference in microwaves.
8) To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9) To determine the refractive index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10) To verify the Stefan's law of radiation and to determine Stefan's constant.
11) To determine Boltzmann constant using V-I characteristics of PN junction diode.
12) To find numerical aperture of an optical fibre.
13) To use a prism shaped double refracting crystal to determine the refractive indices of the quartz/ calcite corresponding to ordinary and extra-ordinary rays.
14) To measure birefringence of Mica
15) To determine the dielectric constant of solids using microwaves

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) Advanced level Physics Practicals, M. Nelson and J. M. Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publisher
3) Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
4) Practical Physics, G. L. Squires, 4th edition, 2015, Cambridge University Press
5) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd

DISCIPLINE SPECIFIC CORE COURSE – DSC - 14: QUANTUM MECHANICS – I

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Quantum Mechanics – I DSC – 14	4	3	0	1	Class XII pass with Physics and Mathematics as main subjects	Light and Matter, and Elements of Modern Physics papers of this course or their equivalents

LEARNING OBJECTIVES

The development of quantum mechanics has revolutionized the human life. In this course, the students will be exposed to the probabilistic concepts of basic non-relativistic quantum mechanics and its applications to understand the sub atomic world.

LEARNING OUTCOMES

After completing this course, the students will be able to,

- Understand the applications of the Schrodinger equation to different cases of potentials namely finite square potential well, harmonic oscillator potential.
- Solve the Schrodinger equation in 3-D.
- Understand the spectrum and eigen functions for hydrogen atom
- Understand the angular momentum operators in position space, their commutators, eigenvalues and eigen functions.
- In the laboratory course, the students will be able to use computational methods to
    - Solve Schrödinger equation for ground state energy and wave functions of various simple quantum mechanical one- dimensional potentials
    - Solve Schrödinger equation for ground state energy and radial wave functions of some central potentials

SYLLABUS OF DSC - 14

THEORY COMPONENT

Unit – I **(10 Hours)**

General discussion of bound states in an arbitrary potential: Continuity of wave function, boundary conditions and emergence of discrete energy levels. Application to energy eigen states for a particle in a finite square potential well, Momentum space wavefunction, Time evolution of Gaussian Wave packet, Superposition Principle, linearity of Schrodinger Equation, General solution as a linear combination of discrete stationary states, Observables as operators, Commutator of position and momentum operators, Ehrenfest's theorem.

Unit – II **(8 Hours)**

Harmonic oscillator: Energy eigen values and eigen states of a 1-D harmonic oscillator using algebraic method (ladder operators) and using Hermite polynomials. Zero point energy and uncertainty principle.

Unit – III **(15 Hours)**

Schrödinger Equation in three dimensions: Probability and probability densities in 3D. Schrödinger equation in spherical polar coordinates, its solution for Hydrogen atom solution using separation of angular and radial variables, Angular momentum operator, quantum numbers and spherical harmonics. Radial wave functions from Frobenius method; shapes of the probability densities for ground and first excited states; Orbital angular momentum quantum numbers l and m_l, s, p, d shells.

Unit – IV **(12 Hours)**

Angular momentum: Commutation relations of angular momentum operators; concept of spin and total angular momentum; ladder operators, eigenvalues, eigenvectors; Pauli matrices; addition of angular momenta

References:

Essential Readings:

1) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 6th edition, 2019, Laxmi Publications, New Delhi.
2) Introduction to Quantum Mechanics, D. J. Griffith, 2nd edition, 2005, Pearson Education.
3) A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd edition, 2010, McGraw Hill.
4) Quantum Mechanics, B. H. Bransden and C. J. Joachain, 2nd edition, 2000, Prentice Hall
5) Quantum Mechanics: Concepts and Applications, 2nd edition, N. Zettili, A John Wiley and Sons, Ltd., Publication
6) Atomic Physics, S. N. Ghoshal, 2010, S. Chand and Company

Additional Readings:

1) Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008, Cambridge University Press.
2) Introduction to Quantum Mechanics, R. H. Dicke and J. P. Wittke, 1966, Addison-Wesley Publications
3) Quantum Mechanics, L. I. Schiff, 3rd edition, 2010, Tata McGraw Hill.
4) Quantum Mechanics, R. Eisberg and R. Resnick, 2nd edition, 2002, Wiley
5) Quantum Mechanics, B. C. Reed, 2008, Jones and Bartlett Learning.
6) Quantum Mechanics, W. Greiner, 4th edition, 2001, Springer.
7) Introductory Quantum Mechanics, R. L. Liboff, 4th edition, 2003, Addison Wesley

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

At least 4 programs must be attempted. The implementation may be done in C++/Scilab /Python. Use of available library functions may be encouraged. Similar programs may be added.

Unit 1

1) Visualize the spherical harmonics by plotting the probability density for various values of the quantum numbers (*l, m*)

2) Use the analytical solution for a particle in finite potential well. Numerically solve the transcendental equation one gets after putting the continuity and boundary conditions to determine the energy eigenvalues for various values of the potential width and depth. Plot the corresponding normalised eigen functions.

Unit 2

Solve the Schrödinger equation using shooting/finite difference or any other method for the following simple 1-D potentials and compare with the analytical solutions:

1) Particle in a box
2) Particle in a finite potential well
3) Harmonic Potential

Unit 3

Solve the s-wave Schrodinger equation for the following cases.

$$\frac{d^2u}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E],$$

1) Ground state and the first excited state of the hydrogen atom:

$$V(r) = \frac{-e^2}{r}$$

Here *m* is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(\text{eVÅ})^{1/2}$, ħc = 1973 (eVÅ) and m = $0.511 \text{x} 10^6$ eV/c^2.

2) For an atom in the screened coulamb potential

$$V(r) = \frac{-e^2}{r} e^{\frac{-r}{a}}$$

Here *m* is the reduced mass of the system (which can be chosen to be the mass of an electron). Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(\text{eVÅ})^{1/2}$, *m* = $0.511 \text{x} 10^6$ eV/c^2, and *a* = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

Unit 4

Solve the s-wave Schrodinger equation $\frac{d^2u}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$, for a particle of mass *m* for the following cases

1) Anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose *m* = 940 MeV/c^2, *k* = 100 MeV fm^{-2}, *b*= 0, 10, 30 MeV fm^{-3}. In these units, $c\hbar$ = 197.3 MeV fm. The ground state energy is expected to lie between 90 and 110 MeV for all three cases.

2) For the vibrations of hydrogen molecule with Morse potential

$$V(r) = D(e^{-2ar'} - e^{-ar'}), r' = \frac{r - r_0}{r}$$

Here m is the reduced mass of the two-atom system for the Morse potential

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: $m = 940 \text{ x}10^6$ eV/c^2, $D = 0.755501$ eV, $\alpha = 1.44$, $r_0 = 0.131349$ Å

References for laboratory work:

1) Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Education.
2) C++ How to Program, P. J. Deitel and Harvey Deitel, 2016, Pearson
3) Scilab (A Free Software to Matlab): H. Ramchandran, A. S. Nair, 2011, S. Chand and Co
4) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
5) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
6) Computational Physics, Darren Walker, 1st edition, 2015, Scientific International Pvt. Ltd
7) An Introduction to Computational Physics, T. Pang, 2010, Cambridge University Press
8) A Guide to MATLAB, B. R. Hunt, R. L. Lipsman, J. M. Rosenberg, 3rd edition, 2014, Cambridge University Press

DISCIPLINE SPECIFIC CORE COURSE – DSC - 15: DIGITAL ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Digital Electronics DSC – 15	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

The objective of the course is to introduce digital electronics and its simple applications to physics Honours students. The course is designed to familiarize the students with the different number systems (binary, octal and hexadecimal), laws of Boolean algebra, logic gates and combinational and sequential logic circuits utilised in designing counters and registers.

LEARNING OUTCOMES

This paper is one of the core papers in the Physics curriculum. After studying this paper students will become familiar with,

- Digital signals, positive and negative logic, Boolean variables, truth table, various number system codes and their inter-conversions.
- Students will be able to learn to minimise a given Boolean function using laws of Boolean algebra and Karnaugh map to minimise the hardware requirement of digital logic circuits.
- Understand the working principle of data processing circuits, arithmetic circuits, sequential logic circuits, registers, counters based on flip flops

SYLLABUS OF DSC - 15

THEORY COMPONENT

Unit – I - Integrated circuits (2 Hours)

Integrated Circuits (Qualitative treatment only), active and passive components, discrete components, wafer, chip, advantages and drawbacks of ICs, scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only), classification of ICs, examples of linear and digital lCs

Unit – II - Digital circuits and Boolean algebra (14 Hours)

Difference between analog and digital circuits, binary number, decimal to binary and binary to decimal conversion, BCD, octal and hexadecimal numbers, AND, OR and NOT gates (realization using diodes and transistor), NAND and NOR gates as universal gates, XOR and XNOR gates and application as parity checkers

De Morgan's theorems, Boolean laws, simplification of logic circuit using Boolean algebra, fundamental products, idea of minterms and maxterms, conversion of truth table into equivalent logic circuit by (1) Sum of Products method and (2) Karnaugh map simplification (upto four variables).

Unit – III - Combinational Logic Circuits (9 Hours)
Data processing circuits: Multiplexers and its applications, de-multiplexers, decoders, encoders Arithmetic logic circuits: Express binary number in signed and unsigned form, 1's and 2's complement representation, binary addition, binary subtraction using 2's complement, half and full Adders, half and full subtractors, 4-bit binary adder/subtractor using 2's complement method.

Unit – IV - Sequential Logic Circuits (8 Hours)
Flip Flops SR, D, and JK clocked (level and edge triggered) flip-flops, preset and clear operations, race-around conditions in JK flip-flop, master-slave JK flip-flop, conversion of one flip flop to another using an excitation table

Unit – V - Application of Sequential Logic Circuits (9 Hours)
Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters: Asynchronous counters, MOD-N synchronous counter designing using excitation table.

Unit – VI – Timers (3 Hours)
IC 555: Pin -out diagram, block diagram and its applications as astable multivibrator and monostable multivibrator

References:
Essential Readings:
1) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th edition, 2011, Tata McGraw
2) Fundamentals of Digital Circuits, A. Kumar, 2nd edition, 2009, PHI Learning Pvt. Ltd.
3) Digital Fundamentals, T. L. Floyd, 1994, Pearson Education Asia
4) Digital Principles and Applications, D. P. Leach and A. P. Malvino, 1995, Tata McGraw Hill
5) Digital Design, M. M. Mano and M. D. Ciletti, 2007, Pearson Education Asia
6) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
7) Digital Electronics G. K. Kharate, 2010, Oxford University Press

Additional Readings:
1) Logic circuit design, S. P. Vingron, 2012, Springer
2) Digital Principles, R. L. Tokheim, 1994, Schaum's Outline Series, Tata McGraw-Hill
3) Solved Problems in Digital Electronics, S. P. Bali, 2005, Sigma Series, Tata McGraw-Hill
4) Digital Electronics: An Introduction To Theory And Practice, W. H. Gothmann, 2000, Prentice Hall of India
5) Modern Digital Electronics, R. P. Jain, 2003, Tata McGraw-Hill
6) Digital Electronics, S. Ghoshal, 2012, Cengage Learning
7) Digital Electronics, S. K. Mandal, 2010, 1st edition, McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

At least five experiments should be performed from the following list.
All designing should be done on the bread boards.

1) (a) To design a combinational logic system for a specified truth table.
   (b) To convert Boolean expression into logic circuit and design it using basic logic gate ICs
2) To minimize a given logic circuit using K-map and design using NAND gates.
3) Designing of Half Adder and Half Subtractor using NAND gates
4) Designing of 4-bit binary adder using adder IC.
5) To build Flip-Flop (RS, Clocked RS) circuits using NAND gates.
6) To build Flip-Flop (D-type and JK) circuits using NAND gate
7) To build a 3-bit Counter using D-type/JK Flip-Flop ICs and study timing diagrams.
8) To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
9) To design an astable multivibrator of given specifications using 555 Timer.

References for laboratory work:

1) Digital Fundamentals, T. L. Floyd, 1994, Pearson Education Asia
2) Digital Principles and Applications, D. P. Leach and A. P. Malvino, 1995, Tata McGraw Hill
3) Digital Design, M. M. Mano and M. D. Ciletti, 2007, Pearson Education Asia
4) Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 6: ASTRONOMY AND ASTROPHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Astronomy and Astrophysics DSE – 6	4	3	1	0	Class XII pass with Physics and Mathematics as main subjects	Mechanics; Waves and Oscillation; Electricity & Magnetism; Mathematical Physics papers of this course or their equivalents

LEARNING OBJECTIVES

This course is meant to introduce undergraduate students to the wonders of the Universe. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics. They will also be introduced to the Indian contribution to astronomy in the modern times, techniques to measure astronomical parameters, the different layers of the Sun and an overview of our Milky Way galaxy.

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LEARNING OUTCOMES

After completing this course, student will gain an understanding of,

- Basic concepts of positional astronomy and astronomical coordinate systems
- Astronomical instruments and the modern telescopes
- Measurement of astronomical parameters such as distance, stellar brightness, stellar mass, radii, temperature and spectra
- The different layers of solar atmosphere and basic results of solar magneto-hydrodynamics
- Basic structure of different galaxies and rotation of the Milky Way galaxy

It is advised that the tutorial sessions should involve discussion on problems meant to help students develop the ability to apply the theory they learn in lectures to diverse astrophysical phenomenon.

SYLLABUS OF DSE - 6

THEORY COMPONENT

Unit – I - Introduction to Astronomy (12 Hours)

Overview of the night sky; diurnal and yearly motions of the Sun; basic concepts of positional astronomy: celestial sphere, astronomical coordinate systems (Horizon and Equatorial systems of coordinates), circumpolar stars

Unit – II - Basic Parameters of Stars (12 Hours)

Measurement of astronomical distances (stellar parallax, aberration, proper motion), measurement of brightness, radiant flux and luminosity (apparent and absolute magnitude scales; distance modulus); determination of stellar mass (visual binaries, eclipsing binaries, spectroscopic binaries); measurement of stellar temperature and radius; stellar spectra, dependence of spectral types on temperature; Stellar classification (Harvard classification scheme), H-R diagram

Unit – III - Sun (9 Hours)

Solar parameters, Sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, basics of solar magneto-hydrodynamics

Unit – IV - Physics of galaxies (12 Hours)

Nature of rotation of the Milky Way: Differential rotation of the Galaxy and Oort constants, rotation curve of the Galaxy and the dark matter, virial theorem
Cosmology: Standard Candles (Cepheids and SNe Type1a); cosmic distance ladder; expansion of the Universe, Cosmological principle, Newtonian cosmology and Friedmann models

References:

Essential Readings:

1) Fundamental Astronomy, H. Karttunen et al., Springer Berlin, Heidelberg
2) Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
3) Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders College Publishing.
4) Astronomy in India: A Historical Perspective, T. Padmanabhan, Springer
5) Foundation of Astrophysics, B. Ryden and B. M. Peterson, Cambridge University Press
6) Astronomy: A Physical Perspective, M. Kutner, Cambridge University Press

Additional Readings:

1) Seven Wonders of the Cosmos, J. V. Narlikar, Cambridge University Press
2) Explorations: Introduction to Astronomy, T. Arny and S. Schneider, McGraw Hill
3) Astrophysics Stars and Galaxies, K. D. Abhyankar, Universities Press
4) An introduction to astrophysics, B. Basu, Prentice Hall of India Private Limited.
5) The Physical Universe: An Introduction to Astronomy, F. H. Shu, University Science Books
6) Telescopes and techniques, C. R. Kitchin, Springer New York, NY
7) Fundamentals of solar astronomy, A. Bhatnagar and W. C. Livingston, World Scientific
8) Astrophysics for Physicists, A. R. Choudhuri, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 7: PHYSICS OF MATERIALS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Materials DSE – 7	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Solid state physics paper of this course or its equivalent

LEARNING OBJECTIVES

This course intends to provide knowledge of emerging topics in condensed matter physics. In addition, this course aims to provide a general introduction to advanced topics by covering polymers, liquid crystals, carbon-based materials, and Diluted Magnetic Semiconductors. More importantly, the students will be exposed to different characterization techniques used in experimental condensed matter physics.

LEARNING OUTCOMES

After completion of this course the students should be able to,

- Identify different materials of technological importance in appliances and objects around us
- Explain the importance of concepts like density of states and its role in determining device characteristics
- Elucidate the ferroelectric, piezoelectric and pyroelectric materials and their applications.
- Explain the properties of liquid crystals and their application.
- Differentiate between different form of carbon based materials and their applications
- Introduce the importance of dilute magnetic semiconductors as a new technologically advance material for electronic devices
- Explain various characterization techniques used in understanding properties of different material

SYLLABUS OF DSE - 7

THEORY COMPONENT

Unit – I – Semiconductors (4 Hours)

Basic concept of mobility and conductivity, density of states, determination of electron and hole concentration in doped semiconductor, Fermi level, Fermi energy, Fermi temperature, Fermi wavelength, Fermi surface.

Unit – II - Dielectric and magnetic materials (9 Hours)

Dielectrics, Ferroelectric, Piezoelectric and Pyroelectric materials, applications of ferroelectrics in capacitors and memory device, Piezoelectrics in micro positioner and actuator, Pyroelectrics in radiation detectors and thermometry

Classification and applications of soft and hard magnetic materials, application in transformers, memory device, introduction of spintronics based systems (spin transport)

Unit – III - Polymers **(3 Hours)**

Chemical structure of polymers of few thermoplastic (polyethylene, PVC, PTFE, PMMA, Polyester, Nylons) and thermosetting (Epoxy resin) polymers, conducting polymers-application in organic electronics

Unit – IV – Liquid crystals **(3 Hours)**

Classification of liquid crystals, structural and orientational ordering (isotropic to Nematic), thermotropic liquid crystals, Phases and phase transitions; anisotropic; Birefringence and display devices

Unit – V – Carbon based materials **(3 Hours)**

Structure and properties of Fullerenes, C_{60}, single walled and multi walled CNTs, Graphene and their energy band diagram.

Unit – VI – Synthesis of materials **(8 Hours)**

Ceramic (Calcination, Sintering, Grain), thin films (general idea of vacuum, thermal evaporation, molecular beam epitaxy, pulsed laser deposition), Crystals (qualitative idea of zone refining and Czochralski method), Polymers (Polymerization mechanism)

References:

Essential Readings:

1) Solid State Physics, M. A. Wahab, 2011, Narosa Publishing House
2) Elementary Solid State Physics, M. Ali Omar, 2006, Pearson
3) Semiconductor Devices: Physics and Technology, S. M. Sze, 2nd edition, 2002, Wiley India
4) Introduction to Polymer Physics, U. Eisele and S. D. Pask, 1990, Springer-Verlag
5) The physics of liquid crystals, Pierre-Gilles de Gennes, 2nd edition, 2003, Oxford University Press
6) Introduction to Liquid Crystals, P. J. Wojtowicz, E. Priestly and P. Sheng, 1975, Plenum Press
7) Dielectric Phenomenon in solids with Emphasis on Physical Concepts of Electronic Processes, K. C. Kao, Elsevier.
8) Physics of Ferroelectrics A Modern Perspective, K. M. Rabe Charles H. Ahn Jean-Marc Triscone, Springer
9) Carbon Nanotubes: Properties and Applications, M. J. O'Connell, 2006, CRC Press
10) Dilute Magnetic Semiconductors, M. Jain, World Scientific.

Additional Readings:

1) Encyclopaedia of materials characterization: surfaces, interfaces, thin films, R. C. Brundle et al., 1992, Butterworth-Heinemann
2) Physical Methods for Materials Characterization, P. E. J. Flewitt, R. K. Wild, (2nd Ed., CRC Press, 2015).
3) Dilute magnetic semiconducting materials, Br. R. Saravanan, MRF

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Study phase transition in a ferroelectric sample by measuring its dielectric constant as a function of frequency and temperature.
2) Study dielectric properties of given polymer sample as a function of frequency and temperature.
3) Study dielectric properties of given piezoelectric sample as a function of frequency and temperature.
4) Determine the coupling coefficient of a given piezoelectric crystal.
5) BH Hysteresis of different ferromagnetic materials (Loop Tracer).
6) Analyse the XRD spectra of a given ferroelectric ceramic sample and determine its lattice parameter.
7) Analyse the XRD spectra of a given ferromagnetic sample (basically ferrites, Fe_3O_4, $CoFe_2O_3$) and determine its lattice parameter.
8) Analyse the XRD spectra of a given compound semiconductor (ZnO, TiO_2, etc) thin film/ceramic sample and determine its lattice parameter.
9) Analyse the UV-Vis spectra of a given wide band gap semiconductor and determine its bandgap.
10) Study the IV characteristics of a polymer material by depositing/painting Aluminum electrodes.
11) To determine the g-factor of a sample by ESR Spectrometer.
12) Analyse the given SEM/TEM/AFM micrographs of the deposited thin film or nanostructure of any material and determine surface roughness, crystallinity, particle size etc.
13) Deposition of any kind of thin film by any technique available in the lab.
14) Liquid crystals (reading project)

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal
3) Elements of Solid State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
4) Elements of X-Ray Diffraction, B. D. Cullity and S. R. Stock
5) Physical Methods for Materials Characterization, P. E. J. Flewitt, R. K. Wild, 2nd edition, 2015, CRC Press
6) Encyclopedia of materials characterization: surfaces, interfaces, thin films, R. C. Brundle et al., 1992, Butterworth-Heinemann

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 8: COMMUNICATION SYSTEM

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Communication System DSE – 8	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of Digital Electronics and Analog Electronics

LEARNING OBJECTIVES

This paper aims to describe the fundamental concepts of communication systems and communication techniques based on Analog Modulation, Analog and digital Pulse Modulation. Communication and Navigation systems such as GPS and mobile telephony system are also introduced. This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

LEARNING OUTCOMES

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

- Understand fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
- Gain an insight on the use of different modulation and demodulation techniques used in analog communication
- Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
- Gain an in-depth understanding of different concepts used in a satellite communication system.
- Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
- In the laboratory course, students will apply the theoretical concepts to gain hands-on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.

SYLLABUS OF DSE - 8

THEORY COMPONENT

Unit – I - Electronic communication and analog modulation (8 Hours)

Electronic communication: Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system, channels and base-band signals

Analog Modulation: Amplitude modulation, modulation index and frequency spectrum. Generation of AM (emitter modulation), amplitude demodulation (diode detector), Single sideband (SSB) systems, advantages of SSB transmission, frequency modulation (FM) and phase modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM.

Unit – II - Analog Pulse Modulation (4 Hours)
Sampling theorem, basic principles - PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing (time division multiplexing and frequency division multiplexing)

Unit – III - Digital Pulse Modulation (10 Hours)
Need for digital transmission, pulse code modulation, digital carrier modulation techniques, sampling, quantization and encoding, concept of amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), and binary phase shift keying (BPSK)

Unit – IV - Satellite Communication and Mobile Telephony system (8 Hours)
Satellite communication: Need for satellite communication, geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), uplink and downlink, Ground and earth stations
Mobile Telephony System: Concept of cell sectoring and cell splitting, SIM number, IMEI number, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset.

References:
Essential Readings:

1) Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
2) Advanced Electronics Communication Systems, Tomasi, 6th edition, Prentice Hall.
3) Electronic Communication systems, G. Kennedy, 3rd edition, 1999, Tata McGraw Hill.
4) Principles of Electronic communication systems, Frenzel, 3rd edition, McGraw Hill
5) Modern Digital and Analog Communication Systems, B. P. Lathi, 4th edition, 2011, Oxford University Press.
6) Communication Systems, S. Haykin, 2006, Wiley India
7) Wireless communications, A. Goldsmith, 2015, Cambridge University Press

Additional Readings:

1) Electronic Communication, L. Temes and M. Schultz, Schaum's Outline Series, Tata McGraw- Hill.
2) Electronic Communication Systems, G. Kennedy and B. Davis, Tata McGraw-Hill
3) Analog and Digital Communication Systems, M. J. Roden, Prentice Hall of India

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) To design an amplitude modulator using transistor
2) To design envelope detector for demodulation of AM signal
3) To study FM - generator and detector circuit
4) To study AM transmitter and receiver
5) To study FM transmitter and receiver
6) To study time division multiplexing (TDM)
7) To design pulse amplitude modulator using transistor.

8) To design pulse width modulator using 555 timer IC.
9) To design pulse position modulator using 555 timer IC
10) To study ASK, PSK and FSK modulators and demodulators

References for laboratory work:

1) Electronic Communication system, Blake, 5th edition, Cengage
2) Introduction to Communication systems, U. Madhow, 1st edition, 2018, Cambridge University Press

Category II

Physical Science Courses
with Physics discipline as one of the Core Disciplines

(B. Sc. Physical Science with Physics as Major discipline)

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 5: ELEMENTS OF MODERN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Elements of Modern Physics PHYSICS DSC – 5	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

This course introduces modern development in Physics. Starting from Planck's law, it develops the idea of probability interpretation and then discusses the formulation of Schrodinger equation. This paper aims to provide knowledge about atomic physics, hydrogen atoms and X-rays. It also introduces concepts of nuclear physics and accelerators

LEARNING OUTCOMES

After getting exposure to this course, the following topics would be learnt.

- Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. Heisenberg's Uncertainty principle and its applications, photoelectric effect and Compton scattering
- The Schrodinger equation in 1-d, wave function, probability and probability current densities, normalization, conditions for physical acceptability of wave functions, position and momentum operators and their expectation values. Commutator of position and momentum operators.
- Time Independent Schrodinger Equation, derivation by separation of variables, wave packets, particle in a box problem, energy levels.
- Modification in Bohr's Quantum Model: Sommerfeld theory of elliptical orbits
- Hydrogen atom energy levels and spectra emission and absorption spectra.
- X-rays: their production and spectra: continuous and characteristic X-rays, Moseley Law.
- Basic Properties of Nuclei, nuclear binding energy, semi-empirical mass formula, nuclear force and meson theory.
- Types of Accelerators, Van de Graaff generator, linear accelerator, cyclotron, synchrotron

SYLLABUS OF PHYSICS DSC – 5

THEORY COMPONENT

Unit - I **(8 Hours)**

Origin of Quantum Theory: Black Body Radiation and failure of classical theory, Planck's Quantum Hypothesis, Planck's Radiation Law, Quantitative treatment of Photo-electric effect and Compton scattering. Wave properties of particles: de Broglie hypothesis, Group and Phase velocities and relation between them. Heisenberg's Uncertainty Principle, Gamma ray microscope thought experiment, Position-Momentum Uncertainty, consequences of uncertainty principle.

Unit - II **(7 Hours)**

The Schrodinger Equation: The Schrodinger equation in 1-d, statistical interpretation of wave function, probability and probability current densities. Normalization, conditions for physical acceptability of wave functions with examples, position and momentum operators and their expectation values; Commutator of position and momentum operators

Unit – III **(5 Hours)**

Time Independent Schrodinger Equation: Demonstration of separation of variable method for time independent Schrodinger equation: Free particle wave function, wave packets, application to energy eigen values and stationary states for particle in a box problem, energy levels.

Unit – IV **(5 Hours)**

Atomic Physics: Beyond the Bohr's Quantum model: Sommerfeld theory of elliptical orbits; hydrogen atom energy levels and spectra emission and absorption spectra
Correspondence principle
X-rays: Method of production, X-ray spectra: Continuous and characteristic X-rays, Moseley Law.

Unit – V **(5 Hours)**

Basic Properties of Nuclei: Introduction (basic idea about nuclear size, mass, angular momentum, spin), semi-empirical mass formula, nuclear force and meson theory.
Accelerators: Accelerator facility available in India: Van de Graaff generator, linear accelerator, cyclotron (principle, construction, working, advantages and disadvantages), discovery of new elements of the periodic table

References:

Essential Readings:

1) Concepts of Modern Physics, A. Beiser, 2002, McGraw-Hill.
2) Modern Physics, R. A. Serway, C. J. Moses and C. A. Moyer, 2012, Thomson Brooks Cole, Cengage
3) Schaum's Outline of Modern Physics, R. Gautreau and W. Savin, 2020, McGraw Hill LLC
4) Modern Physics for Scientists and Engineers, S. T. Thornton Rex, 4th edition, 2013, Cengage Learning
5) Introduction to Modern Physics, R. Meyer, Kennard, Coop, 2002, Tata McGraw Hill
6) Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010.
7) Learning Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill.
8) Modern Physics, R. Murugeshan, S Chand & Co. Ltd
9) Schaum's Outline of Beginning Physics II | Waves, electromagnetism, Optics and Modern Physics, Alvin Halpern, Erich Erlbach, McGraw Hill.
10) Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd edition, Tata McGraw-Hill Publishing Co. Ltd.
11) Quantum Physics, Berkeley Physics, Vol.4. E. H. Wichman, 1971, Tata McGraw-Hill
12) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 2004, Macmillan Publishers India Limited
13) Introduction to Quantum Mechanics, D. J. Griffith, 2005, Pearson Education
14) Concepts of nuclear physics, B. Cohen, 2003, McGraw-Hill Education
15) Atomic Physics, Ghoshal, 2019, S. Chand Publishing House
16) Atomic Physics, J. B. Rajam & foreword by Louis De Broglie, 2010, S. Chand & Co.

17) Nuclear Physics, S. N. Ghoshal, S. Chand Publishers
18) Atomic and Molecular Physics, Rajkumar, RBSA Publishers

Additional Readings:

1) Six Ideas that Shaped Physics: Particles Behave like Waves, T. A. Moore, 2003, McGraw Hill.
2) Thirty years that shook physics: The story of quantum theory, G. Gamow, Garden City, NY: Doubleday, 1966.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Mandatory activity:

- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab
- Familiarization with Schuster`s focusing; determination of angle of prism.

At least six experiments to be performed from the following list

1) Measurement of Planck's constant using black body radiation and photo-detector
2) Photo-electric effect: photo current versus intensity and wavelength of light, maximum energy of photo-electrons versus frequency of light
3) To determine the work function of material of filament of directly heated vacuum diode.
4) To determine the Planck's constant using LEDs of at least 4 different colours.
5) To determine the wavelength of the H-alpha emission line of Hydrogen atoms.
6) To determine the ionization potential of mercury.
7) To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8) To show the tunneling effect in tunnel diodes using I-V characteristics.
9) To determine the wavelength of a laser source using diffraction of a single slit.
10) 10. To determine the wavelength of a laser source using diffraction of double slits.
11) 11. To determine angular spread of He-Ne laser using plane diffraction grating
12) One innovative experiment designed by the teacher relevant to the syllabus.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal.
3) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th edition, reprinted, 1985, Heinemann Educational Publishers.
4) A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal, 1985, Vani Publisher.
5) B.Sc. Practical Physics, H. Singh, S Chand & Co Ltd
6) B.Sc. Practical Physics, G. Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 15a: FOUNDATION OF ASTROPHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Foundation of Astrophysics PHYSICS DSE 15a	**4**	**3**	**1**	**0**	Class XII pass with Physics and Mathematics as main subjects	Mechanics; Electricity & Magnetism; Waves and Optics papers of this course or their equivalents

LEARNING OBJECTIVES

This course is meant to introduce undergraduate students to the wonders of the Universe. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics. They will also be introduced to the Indian contribution to astronomy in the modern times, techniques to measure astronomical parameters, the different layers of the Sun, the characteristics of planets in the solar system, an overview of our Milky Way galaxy and astrobiology.

LEARNING OUTCOMES

After completing this course, student will gain an understanding of,

- Basic concepts of positional astronomy and astronomical coordinate systems
- Astronomical instruments and modern telescopes
- Measurement of basic astronomical parameters such as distance, stellar brightness, stellar mass, radii, temperature and spectra
- Different layers of the Sun's atmosphere
- The difference between the terrestrial planets and the Jovian planets
- Basic structure of different galaxies and rotation of the Milky Way galaxy
- Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life

It is advised that the tutorial sessions should involve discussion on problems meant to help students develop the ability to apply the theory they learn in lectures to diverse astrophysical phenomenon.

SYLLABUS OF PHYSICS DSE – 15a

THEORY COMPONENT

Unit – I - Introduction to Astronomy (12 Hours)

Overview of the night sky; diurnal and yearly motions of the Sun; basic concepts of positional astronomy: celestial sphere, astronomical coordinate systems (Horizon and Equatorial systems of coordinates), circumpolar stars

Unit – II - Basic Parameters of Stars (15 Hours)

Measurement of astronomical distances (stellar parallax, aberration, proper motion), measurement of brightness, radiant flux and luminosity (apparent and absolute magnitude scales; distance modulus); determination of stellar mass by Kepler's law; measurement of stellar temperature and radius; stellar spectra, dependence of spectral types on temperature; Stellar classification (Harvard classification scheme), H-R diagram

Unit – III - Sun and the solar system (9 Hours)
Solar parameters; Sun's internal structure; solar photosphere; solar atmosphere; chromosphere; corona; solar activity; solar system (characteristics of terrestrial and Jovian planets)

Unit – IV- Physics of galaxies, Cosmology, Astrobiology (9 Hours)
Physics of galaxies: Nature of rotation of the Milky Way: Differential rotation of the Galaxy, dark matter
Cosmology: Standard Candles (Cepheids and SNe Type1a); cosmic distance ladder; expansion of the Universe
Astrobiology: History of the Universe; chemistry of life; origin of life; chances of life in the solar system

References:
Essential Readings:

1) Seven Wonders of the Cosmos, J. V. Narlikar, Cambridge University Press
2) Fundamental Astronomy, H. Karttunen et al., Springer Berlin, Heidelberg
3) Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
4) Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders College Publishing.
5) Astronomy in India: A Historical Perspective, T. Padmanabhan, Springer
6) Foundation of Astrophysics, B. Ryden and B. M. Peterson, Cambridge University Press
7) Astronomy: A Physical Perspective, M. Kutner, Cambridge University Press

Additional Readings:

1) Explorations: Introduction to Astronomy, Thomos Arny and Stephen Schneider, McGraw Hill
2) Astrophysics Stars and Galaxies, K. D. Abhyankar, Universities Press
3) An introduction to astrophysics, B. Basu, Prentice Hall of India Private Limited.
4) The Physical Universe: An Introduction to Astronomy, F. H. Shu, University Science Books
5) Telescopes and techniques, C. R. Kitchin, Springer New York, NY
6) Fundamentals of solar astronomy, A. Bhatnagar and W. C. Livingston, World Scientific
7) Astrophysics for Physicists, A. R. Choudhuri, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 15b: DIGITAL ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Digital Electronics PHYSICS DSE – 15b	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

The objective of the course is to introduce digital electronics and its simple applications to physics program students. The course is designed to familiarize the students with the different number systems (binary, octal and hexadecimal), laws of Boolean algebra, logic gates and combinational and sequential logic circuits utilised in designing counters and registers.

LEARNING OUTCOMES

After studying this paper students will become familiar with,

- Digital signals, positive and negative logic, Boolean variables, truth table, various number system codes and their inter-conversions.
- Students will be able to learn to minimise a given Boolean function using laws of Boolean algebra and Karnaugh map to minimise the hardware requirement of digital logic circuits
- Understand the working mechanism of data processing circuits, arithmetic circuits, sequential logic circuits, register and their applications.

SYLLABUS OF PHYSICS DSE 15b

THEORY COMPONENT

Unit – I - Integrated Circuits (qualitative treatment only) (2 Hours)

Advantages and drawbacks of ICs, scale of integration, SSI, MSI, LSI and VLSI (basic idea and definitions only), classification of ICs, examples of linear and digital lCs

Unit – II - Digital circuits and Boolean Aalgebra (13 Hours)

Binary numbers, decimal to binary and binary to decimal conversion, octal and hexadecimal numbers, NAND and NOR gates as universal gates, XOR and XNOR gates and their application as parity checkers

Boolean algebra: De Morgan's theorems, Boolean laws, idea of minterms, simplification of logic circuit using Boolean algebra and Karnaugh map

Unit – III - Combinational logic Circuits (7 Hours)

Data processing circuits: Multiplexers and its applications, de-multiplexers, decoders, encoders

Arithmetic circuits: Binary addition, binary subtraction using 2’s complement, half and full adders, half and full subtractor

Unit – IV - Sequential Circuits (8 Hours)

Flip Flops: SR, D, and JK, clocked (edge triggered) flip-flops, race-around conditions in JK flip-flop, application of flip flops in designing shift register (serial -in- parallel out) and 2- bit (MOD-4) up-down asynchronous counter

References:

Essential Readings:

1) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th edition, 2011, Tata McGraw
2) Fundamentals of Digital Circuits, A. Kumar, 2nd edition, 2009, PHI Learning Pvt. Ltd.
3) Digital Fundamentals, T. L. Floyd, 1994, Pearson Education Asia
4) Digital Principles and Applications, D. P. Leach and A. P. Malvino, 1995, Tata McGraw Hill
5) Digital Design, M. M. Mano and M. D. Ciletti, 2007, Pearson Education Asia
6) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
7) Digital Electronics, G. K. Kharate, 2010, Oxford University Press

Additional Readings:

1) Logic circuit design, S. P. Vingron, 2012, Springer
2) Digital Principles, Schaum's Outline Series, R. L. Tokheim, 1994, Tata McGraw-Hill
3) Solved Problems in Digital Electronics, S. P. Bali, 2005, Sigma Series, Tata McGraw-Hill
4) Digital Electronics: An Introduction To Theory And Practice, W. H. Gothmann, 2000, Prentice Hall of India
5) Modern Digital Electronics, R. P. Jain, 2003, Tata McGraw-Hill
6) Digital Electronics, S. Ghoshal, 2012, Cengage Learning.
7) Digital Electronics, S. K. Mandal, 2010, 1st edition, McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Either (1) At least 6 experiments or (II) 4 experiments and one project equivalent to two experiments and all designing should be done on the bread boards.

1) Study of truth tables of basic logic gates, universal logic gates XOR and XNOR logic gates
2) (a)To design a combinational logic system for a specified truth table.
   (b) To convert Boolean expression into logic circuit and design it using basic logic gate ICs
3) To minimize a given logic circuit using K-map and design using NAND gates.
4) Designing of Half Adder and Half Subtractor using NAND gates.
5) Designing of Full adder/Full Subtractor using NAND gates
6) Designing of 4-bit binary adder using adder IC.
7) To build Flip-Flop (RS, Clocked RS) circuits using NAND gates.
8) To build Flip-Flop (D-type and JK) circuits using NAND gate
9) To build a 2-bit Asynchronous Counter using D-type/JK Flip-Flop ICs and study timing diagrams.
10) To make a 3-bit Shift Register (serial in- and parallel out) using D-type/JK Flip-Flop ICs.

References for laboratory work:

1) Digital Fundamentals, T. L. Floyd, 1994, Pearson Education Asia
2) Digital Principles and Applications, D. P. Leach and A. P. Malvino, 1995, Tata McGraw

Hill
3) Digital Design, M. M. Mano and M. D. Ciletti, 2007, Pearson Education Asia
4) Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 15c: RADIATION AND ITS APPLICATIONS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Radiation and its Applications PHYSICS DSE – 15c	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows.

- To focus on the applications of nuclear techniques and radiation protection.
- To not only enhance the skills towards the basic understanding of the radiation but also provide the knowledge about the protective measures against radiation exposure.
- To impart all the skills required by a radiation safety officer or any job dealing with radiation such as X-ray operators, jobs dealing with nuclear medicine: chemotherapists, operators of PET, MRI, CT scan, gamma camera etc.

LEARNING OUTCOMES

After studying this course, the student will be able to,

- Understand and use the applications of nuclear techniques and radiation protection to guard against nuclear radiation hazards.
- Understand and use the units of radiations and their safety limits, the devices to detect and measure radiation.
- Understand and use radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards,
- Use the devices which apply radiations in medical sciences, such as X - ray, MRI, PET, CT-scan with the required safety measures.
- Understand and perform experiments like study the background radiation levels using Radiation detectors, Determination of gamma ray linear and mass absorption coefficient of a given material for radiation shielding application.
- Use graphical software to plot the simulations done through SRIM or similar software.

SYLLABUS OF PHYSICS DSE 15c

THEORY COMPONENT

Unit – I **(8 Hours)**

Radiation and its interaction with matter: Basic ideas of different type of radiation electromagnetic (X-ray, gamma rays, cosmic rays etc.), nuclear radiation and their origin (stable and unstable isotopes), half life and mean life

Nuclear Radiation: Basic idea of alpha, beta, gamma and neutron radiation and their sources (sealed and unsealed sources). Kinematics of nuclear reactions, Q value

Interaction of charged particles (including alpha particles): Heavy charged particles (e.g.

accelerated ions) - Beth-Bloch formula, scaling laws, mass stopping power, range, straggling. Cherenkov radiation
Interaction of beta particles: Collision and Radiation loss (Bremsstrahlung).
Interaction of photons: Linear and Mass Attenuation Coefficients. Interaction of Neutrons: Collision, slowing down and Moderation.

Unit - II **(8 Hours)**
Radiation Units, dosage and safety management:
Radiation Quantities and Units: Biological effects of ionizing radiation, Interaction of ionising and non-ionising radiation at the cellular level. Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, quality factor, radiation and tissue weighting factors, annual limit of intake (ALI) and derived air concentration (DAC).
Radiation safety management: Operational limits and basics of radiation hazards, its evaluation and control: radiation protection standards. Concept of ALARA Principle using Distance, time and shielding

Unit - III **(8 Hours)**
Radiation detection and monitoring devices: Basic concepts and working principle of gas detectors, Scintillation Detectors, Solid State Detectors and Neutron Detectors, Types of Radiation Dosimeters: thermoluminescence, radiographic films, calorimetry, semiconductor diodes; Relation between detection and dosimetry, Interaction of ionising and non-ionising radiation at the cellular level.

Unit - IV **(6 Hours)**
Application of radiation as a technique: Application in medical science (e.g., basic principles of X- rays, MRI, PET, CT scan, Projection Imaging Gamma Camera, Radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterilization, Food preservation.

References:
Essential Readings:

1) Basic ideas and concepts in nuclear physics: An introductory approach, K. Heyde, 3rd edition, 1999, IOP Publication.
2) Nuclear Physics, S. N. Ghoshal, 1st edition, 2010, S. Chand Publication
3) Nuclear Physics: Principles and Applications, J. Lilley, 2006, Wiley Publication
4) Fundamental Physics of Radiology, W. J. Meredith and B. Massey, 1989, John Wright and Sons, UK
5) An introduction to radiation protection by A Martin and S A Harbisor, John Willey & Sons, Inc. NewYork, 1981.
6) Radioactivity and Radiation, C. Grupen and M. Rodgers, 2016, Springer
7) Introduction to radiation protection, C. Grupen, 2010, Springer
8) An introduction to radiation protection, A. Martin, S. Harbison, K. Beach and P. Cole, H. Arnold, 2012.

Additional Readings:

1) Radiation detection and measurement, G. F. Knoll, 4th edition, 2010, Wiley Publications
2) Techniques for Nuclear and Particle Physics experiments, W. R. Leo, 1994, Springer
3) Thermoluminescence dosimetry, A. F. Mcknlay, Bristol, Adam Hilger (Medical Physics Hand book 5)

4) Medical Radiation Physics, W. R. Hendee, 1981, Year book Medical Publishers, Inc., London
5) Physics and Engineering of Radiation Detection, S. N. Ahmed, 2007, Academic Press Elsevier
6) Nuclear and Particle Physics, W. E. Burcham and M. Jobes, 1995, Harlow Longman Group
7) IAEA Publications: (a) General safety requirements Part 1, No. GSR Part 1 (2010), Part 3 No. GSR Part 3 (Interium) (2010); (b) Safety Standards Series No. RS-G-1.5 (2002), Rs-G-1.9 (2005), Safety Series No. 120 (1996); (c) Safety Guide GS-G-2.1 (2007).

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least five experiments need to be performed from the following list.

1) Estimate the energy loss of different projectiles/ions (at least 3 projectiles between ZP = 1 to 92, where ZP is atomic number of projectile/ion) in water and carbon, using SRIM/TRIM etc. simulation software.
2) Simulation study (using SRIM/TRIM or any other software) of radiation depth in materials (Carbon, Silver, Gold, Lead) using H as projectile/ion.
3) Comparison of interaction of projectiles with ZP = 1 to 92 (where ZP is atomic number of projectile/ion) in a given medium (Mylar, Aluminium, cadmium, lead) using simulation software (SRIM etc).
4) SRIM/TRIM based experiments to study ion-matter interaction of heavy projectiles on heavy atoms. The range of investigations will be ZP = 6 to 92 on ZA = 16 to 92 (where ZP and ZA are atomic numbers of projectile and atoms respectively). Draw and infer appropriate Bragg Curves.
5) Calculation of absorption/transmission of X-rays, γ-rays through Mylar, Be, C, Al, Fe and ZA = 47 to 92 (where ZA is atomic number of atoms to be investigated as targets) using XCOM, NIST (https://physics.nist.gov/PhysRefData/Xcom/html/xcom1.html).
6) Study the background radiation in different places and identify the source material from gamma ray energy spectrum. (Data may be taken from the Department of Physics & Astrophysics; University of Delhi and gamma ray energies are available in the website http://www.nndc.bnl.gov/nudat2/).
7) Study the background radiation levels using Radiation meter
8) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
9) Study of counting statistics using background radiation using GM counter.
10) Study of radiation in various materials (e.g. KSO_4 etc.). Investigation of possible radiation in different routine materials by operating GM counter at operating voltage.
11) Study of absorption of beta particles in Aluminium using GM counter.
12) Detection of α particles using reference source & determining its half life using spark counter.
13) Gamma spectrum of gas light mantle (Source of Thorium).
14) Demonstration of radiation detection equipment for dose, risk and crime scene management.

References for laboratory work:

1) Schaum's Outline of Modern Physics, 1999, McGraw-Hill
2) Schaum's Outline of College Physics, E. Hecht, 11^{th} edition, 2009, McGraw Hill
3) Modern Physics, K Sivaprasath and R Murugeshan, 2010, S. Chand Publication
4) AERB Safety Guide (Guide No. AERB/RF-RS/SG-1), Security of radioactive sources in radiation facilities, 2011
5) AERB Safety Standard No. AERB/SS/3 (Rev. 1), Testing and Classification of sealed Radioactivity Sources., 2007.

Category II

Physical Science Courses (with Electronics) with Physics and Electronics discipline as Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 9: ELEMENTS OF MODERN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Elements of Modern Physics PHYSICS DSC 9	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

This course introduces modern development in Physics. Starting from Planck's law, it develops the idea of probability interpretation and then discusses the formulation of Schrodinger equation. This paper aims to provide knowledge about atomic physics, hydrogen atoms and X-rays. It also introduces concepts of nuclear physics and accelerators

LEARNING OUTCOMES

After getting exposure to this course, the following topics would be learnt.

- Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. Heisenberg's Uncertainty principle and its applications, photoelectric effect and Compton scattering
- The Schrodinger equation in 1-d, wave function, probability and probability current densities, normalization, conditions for physical acceptability of wave functions, position and momentum operators and their expectation values; Commutator of position and momentum operators.
- Time Independent Schrodinger Equation, derivation by separation of variables, wave packets, particle in a box problem, energy levels.
- Modification in Bohr's Quantum Model: Sommerfeld theory of elliptical orbits
- Hydrogen atom energy levels and spectra emission and absorption spectra.
- X-rays: their production and spectra: continuous and characteristic X-rays, Moseley Law.
- Basic Properties of Nuclei, nuclear binding energy, semi-empirical mass formula, nuclear force and meson theory.
- Types of Accelerators, Van de Graaff generator, linear accelerator, cyclotron, synchrotron

SYLLABUS OF PHYSICS DSC – 9

THEORY COMPONENT

Unit - I **(8 Hours)**

Origin of Quantum Theory: Black Body Radiation and failure of classical theory, Planck's Quantum Hypothesis, Planck's Radiation Law, Quantitative treatment of Photo-electric effect and Compton scattering. Wave properties of particles: de Broglie hypothesis, Group and Phase velocities and relation between them. Heisenberg's Uncertainty Principle, Gamma ray microscope thought experiment, Position-Momentum Uncertainty, consequences of uncertainty principle.

Unit - II **(7 Hours)**

The Schrodinger Equation: The Schrodinger equation in 1-d, statistical interpretation of wave function, probability and probability current densities. Normalization, conditions for physical acceptability of wave functions with examples, position and momentum operators and their expectation values; Commutator of position and momentum operators.

Unit – III **(5 Hours)**

Time Independent Schrodinger Equation: Demonstration of separation of variable method for time independent Schrodinger equation: Free particle wave function, wave packets, application to energy eigen values and stationary states for particle in a box problem, energy levels.

Unit – IV **(5 Hours)**

Atomic Physics: Beyond the Bohr's Quantum Model: Sommerfeld theory of elliptical orbits; hydrogen atom energy levels and spectra emission and absorption spectra.
Correspondence principle
X-rays: Method of production, X-ray spectra: Continuous and characteristic X-rays, Moseley law

Unit – V **(5 Hours)**

Basic Properties of Nuclei: Introduction (basic idea about nuclear size, mass, angular momentum, spin), semi-empirical mass formula, nuclear force and meson theory.
Accelerators: Accelerator facility available in India: Van de Graaff generator, linear accelerator, cyclotron (principle, construction, working, advantages and disadvantages); discovery of new elements of the periodic table

References:

Essential Readings:

1) Concepts of Modern Physics, A. Beiser, 2002, McGraw-Hill.
2) Modern Physics, R. A. Serway, C. J. Moses and C. A. Moyer, 2012, Thomson Brooks Cole, Cengage
3) Schaum's Outline of Modern Physics, R. Gautreau and W. Savin, 2020, McGraw Hill LLC
4) Modern Physics for Scientists and Engineers, S. T. Thornton Rex, 4th edition, 2013, Cengage Learning
5) Introduction to Modern Physics, R. Meyer, Kennard, Coop, 2002, Tata McGraw Hill
6) Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010.
7) Learning Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill.
8) Modern Physics, R. Murugeshan, S Chand & Co. Ltd
9) Schaum's Outline of Beginning Physics II | Waves, electromagnetism, Optics and Modern Physics, Alvin Halpern, Erich Erlbach, McGraw Hill.
10) Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd edition, Tata McGraw-Hill Publishing Co. Ltd.
11) Quantum Physics, Berkeley Physics, Vol.4. E. H. Wichman, 1971, Tata McGraw-Hill
12) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 2004, Macmillan Publishers India Limited
13) Introduction to Quantum Mechanics, D. J. Griffith, 2005, Pearson Education
14) Concepts of nuclear physics, B. Cohen, 2003, McGraw-Hill Education
15) Atomic Physics, Ghoshal, 2019, S. Chand Publishing House
16) Atomic Physics, J. B. Rajam & foreword by Louis De Broglie, 2010, S. Chand & Co.

17) Nuclear Physics, S. N. Ghoshal, S. Chand Publishers
18) Atomic and Molecular Physics, Rajkumar, RBSA Publishers

Additional Readings:

1) Six Ideas that Shaped Physics: Particles Behave like Waves, T. A. Moore, 2003, McGraw Hill.
2) Thirty years that shook physics: The story of quantum theory, G. Gamow, Garden City, NY: Doubleday, 1966.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Mandatory activity:

- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab
- Familiarization with Schuster`s focusing; determination of angle of prism.

At least six experiments to be performed from the following list

1) Measurement of Planck's constant using black body radiation and photo-detector
2) Photo-electric effect: photo current versus intensity and wavelength of light, maximum energy of photo-electrons versus frequency of light
3) To determine the work function of material of filament of directly heated vacuum diode.
4) To determine the Planck's constant using LEDs of at least 4 different colours.
5) To determine the wavelength of the H-alpha emission line of Hydrogen atoms.
6) To determine the ionization potential of mercury.
7) To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
8) To show the tunneling effect in tunnel diodes using I-V characteristics.
9) To determine the wavelength of a laser source using diffraction of a single slit.
10) 10. To determine the wavelength of a laser source using diffraction of double slits.
11) 11. To determine angular spread of He-Ne laser using plane diffraction grating
12) One innovative experiment designed by the teacher relevant to the syllabus.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th edition, 2011, Kitab Mahal.
3) Advanced level physics practicals, Michael Nelson and Jon M. Ogborn, 4th edition, reprinted, 1985, Heinemann Educational Publishers.
4) A laboratory manual of physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Publisher.
5) B.Sc. Practical Physics, H. Singh, S Chand & Co Ltd
6) B.Sc. Practical Physics, G. Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 3: SEMICONDUCTOR DEVICES FABRICATION

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Semiconductor Devices Fabrication PHYSICS DSE 3	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	NIL

LEARNING OBJECTIVES

This course provides a review of basics of semiconductors such as energy bands, doping, defects etc. and introduces students to various semiconductor and memory devices, thin film growth techniques and processes including various vacuum pumps, sputtering, evaporation, oxidation and VLSI processing are described in detail. By the end of the syllabus, students will have an understanding of MEMS based transducers.

LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- Learn to distinguish between single crystal, polycrystalline and amorphous materials based on their structural morphology and learn about the growth of single crystals of silicon, using Czochralski technique, on which a present day electronics and IT revolution is based.
- Students will understand about the various techniques of thin film growth and processes.
- Appreciate the various VLSI fabrication technologies and learn to design the basic fabrication process of R, C, P- N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology.
- Gain basic knowledge on overview of MEMS (Micro-Electro-Mechanical System) and MEMS based transducers.

SYLLABUS OF PHYSICS DSE – 3

THEORY COMPONENT

Unit – I **(9 Hours)**

Introduction: Review of energy bands in materials, metal, semiconductor and insulator, doping in semiconductors, defects (point, line, Schottky and Frenkel), single crystal, polycrystalline and amorphous materials, Czochralski technique for silicon single crystal growth, silicon wafer slicing and polishing.

Vacuum Pumps: Primary pump (mechanical) and secondary pumps (diffusion, turbomolecular, cryopump, sputter-ion) – basic working principle, throughput and characteristics in reference to pump selection, vacuum gauges (Pirani and Penning)

Unit – II **(10 Hours)**

Thin film growth techniques and processes: Sputtering, evaporation (thermal, electron beam),

pulse laser deposition (PLD), chemical vapour deposition (CVD), epitaxial growth
Thermal oxidation process (dry and wet) passivation, metallization, diffusion

Unit – III **(7 Hours)**
VLSI Processing: Clean room classification, line width, photolithography: resolution and process, positive and negative shadow masks, photoresist, step coverage, developer, electron beam lithography, etching: wet etching, dry etching (RIE and DRIE), basic fabrication process of R, C, P-N Junction diode, BJT, JFET, MESFET, MOS, NMOS, PMOS and CMOS technology, wafer bonding, wafer cutting, wire bonding and packaging issues (qualitative idea)

Unit – IV **(4 Hours)**
Micro Electro-Mechanical System (MEMS): Introduction to MEMS, materials selection for MEMS devices, selection of etchants, surface and bulk micromachining, sacrificial subtractive processes, additive processes, cantilever, membranes, general idea of MEMS based pressure, force, and capacitance transducers

References:
Essential Readings:
1) Physics of Semiconductor Devices, S. M. Sze. Wiley-Interscience.
2) Fundamentals of Semiconductor Fabrication, S.M. Sze and G. S. May, John-Wiley and Sons, Inc.
3) Introduction to Semiconductor materials and Devices, M. S. Tyagi, John Wiley & Sons
4) VLSI Fabrication Principles (Si and GaAs), S. K. Gandhi, John Wiley & Sons, Inc.

Additional Readings:
1) Handbook of Thin Film Technology, L. I. Maissel and R. Glang

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list
1) Deposition of thin films using dip coating and deposition of metal contacts using thermal Evaporation and study its IV characteristics
2) Deposition of thin films using spin coating and deposition of metal contacts using thermal evaporation and study its I-V characteristics
3) Fabrication of p-n Junction diode and study its I-V characteristics
4) Create vacuum in a small tube (preferably of different volumes) using a mechanical rotary pump and measure pressure using vacuum gauges.
5) Selective etching of different metallic thin films using suitable etchants of different concentrations.
6) Wet chemical etching of Si for MEMS applications using different concentration of etchant.
7) Calibrate semiconductor type temperature sensor (AD590, LM 35, LM 75)
8) To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150C) by four-probe method.
9) To fabricate a ceramic and study its capacitance using LCR meter.
10) To fabricate a thin film capacitor using dielectric thin films and metal contacts and study its capacitance using LCR meter

References for laboratory work:

1) The science and Engineering of Microelectronics Fabrication, S. A. Champbell, 2010, Oxford University Press
2) Introduction to Semiconductor Devices, F. Kelvin Brennan, Cambridge University Press, 2010

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 4: ELECTRONICS INSTRUMENTATION

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electronics Instrumentation Physics DSE 4	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital electronics and analog electronics

LEARNING OBJECTIVES

This course aims to provide an exposure on basics of measurement and instrumentation and its various aspects and their usage through hands-on mode. It also aims to provide exposure of various measurement instruments such as power supply, oscilloscope, multivibrators, signal generators are also discussed. It also aims to develop an understanding of virtual instrumentation and transducers.

LEARNING OUTCOMES

At the end of this course, students will have understanding of,

- Basic principles of the measurement and errors in measurement, specifications of basic Measurement instruments and their significance with hands on mode.
- Principles of voltage measurement, advantages of electronic voltmeter over conventional multimeter in terms of sensitivity etc.
- Measurement of impedance using bridges, Power supply, Filters, IC regulators and Load and line regulation.
- Specifications of CRO and their significance, the use of CRO and DSO for the measurement of voltage (dc and ac), frequency and time period.
- Multivibrators, working circuits of astable and monostable multivibrators.
- Explanation and specifications of signal and pulse generators
- The Interfacing techniques, Arduino microcontroller and interfacing software,
- Understanding and usage of transducers

SYLLABUS OF PHYSICS DSE 4

THEORY COMPONENT

Unit – I **(12 Hours)**

Measurements: Shielding and grounding, electromagnetic interference

Basic Measurement Instruments: DC measurement-ammeter, voltmeter, ohm meter, AC measurement, digital voltmeter systems (integrating and non-integrating), digital multimeter, block diagram, principle of measurement of I, V, C, measurement of impedance - A.C. bridges, measurement of self-inductance (Anderson's bridge), measurement of capacitance (De-Sauty's bridge), measurement of frequency (Wien's bridge)

Unit - II **(6 Hours)**

Power supply: Using IC regulators (78XX and 79XX), line and load regulation, short circuit protection, idea of switched mode power supply (SMPS) and uninterrupted power supply

(UPS)
Oscilloscope: Block diagram, CRT, deflection (qualitative), screens for CRT, oscilloscope probes, measurement of voltage, frequency, and phase by oscilloscope, digital storage oscilloscope

Unit – III **(3 Hours)**
Multivibrators (IC 555): Block diagram, astable and monostable multivibrator circuits
Signal Generators: Function generator (black box approach)

Unit – IV **(9 Hours)**
Virtual Instrumentation: Introduction, interfacing techniques (RS 232, GPIB, USB), idea about Arduino microcontroller and interfacing software like lab View
Transducers: Classification of transducers, measurement of temperature (RTD, semiconductor IC sensors), light transducers (photo resistors and photovoltaic cells)

References:
Essential Readings:

1) Electronic Instrumentation and Measurement Techniques, W. D. Cooper and A. D. Helfrick, 2005, Prentice Hall
2) Measurement Systems: Application and Design, E. O. Doebelin, 5^{th} edition, 2003, McGraw Hill Book
3) Electronic Devices and Circuits, D. A. Bell, 2015, Oxford University Press

Additional Readings:

1) Instrumentation Devices and Systems, S. Rangan, G. R. Sarma and V. S. Mani, 1998, Tata McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)
- Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the lab, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.”

At least eight experiments to be performed from the following list
1) Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
2) Measurement of Capacitance by De Sauty’s bridge.
3) Design a regulated power supply of given rating (5 V or 9V).
4) To determine the Characteristics of Thermistors and RTD.
5) Measurement of temperature by Thermocouples.
6) To design an astable multivibrator of given specification using IC 555 Timer.
7) To design a monostable multivibrator of given specification using IC 555 Timer.
8) To design and study the sample and hold circuit.
9) To plot the frequency response of a microphone.
10) Glow an LED via USB port of PC.
11) Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

References for laboratory work:

1) Measurement and Instrumentation Principles, A. S. Morris, 2008, Elsevier (Butterworth Heinmann)
2) Basic Electronics: A text lab manual, P. B. Zbar, A. P. Malvino and M. A. Miller, 1990, Mc-Graw Hill

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 5: DIGITAL SIGNAL PROCESSING

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Digital Signal Processing Physics DSE 5	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	Basics of digital electronics and analog electronics

LEARNING OBJECTIVES

This paper describes the discrete-time signals and systems, Fourier transform representation of aperiodic discrete time signals. This paper also highlights the concept of filters and realization of digital filters. At the end of the syllabus, students will develop an understanding of discrete and fast Fourier transform.

LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes.

- Students will learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems.
- The student will be in position to understand use of different transforms and analyse the discrete time signals and systems. They will learn to analyse a digital system using z-transforms and discrete time Fourier transforms, region of convergence concepts, their properties and perform simple transform calculations.
- The student will realize the use of LTI filters for filtering different real world signals. The concept of transfer Function and difference-equation system will be introduced. Also, they will learn to solve difference equations.
- Students will develop an ability to analyse DSP systems like linear-phase, FIR, IIR, All-pass, averaging and notch Filter etc.
- Students will be able to understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques.
- Students will be able to learn the realization of digital filters, their structures, along with their advantages and disadvantages. They will be able to design and understand different types of digital filters such as finite and infinite impulse response filters for various applications.

SYLLABUS OF PHYSICS DSE 5

THEORY COMPONENT

Unit – I **(7 Hours)**

Discrete-Time Signals and Systems: Classification of signals, transformations of the independent variable, periodic and aperiodic signals, energy and power signals, even and odd signals, discrete time systems, system properties, impulse response, convolution sum, graphical and analytical method, properties of convolution (general idea), sum property system response to periodic inputs, relationship between LTI system properties and the impulse response

Unit – II **(9 Hours)**

Discrete time Fourier transform: Fourier transform representation of aperiodic discrete time signals, periodicity of DTFT, properties; linearity; time shifting; frequency shifting; differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. The z-Transform: Bilateral (Two-Sided) z-Transform, Inverse z- Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-of-Convergence; Differentiation in the z-Domain; Power Series Expansion Method (General Idea). Transfer Function and Difference-Equation System.

Unit – III **(10 Hours)**

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters.Only Qualitative treatment

Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation (General Idea), Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution).

Unit – IV **(4 Hours)**

Realization of Digital Filters: FIR Filter structures; Direct-Form; Cascade-Form

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR Filters

References:

Essential Readings:

1) Digital Signal Processing, T. K. Rawat, 2015, Oxford University Press, India
2) Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
3) Principles of Signal Processing and Linear Systems, B. P. Lathi, 1st edition, 2009, Oxford University Press.
4) Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press
5) Digital Signal Processing Principles Algorithm & Applications, J. G. Proakis and D. G. Manolakis, 4th edition, 2007, Prentice Hall.

Additional Readings:

1) Digital Signal Processing, A. Kumar, 2nd edition, 2016, PHI learning Private Limited.
2) Digital Signal Processing, P. S. R. Diniz, E. A. B. da Silva and S. L. Netto, 2nd edition, 2017, Cambridge University Press

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

- Introduction to numerical computation software Scilab/Matlab/Python be introduced in the lab.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab"

At least six experiments to be performed from the following using Scilab/ Matlab/ Python

1) Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence *u(n)*, (c) ramp sequence *r(n)*, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \leq n \leq 50$.
2) Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for N = 5

$$x(n) = rect\left(\frac{n}{2N}\right) = \prod \left(\frac{n}{2N}\right) = \{1 \quad -N \leq n \leq N \ 0 \qquad otherwise$$

3) An LTI system is specified by the difference equation *y(n)=0.8y(n-1)+x(n)*
   (a)Determine $H(e^{iw})$
   (b) Calculate and plot the steady state response *y(n)* to $x(n) = cos\ cos\ (0.5\pi n)\ u(n)$
4) Given a casual system *y(n)=0.9y(n-1)+x(n)*
   (a) Find H(z) and sketch its pole-zero plot
   (b) Plot the frequency response $|H(e^{jw})|$ and $\angle H(e^{jw})$
5) Design a digital filter to eliminate the lower frequency sinusoid of *x(t)=sin7t+sin200t*. The sampling frequency is 500 Hz. Plot its pole zero diagram, magnitude response, input and output of the filter.
6) Let *x(n)* be a 4-point sequence:
   $x(n) = \{1,1,1,1\} = \{1 \ \ 0 \leq n \leq 3 \ 0 \ \ otherwise$

   Compute the DTFT $X(e^{jw})$ and plot its magnitude
   (a) Compute and plot the 4 point DFT of *x(n)*
   (b) Compute and plot the 8 point DFT of *x(n)* (by appending 4 zeros)
   (c) Compute and plot the 16 point DFT of *x(n)* (by appending 12 zeros)

7) Let *x(n)* and *h(n)* be the two 4-point sequences,
   x(n)={1,2,2,1} *h(n)={1,-1,-1,1}*
   Write a program to compute their linear convolution using circular convolution.

8) Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.
9) Design an FIR filter to meet the following specifications:
   Passband edge F_p=2 KHz
   Stopband edge F_s=5 KHz
   Passband attenuation A_p=2 dB
   Stopband attenuation A_s=42 dB
   Sampling frequency F_{sf}=20 KHz
10) The frequency response of a linear phase digital differentiator is given by

$$H_d\left(e^{jw}\right) = jwe^{-j\tau w} \ |w| \leq \pi$$

   Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response

References for laboratory work:

1) A Guide to MATLAB, B. R. Hunt, R. L. Lipsman and J. M. Rosenberg, 3rd edition, 2014, Cambridge University Press.
2) Fundamentals of Digital Signal processing using MATLAB, R. J. Schilling and S. L. Harris, 2005, Cengage Learning.
3) Getting started with MATLAB, R. Pratap, 2010, Oxford University Press.

ANNEXURE-2

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B. SC. (HONOURS) PHYSICS

DISCIPLINE SPECIFIC CORE COURSE – DSC -16: STATISTICAL MECHANICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Statistical Mechanics DSC – 16	4	3	1	0	Class XII pass with Physics and Mathematics as main subjects	Thermal physics and quantum mechanics papers of this course or their equivalents. Basics of probability and statistics

LEARNING OBJECTIVES

Statistical Mechanics deals with the derivation of the macroscopic parameters (internal energy, pressure, specific heat etc.) of a physical system consisting of large number of particles (solid, liquid or gas) from knowledge of the underlying microscopic behaviour of atoms and molecules that comprises it. The main objective of this course is to introduce the techniques of statistical mechanics which has applications in various fields including astrophysics, semiconductor physics, plasma physics, biophysics etc. and in many other directions. All the problems of different units should be done in the tutorial classes.

LEARNING OUTCOMES

By the end of the course, students will be able to,

- Understand the concepts of phase space, macrostate, microstate, thermodynamic probability and partition function.
- Understand the use of thermodynamic probability and partition function for calculation of thermodynamic properties for physical systems (ideal gas, finite level system).
- Understand the difference between classical and quantum statistics and their applicability.
- Understand the properties and laws associated with thermal radiation.
- Apply the Fermi- Dirac distribution to model problems such as electrons in solids and white dwarf stars
- Apply the Bose-Einstein distribution to model problems such as blackbody radiation and liquid Helium.

SYLLABUS OF DSC – 16

THEORY COMPONENT

Unit - I **(22 Hours)**

Classical Statistics: Phase space, macrostates and microstates, entropy and thermodynamic probability, concept of ensemble - Introduction to three types, Maxwell-Boltzmann distribution law, partition function, thermodynamic functions of an ideal gas, Gibbs paradox, Sackur-Tetrode equation. Saha's ionization formula, Law of equipartition of energy (with proof) – Applications to specific heat of gases (monoatomic and diatomic), solids and its limitations, thermodynamic functions of a finite level system, negative temperature

Unit – II **(5 Hours)**

Radiation: Blackbody radiation and its spectral distribution. Kirchhoff law (No Proof), Planck's quantum postulates, Planck's law of blackbody radiation, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law and Wien's displacement law from Planck's law, ultraviolet catastrophe

Unit – III **(9 Hours)**

Bose-Einstein Statistics: Bose-Einstein distribution law, thermodynamic functions of a strongly degenerate Bose gas (non- relativistic), Bose-Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and thermodynamic functions of photon gas. Bose derivation of Planck's law

Unit – IV **(9 Hours)**

Fermi-Dirac Statistics: Fermi-Dirac distribution law, thermodynamic functions of a completely and strongly degenerate fermions (non-relativistic), specific heat of metals, relativistic Fermi gas, white dwarf stars, Chandrasekhar mass limit.

References:

Essential Readings:

1) Statistical Mechanics, R. K. Pathria and P. D. Beale, Academic Press
2) Introductory Statistical Mechanics, R. Bowley and M. Sanchez, Oxford Univ. Press
3) Statistical Physics, F. Mandl, Wiley
4) A treatise on Heat, M. N. Saha and B. N. Srivastava, Indian Press
5) Problems and Solutions on Thermodynamics and Statistical Mechanics, Lim Yung-Kou, Sarat Book House
6) An Introduction to Thermal Physics, D. Schroeder, Pearson
7) Statistical Physics, Berkeley Physics Course, F. Reif, McGraw-Hill

Additional Readings:

1) An Introduction to Statistical Physics, W. G. V. Rosser, Wiley
2) Thermal Physics, Kittel and Kroemer, CBS
3) Concepts in Thermal Physics, Blundell and Blundell, Oxford University Press
4) Statistical and Thermal Physics, Loknathan and Gambhir, PHI
5) Thermodynamics, Kinetic theory and Statistical thermodynamics, Sears and Salinger, PHI
6) Statistical Mechanics, G. Sanon, Alpha Science International Ltd.

DISCIPLINE SPECIFIC CORE COURSE – DSC - 17: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Atomic, Molecular and Nuclear Physics DSC – 17	**4**	**3**	**1**	**0**	Class XII pass with Physics and Mathematics as main subjects	Light and Matter, Modern Physics and Quantum Mechanics-I of this course or their equivalent

LEARNING OBJECTIVES

This course introduces the basic concepts of atomic, molecular and nuclear physics to an undergraduate student. Advanced mathematics is avoided and the results of quantum mechanics are attempts to explain, or even to predict, the experimental observations of spectroscopy. The student learns to visualize a nucleus, an atom or molecule as a physical entity rather than a series of mathematical equations.

LEARNING OUTCOMES

On successful completion of the module students should be able to elucidate the following main features.

- Stern-Gerlach experiment, electron spin, spin magnetic moments, space quantization and Zeeman effect, spectral notations for atomic and molecular states and corresponding term symbols, understanding of atomic spectra and molecular spectra
- Basic principle of Raman spectroscopy and Franck Condon principle.
- The radioactive processes, stability of the nuclei and the nuclear models
- The full scientific potential lies on how we are able to interpret the fundamental astrophysical and nuclear data. The acquired knowledge can be applied in the areas of astrophysics, nuclear, medical, geology and other interdisciplinary fields of Physics, Chemistry and Biology. It will enhance the special skills required for these fields

SYLLABUS OF DSC - 17

THEORY COMPONENT

Unit – I - Atomic Physics (15 Hours)

One-electron atoms: Degeneracy of energy levels and selection rules, modes of relaxation of an excited atomic state.

Fine structure of Hydrogenic atoms: Shifting of energy levels, Splitting of spectral lines, relativistic correction to kinetic energy, spin-orbit term, Darwin term, fine structure spectral lines, Lamb shift (qualitative idea).

Atoms in external magnetic fields: Larmor's theorem, Stern-Gerlach experiment, normal Zeeman Effect, Paschen Back effect, anomalous Zeeman effect, Lande g-factor.

Unit - II – Molecular Physics **(15 Hours)**

Molecular structure: The Born-Oppenheimer approximation, Concept of bonding and anti-bonding molecular orbitals, Concept of Potential energy curve for a diatomic molecule, Morse potential, Classification of molecular states of diatomic molecule, The Franck-Condon principle

Molecular spectra of diatomic molecule: Rotational Spectra (rigid and non-rigid rotor), Vibrational Spectra (harmonic and anharmonic), Vibration-Rotation Spectrum of a diatomic molecule, Isotope effect, Intensity of spectral lines

Raman Effect: Classical theory (with derivation) of Raman effect, pure rotational Raman Lines, Stoke's and Anti-Stoke's Lines, comparison with Rayleigh scattering.

Unit – III – Nuclear Physics **(15 Hours)**

Nucleus stability: *Alpha decay:* Energetics of alpha-particle decay, barrier penetration model, Geiger-Nuttall rule, α- decay spectroscopy, decay Chains. *Beta Decay:* Q-values for beta decay, β-spectrum, positron emission, electron capture, neutrino hypothesis, Qualitative idea about Fermi theory, Fermi and Gamow-Teller decays, the role of angular momentum and parity, electron capture, and selection rules. *Gamma decay:* Gamma-ray production, and multipolarities, Weisskopf estimates, the role of angular momentum and parity, internal conversion.

Nuclear models: Evidence of shell structure in nuclei, Magic numbers, nuclear mean field, single particle shell model, spin-orbit splitting, shell model configurations for nuclear ground states, and low-lying excited levels

References:

Essential Readings:

1) Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain, 2nd edition, Pearson
2) Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, 1994, Tata McGraw – Hill
3) Atomic physics, J. B. Rajam and foreword by Louis De Broglie, 2010, S. Chand & Co.
4) Atoms, Molecules and Photons, W. Demtroder, 2nd edition, 2010, Springer
5) Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman, G. A. Kriz and J. R. Vyvyan, 5th edition, 2014, Brookes/Cole
6) Concept of Nuclear Physics, B. L. Cohen, 2003, Tata McGraw – Hill
7) Nuclear Physics, S. N. Ghoshal, 1st edition, 2019, S. Chand Publication
8) Introducing Nuclear Physics, K. S. Krane, 2008, Wiley India

Additional Readings:

1) Basic Atomic and Molecular Spectroscopy, J. M. Hollas, Royal Society of Chemistry
2) Molecular Spectra and Molecular Structure, G. Herzberg
3) Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach (Series in Fundamental and Applied Nuclear Physics), K. Heyde (Institute of Physics Publishing 3rd edition
4) Nuclear Physics: principles and applications, John Lilley, 2006, Wiley
5) Schaum's Outline of Modern Physics, 1999, McGraw-Hill Education
6) Introduction to elementary particles, D. J. Griffiths, 2008, Wiley
7) Atomic and molecular Physics, R. Kumar, 2013, Campus Book Int.
8) The Fundamentals of Atomic and Molecular Physics (Undergraduate Lecture Notes in Physics), 2013, Springer

DISCIPLINE SPECIFIC CORE COURSE – DSC - 18: STATISTICAL ANALYSIS IN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Statistical Analysis in Physics DSC – 18	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basic understanding of statistics and probability

LEARNING OBJECTIVES

This course provides an elementary introduction to the principles of Bayesian statistics and working knowledge of some of the data analysis techniques. The objective is to equip the students with certain techniques so that they may successfully apply these to the real world problems, in their research areas as well as in industry.

LEARNING OUTCOMES

After completing this course, students will be able to,

- Understand the fundamental concepts in statistical data analysis.
- Define in a Bayesian context, the likelihood, prior and posterior distributions and their role in Bayesian inference and hypothesis testing.
- Estimate the parameters of a distribution from sample.
- Perform hypothesis testing and validate a model.
- Apply multi-linear and logistic models to real life situation.

In the practical component, students will be able to

- Learn basic data analysis techniques such as linear and non-linear fittings
- Apply hypothesis testing techniques in physics
- Perform multi-linear and logistic regression analysis for a given data
- Understand the concept of gradient descent and use it for the regression analysis
- Understand the stochastic processes, Markov chains and transition probability matrix.

SYLLABUS OF DSC - 18

THEORY COMPONENT

Unit – I **(8 Hours)**

Random variables, Discrete and Continuous Probability Distributions. Bivariate and multivariate random variables, Joint Distribution Functions (with examples from Binomial, Poisson and Normal). Mean, variance and moments of a random vector, covariance and correlation matrix, eigendecomposition of the covariance matrix (bivariate problem). Cumulative Distribution Function and Quantiles. Point Estimation, Interval estimation, Central Limit Theorem (statement, consequences and limitations).

Unit – II **(11 Hours)**

Bayesian Statistics: Conditional probability and Bayes Theorem, Prior and Posterior probability distributions, examples of Bayes theorem in everyday life. Bayesian parameter estimation. Normal, Poisson and Binomial distributions, their conjugate priors and properties. Bayes factors and model selection.

Unit – III **(11 Hours)**

Bayesian Regression: Introduction to Bayesian Linear Regression. Bayesian logistic regression and its applications. Bayesian parameter estimation for regression models. Posterior distribution of model parameters and the posterior predictive distributions.

References:

Essential Readings:

1) Schaum's Outline Series of Probability and Statistics, M. R. Spiegel, J. J. Schiler and R. A. Srinivasan, 2012, McGraw Hill Education
2) Schaum's Outline Series of Theory and Problems of Probability, Random Variables, and Random Processes, H. Hsu, 2019, McGraw Hill Education
3) Bayesian Logical Data Analysis for the Physical Sciences: A Comparative Approach with Mathematica Support, P. Gregory, 2010, Cambridge University Press
4) Linear Regression: An Introduction to Statistical Models, P. Martin, 2021, Sage Publications Ltd.
5) Data Analysis: A Bayesian Tutorial, D. S. Sivia and J. Skilling, 2006, Oxford University Press
6) Data Reduction and Error analysis for the Physical Sciences, P. R. Bevington and D. K. Robinson, 2002, McGraw-Hill Education

Additional Readings:

1) A Guide to the Use of Statistical Methods in the Physical Sciences, R. J. Barlow, 1993, Wiley Publication
2) An Introduction to Error Analysis, J. R. Taylor, 1996, Univ. Sci. Books
3) Applied Multivariate Data Analysis, Volume I: Regression and Experimental Design, J. D. Jobson, 2012, Springer-Verlag
4) Statistical Rethinking A Bayesian Course with Examples in R and STAN, Richard McElreath, 2020, CRC Press
5) Introduction to Bayesian Statistics, W. Bolstad, 2007, John Wiley

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The objective of this lab is to familiarise the students with the techniques of data analysis. The instructors are required to discuss the concepts and the pseudo-codes of the recommended programs in the practical sessions before their implementation. The implementation can be in any programming language. Inbuilt libraries can be used wherever applicable. **All units are mandatory.**

Unit 1 (12 Hours)

Probability Distributions

1) Generate sequences of N random numbers M (at least 10000) number of times from different distributions (e.g. Binomial, Poisson, Normal). Use the arithmetic mean of each random vector (of size N) and plot the distribution of the arithmetic means. Verify the Central Limit Theorem (CLT) for each distribution. Show that CLT is violated for the

Cauchy-Lorentz distribution.

2) Given a data for two independent variables (x_i, y_i). Write a code to compute the joint probability in a given sample space. Verify the same for the data generated by random number generator based on a given probability distribution of pair of independent variables (both discrete and continuous).

Unit 2 (16 Hours)

1) Hypothesis testing
   Make a random number generator to simulate the tossing of a coin n times with the probability for the head being q. Write a code for a Binomial test with the Null hypothesis H_0 ($q = 0.5$) against the alternative hypothesis H_1 ($q \neq 0.5$).

2) Bayesian Inference
   a) In an experiment of flipping a coin N times, M heads showed up (fraction of heads $f = M/N$). Write a code to determine the posterior probability, given the following prior for the probability of f:
      i. Beta Distribution $B(a, b)$ with given values of a and b .
      ii. Gaussian Distribution with a given mean and variance.
   b) Using the Likelihood of Binomial distribution, determine the value of f (fraction of heads) that maximizes the probability of the data.
   c) Plot the Likelihood (normalised), Prior and Posterior Distributions.

Unit 3 (20 hours)

Regression Analysis and Gradient Descent:

1) Given a dataset (Xi, Yi). Write a code to obtain the parameters of linear regression equation using the method of least squares with both constant and variable errors in the dependent variable (Y). The data obtained in a physics lab may be used for this purpose. Also obtain the correlation coefficient and the 90% confidence interval for the regression line. Make a scatter plot along with error bars. Also, overlay the regression line and show the confidence interval.

2) Write a code to minimize the cost function (mean squared error) in the linear regression using gradient descent (an iterative optimization algorithm, which finds the minimum of a differentiable function) with at least two independent variables. Determine the correlation matrix for the regression parameters.

3) Write a code to map a random variable X that can take a wide range of values to another variable Y with values lying in limited interval say [0, 1] using a sigmoid function (logistic function). Considering the Log Loss as the cost function of logistic regression, compute its minimum with gradient descent method and estimate the parameters.

Unit 4 (12 Hours)

Markov Chain (Any one)

1) Write a code to generate a Markov chain by defining (a finite number of) M (say 2) states. Encode states using a number and assign their probabilities for changing from state i to state j. Compute the transition matrix for $1, 2, \ldots, N$ steps. Following the rule, write a code for Markovian Brownian motion of a particle.

2) Given that a particle may exist in one of the given energy states (E_i, $i = 1, \ldots 4$) and the

transition probability matrix T, so that T_{ij} gives the probability for the particle to make transition from energy state E_i to state E_j. Determine the long-term probability of a particle to be in state in the state E_f if the particle was initially in state E_i.

References for laboratory work:

1) Data Science from Scratch – First Principles with Python, J. Grus, O'Reilly, 2019, Media Inc.
2) Bayes' Rule with Python: A tutorial introduction to Bayesian Analysis, J. V. Stone, 2016, Sebtel Press
3) Practical Bayesian Inference, B. Jones, 2017, Cambridge University Press
4) Modeling and Simulation in Scilab/Scicos with Scicos Lab 4.4, S. L. Campbell, Jean-P. Chancelier and R. Nikoukhah, Springer.
5) Scilab Textbook Companion for Probability And Statistics For Engineers And Scientists, S. M. Ross, 2005, Elsevier
6) Numerical Recipes: The art of scientific computing, W. H. Press, S. A. Teukolsky and W. Vetterling, 2007, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 9: ADVANCED MATHEMATICAL PHYSICS II

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Advanced Mathematical Physics II DSE – 9	4	3	1	0	Class XII pass with Physics and Mathematics as main subjects	DSC Mathematical Physics-I and Mathematical Physics-II of this course or their equivalent

LEARNING OBJECTIVES

The emphasis of the course is to acquire advanced mathematical inputs while solving problems of interest to physicists. The course aims to introduce the students to the principles of tensor analysis and equip them to use the concept in modelling of continuous media, electrodynamics, elasticity theory and the general theory of relativity. The mathematical skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will,

- Have a knowledge and understanding of tensor analysis and tensor calculus
- Be able to do computation with tensors, both in coordinates and in coordinate-free form.
- Understand the transformation properties of covariant, contravariant and mixed tensors under general coordinate transformation.
- Be able to apply the concepts of tensors in anisotropic media with examples of moment of inertia tensor, elasticity tensor and polarizability tensor.
- Understand physical examples of tensors such as Moment of Inertia and Elasticity of asymmetrical physical systems.
- Be able to write down the Lorentz Transformation in four vector notation.
- Understand inner product and outer product of general tensors.
- Understand the concept of covariant derivatives.

SYLLABUS OF DSE - 9

THEORY COMPONENT

Unit - I **(12 Hours)**

Cartesian Tensors: Transformation of co-ordinates under rotation of axes. Einstein's Summation Convention. Relation between direction cosines. Transformation Law for a tensor of rank n. Sum, inner product and outer product of tensors, contraction of tensors, Quotient Law of tensors, symmetric and anti-symmetric tensors. Invariant tensors (Kronecker and Alternating Tensor). Association of anti-symmetric tensor of rank two with vectors. Vector algebra and calculus in tensor notation. Differentiation, gradient, divergence and curl of Tensor Fields. Vector Identities in tensor notation.

Unit - II **(12 hours)**

Applications of Cartesian Tensors: Equation of a Line, Angle between Lines, Projection of a Line on another Line, Condition for Two Lines to be Coplanar and Length and Foot of the Perpendicular from a Point on a Line. Rotation Tensor and its properties.
Moment of Inertia Tensor, Stress and Strain Tensors, Elasticity Tensor, Generalized Hooke's Law, Electric Polarizability Tensor.

Unit - III **(9 hours)**

General Tensors: Transformation of co-ordinates and contravariant and covariant vectors. Transformation law for contravariant, covariant and mixed tensors. Kronecker Delta and permutation tensors. Algebra of general tensors. Quotient Law general tensors. Symmetric and anti-symmetric tensors. Metric Tensor. Reciprocal Tensors. Associated Tensors.

Unit - IV **(12 hours)**

Christoffel Symbols of first and second kind and their transformation laws. Covariant derivative, gradient, divergence and curl of tensor fields.
Minkowski Space, Four Vectors (four-displacement, four-velocity, four-momentum, four-vector potential, four- current density,). Tensorial form of Lorentz Transformation.

References:

Essential Readings:

1) Vector Analysis and Cartesian Tensors, 3rd edition, D. E. Bourne, P. C. Kendall, 1992
2) Cartesian Tensors, H. Jeffreys, 1931, Cambridge University Press.
3) Mathematical Methods for Physicists, H. J. Weber and G. B. Arfken, 2010, Elsevier.
4) A Brief on Tensor Analysis, J. G. Simmonds, 1997, Springer.
5) Schaum's outlines series on Vector Analysis, M. Spiegel, 2nd edition, 2017.
6) Schaum's Outline Series on Tensor Calculus, D. Kay, Revised 1st edition, 2011.
7) An Introduction to Tensor Calculus and Relativity, D. F. Lawden, 2013, Literary Licensing
8) Matrices and tensors in physics by A. W. Joshi, 1995, New Age International Publications.

Additional Readings:

1) A Student's Guide to Vectors and Tensors, D. A. Fleisch, 2011, Cambridge Univ. Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) Classical Electrodynamics, J. D. Jackson, 3rd edition, 2009, Wiley Publication.
4) A Primer in Tensor Analysis and Relativity, I. L. Shapiro, 1st edition, 2019, Springer.
5) Gravity-An introduction to Einstein's General Relativity, J. B. Hartle, 2009, Pearson Education.
6) A first course in general relativity, B. F. Schutz, 2004, Cambridge University Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 10: MICROPROCESSOR

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Microprocessor DSE – 10	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of Digital Electronics

LEARNING OBJECTIVES

Students will be able to outline the types and the functions of storage, learn the characteristics of RAM and ROM and their architecture, describe the architecture of 8085 microprocessors and develop programs for microprocessor 8085

LEARNING OUTCOMES

At the end of the course, students will develop ability to,

- Define storage state the types and functions of storage
- Describe the characteristics of RAM and ROM and their architecture.
- Describe memory organization, addressing, interfacing and mapping
- Describe the architectures of 8085 microprocessors
- Draw timing diagram
- Write programs using 8085

SYLLABUS OF DSE - 10

THEORY COMPONENT

Unit – I - Introduction to 8085 Microprocessor Architecture (16 Hours)

Introduction to microprocessor: Basic computer system organization, introduction, classification and applications of microprocessors, types of memory-primary memory types (SRAM, DRAM, PROM, EPROM, EEPROM), secondary memory (SSD, Optical Drive) memory organization and addressing

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

Unit – II - 8085 Programming (14 Hours)

Operation code, operand and mnemonics, instruction set of 8085, instruction classification, addressing modes, instruction format, data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions, subroutine, call and return instructions, timing diagrams-instruction cycle, machine cycle, T- states, basic idea of interrupts, assembly language programming examples (addition with and without carry, subtraction with and without borrow, double addition, multiplication by repeated addition, division by repeated subtraction, block data transfer and checking of parity of a binary number)

References:
Essential Readings:

1) Microprocessor Architecture Programming and applications with 8085, R. S. Gaonkar, 2002, Prentice Hall
2) Microelectronic Circuits, S. Sedra
3) Fundamentals of Microprocessor and Microcomputer, B. Ram, Dhanpat Rai Publications
4) The Intel Microprocessors - Architecture, Programming and Interfacing, B. Brey, 2003, Pearson Education

Additional Readings:

1) Microprocessors and Microcontrollers, M. Ali Mazidi, 2006, Pearson

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list.

8085 Assembly language programs
1) Add two 8-bit numbers using Direct and Indirect Addressing Mode
2) Subtract two 8-bit numbers using Direct and Indirect Addressing Mode
3) Multiply two 8-bit numbers with and without subroutine
4) Divide two-8 bit numbers with and without subroutine
5) Add a list of 8-bit numbers
6) Transfer a Block of Data
7) Add two 16 bit numbers with DAD and without DAD
8) Convert byte to Nibble
9) Convert nibble to Byte
10) Check the parity of a given number

References for laboratory work:

1) Microprocessor Architecture Programming and applications with 8085, R. S. Gaonkar, 2002, Prentice Hall
2) Microelectronic Circuits, S. Sedra
3) Fundamentals of Microprocessor and Microcomputer, B. Ram, Dhanpat Rai Publications
4) Microprocessors and Microcontrollers, M. Ali Mazidi, 2006, Pearson
5) The Intel Microprocessors - Architecture, Programming and Interfacing, B. Brey, 2003, Pearson Education

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 11: RESEARCH METHODOLOGY

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Research Methodology DSE – 11	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	Basic ICT related skills

LEARNING OBJECTIVES

This course has been designed to explore the basic dimensions of research and to impart quantitative and qualitative knowledge for conducting meaningful research. Starting from the philosophy of research, through awareness about the publication ethics and misconducts, this course covers all the methodological and conceptual issues required for a successful conduct of research. It gives an overview of research techniques, data management and analysis, and commonly used statistical methods in physical sciences.

LEARNING OUTCOMES

After successful completion of this course, students will be trained in the following.

- Skills to review literature and frame research problem
- Comprehend the relevance of the tools for data collection and analysis
- Writing a scientific report/research proposal
- Software tools for research in physical sciences
- Research integrity and publication ethics
- Importance of intellectual property rights
- Role of funding agencies in research

SYLLABUS OF DSE - 11

THEORY COMPONENT

Unit - I - Introduction to research methodology (6 Hours)

Brief history of scientific method and research, role and objectives of research, basic tenets of qualitative research; research problem and review of literature: identifying a research problem (philosophy and meaning of research, identification and definition of research problem, formulation of research problem, sources of prejudice and bias); literature survey (open-source and paid tools for keeping track of the literature)

Unit - II - Data collection, analysis and interpretation (15 Hours)

Methods of data collection: survey, interview, observation, experimentation and case study;
Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation);
Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts of multiple linear regression analysis and theory of attributes);
Curve fitting using linear and nonlinear regression (parameter space, gradient search method

and Marquardt method);
Role of simulation, calibration methods, error analysis, and background handling in experimental design

Unit - III – Journals, Database and Research Metrics (7 Hours)
Journals: Free, open source and paid journals, concept of peer reviewed journals, predatory and fake journals
Databases: Indexing databases; citation databases (Web of science, Scopus); experimental physics databases (astrophysics (ADS, NED, SIMBAD, VizieR), biophysics (PubMed), particle physics (INSPIRE, CDS), condensed matter physics (X-ray database))
Research Metrics: Journal impact factor, SNIP, SJR, IPP, cite score; metrics (h-index, g index, i10 index, altmetrics), variations in research metrics across various disciplines, other limitations of the research metrics and impact factors

Unit - IV – Scientific Conduct and Publication Ethics (8 Hours)
Current understanding of ethics; intellectual honesty and research integrity; communicating errors (erratum, correction and withdrawal); records and logs (maintaining records of samples, raw data, experimental protocols, observation logs, analysis calculations, and codes); scientific publication misconducts: plagiarism (concept, importance, methods and ways to detect and avoid plagiarism) and redundant publications (salami slicing, duplicate and overlapping publications, selective reporting and misrepresentation of data); environmental and other clearances (waste management, disposal of hazardous waste).
COPE guidelines on best practices in publication ethics

Unit V – Scientific Writing and Software Tools (5 Hours)
Writing a research paper and report: introduction, motivation, scientific problem, its methodology, any experimental set up, data analysis, discussion of results, conclusions
Referencing formats (APA, MLA) and bibliography management
Graphical software (open source, magic plot, gnu plot, origin); presentation tools (beamer)

Unit VI - Intellectual Property Right and Research Funding (4 Hours)
Basic concepts and types of intellectual property (patent, copyright and trademark)
Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships

References:
Essential Readings:

1) Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M. Mathirajan, 2006, Pearson Education, New Delhi.
2) Research Methodology, Methods and Techniques, C. R. Kothari, 2nd edition, 2008, New Age International Publication.
3) Research Methodology, A step by step guide for beginners, R. Kumar, 6th edition, 2009, Pearson Education
4) Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill
5) Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland, 2007, Entrepreneur Press

Additional Readings:

1) Research Methods, R. Ahuja, 2001, Rawat Publications, New Delhi.
2) Research design: Qualitative, quantitative, and mixed methods approaches, J. W. Creswell, and J. D. Creswell, 2017, Sage Publications.
3) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, A. R. Miller and M. H. Davis, 2000, West Group Publishers

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

Students should perform at least six practicals from the following list, such that all the units mentioned below are covered.

Unit 1:

1) Identify a research problem, write its brief summary and make a corresponding flow chart
2) Identify a survey-based research problem in physics and create a questionnaire to collect data to perform meaningful research.
3) Write a literature review for a research problem.
4) Create a list of research topics (at least three) and read at least one research paper in each topic.

Unit 2:

1) Attend a research seminar and write a brief summary in 1000 words. Check the extent of plagiarism in this summary by using on-line plagiarism detection tools
2) Read a research paper based on the use of statistics in experimental physics and summarise its importance.
3) Collect publicly available experimental physics data. Identify the independent, dependent and control variables. Fit at least two mathematical models that can describe the data and compare their statistical significance.

Unit 3:

1) Review any three research papers.
    a) List the major strengths and weakness of all of them.
    b) For any one of these, create a referee report assuming you are a reviewer of the paper. Also draft a response to the referee's report assuming you are the author.
2) Review any research paper. Rewrite it as if the work has been done by you for the first time. Use two different referencing and bibliography styles

Unit 4:

1) Take data from any publicly available experimental physics database. Use Microsoft Office tools (such as chart/bar diagrams, equation editor etc. in Word, PowerPoint or Excel) to present, plot and infer relevant information from the data.
2) Write a scientific synopsis of a research paper using LaTeX.
3) Create a presentation using LaTeX and Beamer on any research topic
4) Select a funding agency and any two schemes or fellowships offered by them. Make a report (using LaTeX) describing the objectives, areas of research support and various components of grants offered by them.

Category II

Physical Science Courses
with Physics discipline as one of the Core Disciplines

(B. Sc. Physical Science with Physics as Major discipline)

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 6: SOLID STATE PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Solid State Physics PHYSICS DSC – 6	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Understanding of basic concepts of Physics

LEARNING OBJECTIVES

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. It also communicates the importance of solid state physics in modern society.

LEARNING OUTCOMES

On successful completion of the module students should be able to,

- Elucidate the concept of lattice, crystals and its planes
- Understand the elementary lattice dynamics and its influence on the properties of materials
- Understanding about origin of energy bands, and their influence on electronic behaviour
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids
- Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability
- In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

SYLLABUS OF PHYSICS DSC – 6

THEORY COMPONENT

Unit – I - Crystal Structure (10 Hours)

Solids: amorphous and crystalline materials, lattice translation vectors, lattice with a basis, unit cell, types of lattices, Miller indices, reciprocal lattice, Ewald's construction (geometrical approach), Brillouin zones, diffraction of X-rays by crystals. Bragg's law

Unit – II - Elementary Lattice Dynamics (6 Hours)

Lattice vibrations and phonons: linear monoatomic and diatomic chains, acoustical and optical phonons, Dulong and Petit's law, qualitative discussion of Einstein and Debye theories, T^3 law.

Unit – III - Elementary Band Theory **(5 Hours)**
Qualitative understanding of Kronig and Penny model (without derivation) and formation of bands in solids, concept of effective mass, Hall effect in semiconductor, Hall coefficient, application of Hall Effect, basic introduction to superconductivity

Unit – IV - Magnetic Properties of Matter **(6 Hours)**
dia-, para-, and ferro- magnetic materials, classical Langevin theory of dia– and para-magnetism (no quantum mechanical treatment), qualitative discussion about Weiss's theory of ferromagnetism and formation of ferromagnetic domains, B-H curve hysteresis and energy loss

Unit – V - Dielectric Properties of Materials **(3 Hours)**
Polarization, local electric field in solids, electric susceptibility, polarizability, Clausius Mossoti equation, qualitative discussion about ferroelectricity and PE hysteresis loop

References:
Essential Readings:

1) Introduction to Solid State Physics, C. Kittel, 8th edition, 2004, Wiley India Pvt. Ltd.
2) Elements of Solid-State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
3) Introduction to Solids, L. V. Azaroff, 2004, Tata Mc-Graw Hill
4) Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976, Cengage Learning
5) Solid State Physics, M. A. Wahab, 2011, Narosa Publications

Additional Readings:

1) Elementary Solid State Physics, M. Ali Omar, 2006, Pearson
2) Solid State Physics, R. John, 2014, McGraw Hill
3) Superconductivity: A very short introduction, S. J. Blundell, Audiobook

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Measurement of susceptibility of paramagnetic solution (Quinck's tube method)
2) To measure the magnetic susceptibility of solids
3) To determine the coupling coefficient of a piezoelectric crystal
4) To study the dielectric response of materials with frequency
5) To determine the complex dielectric constant and plasma frequency of a metal using Surface Plasmon Resonance (SPR) technique
6) To determine the refractive index of a dielectric layer using SPR technique
7) To study the PE Hysteresis loop of a ferroelectric crystal
8) To draw the BH curve of iron (Fe) using a Solenoid and determine the energy loss from hysteresis loop
9) To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150^{o} C) by four-probe method and determine its band gap
10) To determine the Hall coefficient of a semiconductor sample
11) Analysis of X-ray diffraction data in terms of unit cell parameters and estimation of particle size
12) Measurement of change in resistance of a semiconductor with magnetic field.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) Advanced level Physics Practicals, M. Nelson and J. M. Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers
3) Elements of Solid-State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
4) An Advanced Course in Practical Physics, D. Chattopadhyay and P. C. Rakshit, 2013, New Book Agency (P) Ltd.
5) Practical Physics, G. L. Squires, 4th edition, 2015
6) Practical Physics, C. L. Arora, 19th edition, 2015, S. Chand

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16a: MATHEMATICAL PHYSICS II

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Mathematical Physics II PHYSICS DSE 16a	4	3	1	0	Class XII pass with Physics and Mathematics as main subjects	Mathematics as DSC course containing linear algebra and calculus

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The mathematical tools might be building blocks to understand the fundamental computational physics skills and hence enable them to solve a wide range of physics problems. Overall, to help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Understand Complex Analysis
- Understand algebraic structures in n-dimension and basic properties of the linear vector spaces.
- Apply vector spaces and matrices in the quantum world.
- Learn Fourier Transforms (FTs)

SYLLABUS OF PHYSICS DSE 16a

THEORY COMPONENT

Unit – I **(20 Hours)**

Complex Analysis: Introduction to complex variables, Functions of Complex variable, limit, continuity, Analytic functions, Cauchy-Riemann equations, singular points, Cauchy Integral Theorem, Cauchy's Integral Formula, Residues, Cauchy's residue theorem, application of contour integration in solving real integrals.

Unit – II **(15 Hours)**

Linear Algebra: Linear Vector Spaces, Inner Product of Vectors and Norm of a Vector, Euclidean spaces, unitary spaces and inner product spaces. Properties of inner product spaces, Cauchy-Schwartz inequality, concept of length and distance, metric spaces. Orthogonality of vectors, orthonormal basis. Eigenvalue and Eigenvector, Adjoint of a linear operator, Hermitian or Self adjoint operators and their properties and Unitary Operators. Hilbert Space (Definition only).

Unit – III **(10 Hours)**

Fourier Transforms (FTs): Fourier Integral Theorem. Sine and Cosine Transforms. Properties of FTs: (1) FTs of Derivatives of Functions, (2) Change of Scale Theorem, (3) FTs of Complex Conjugates of Functions, (4) Shifting Theorem, (5) Modulation Theorem, (6) Convolution Theorems, and (7) Parseval's Identity.

References:

Essential Readings:

1) Complex Variables and Applications, J. W. Brown and R. V. Churchill, 9th edition, 2021, Tata McGraw-Hill
2) Mathematical Tools for Physics, J. Nearing, 2010, Dover Publications
3) Theory and Problems of Linear Algebra, S. Lipschutz, 1987, McGraco-Hill Inc.
4) Mathematical Methods for Physicists, H. J. Weber and G. B. Arfken, 2010, Elsevier.
5) Introduction to Matrices & Linear Transformations, D. T. Finkbeiner, 1978, Dover Pub.
6) Matrices and tensors in Physics: A.W. Joshi, 2017, New Age International Pvt.
7) Mathematical Methods in the Physical Sciences, M. L. Boas, 3rd edition, 2007, Wiley India.
8) Advanced Engineering Mathematics, E. Kreyszig, 2008, Wiley India.

Additional Readings:

1) Elementary Linear Algebra, Applications Version, H. Anton and C. Rorres, Wiley Student edition.
2) Mathematics for Physicists, S. M. Lea, 2004, Thomson Brooks/Cole
3) An Introduction to Linear Algebra and Tensors, M. A. Akivis, V. V. Goldberg, Richard and Silverman, 2012, Dover Publications

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16b: COMMUNICATION SYSTEM

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Communication System PHYSICS DSE 16b	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital and analog electronics

LEARNING OBJECTIVES

This paper aims to describe the fundamental concepts of communication systems and communication techniques based on analog modulation, analog and digital pulse modulation. Communication and Navigation systems such as GPS and mobile telephony system are also introduced. This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

LEARNING OUTCOMES

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

- Understand fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
- Gain an insight on the use of different modulation and demodulation techniques used in analog communication
- Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
- Gain an in-depth understanding of different concepts used in a satellite communication system.
- Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA.
- In the laboratory course, students will apply the theoretical concepts to gain hands-on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.

SYLLABUS OF PHYSICS DSE 16b

THEORY COMPONENT

Unit – I - Electronic communication and analog modulation (8 Hours)

Electronic communication: Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system, channels and base-band signals

Analog Modulation: Amplitude modulation, modulation index and frequency spectrum. Generation of AM (emitter modulation), amplitude demodulation (diode detector), Single sideband (SSB) systems, advantages of SSB transmission, frequency modulation (FM) and phase modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM.

Unit – II - Analog Pulse Modulation (4 Hours)
Sampling theorem, basic principles - PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing (time division multiplexing and frequency division multiplexing)

Unit – III - Digital Pulse Modulation (10 Hours)
Need for digital transmission, pulse code modulation, digital carrier modulation techniques, sampling, quantization and encoding, concept of amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), and binary phase shift keying (BPSK)

Unit – IV - Satellite Communication and Mobile Telephony system (8 Hours)
Satellite communication: Need for satellite communication, geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), uplink and downlink, Ground and earth stations
Mobile Telephony System: Concept of cell sectoring and cell splitting, SIM number, IMEI number, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset.

References:
Essential Readings:

1) Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
2) Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
3) Electronic Communication systems, G. Kennedy, 3rd edition, 1999, Tata McGraw Hill.
4) Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
5) Modern Digital and Analog Communication Systems, B. P. Lathi, 4th edition, 2011, Oxford University Press.
6) Communication Systems, S. Haykin, 2006, Wiley India
7) Wireless communications, A. Goldsmith, 2015, Cambridge University Press

Additional Readings:

1) Electronic Communication, L. Temes and M. Schultz, Schaum's Outline Series, Tata McGraw- Hill.
2) Electronic Communication Systems, G. Kennedy and B. Davis, Tata McGraw-Hill
3) Analog and Digital Communication Systems, M. J. Roden, Prentice Hall of India

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) To design an amplitude modulator using transistor
2) To design envelope detector for demodulation of AM signal
3) To study FM - generator and detector circuit
4) To study AM transmitter and receiver
5) To study FM transmitter and receiver
6) To study time division multiplexing (TDM)

7) To design pulse amplitude modulator using transistor.
8) To design pulse width modulator using 555 timer IC.
9) To design pulse position modulator using 555 timer IC
10) To study ASK, PSK and FSK modulators and demodulators

References for laboratory work:

1) Electronic Communication system, Blake, Cengage, 5th edition
2) Introduction to Communication systems, U. Madhow, 1st edition, 2018, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16c: LASER PHYSICS AND ITS APPLICATIONS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Laser Physics and its Applications PHYSICS DSE 16c	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Waves and optics paper of this course or its equivalent. Basic idea of energy levels in atoms and molecules

LEARNING OBJECTIVES

Laser physics is a branch of optics that covers the fundamental and applied aspects of laser science. Laser is an acronym for 'Light Amplification by Stimulated Emission of Radiation'. This radiation has some specific properties different from the common light. The main objective of this course is to introduce the basic principle of its production, its types, the different kinds and techniques of laser devices and applications of laser in various fields including research, high energy applications, medical applications, industrial applications, and nuclear science. Also to perform experiments and to measure some physical quantities based on the experiments using lasers.

LEARNING OUTCOMES

After completing this course, students should be able to,

- Understand the nature of interaction of radiation with matter in the form of absorption of light, spontaneous and stimulated emission of radiation.
- Understand the principle of laser action, including population inversion, metastable states, gain medium, optical pumping, feedback mechanism and threshold condition for laser beam generation
- Understand the various types of lasers such as three and four-level lasers
- Understand various characteristic properties of lasers and how they are utilized in different applications
- Know the importance of lasers in holography and in fibre optics
- Perform some experiments based on the laser technique and to be able to measure some quantities through these experiments

SYLLABUS OF PHYSICS DSE 16c

THEORY COMPONENT

Unit 1 – Introduction (12 Hours)

Planck's theory of radiation (qualitative idea), energy levels, absorption process, spontaneous and stimulated emission processes, theory of laser action, population inversion, Einstein's A and B coefficients of transition, optical pumping, optical amplification, threshold for laser oscillation, line shape function (various line broadening mechanisms: collisional broadening, natural broadening, Doppler broadening), coherence (temporal and spatial type, role of coherence in laser action), optical resonator (different configurations and stability condition)

Unit 2 – Types of Laser **(8 Hours)**

Doped insulator laser (Nd:YAG laser, Ruby laser)

Semiconductor lasers (GaAs laser): Energy bands and carrier distribution in semiconductors, absorption and emission in a semiconductor, optical gain, laser oscillation, threshold current density, power output

Gas lasers: He-Ne laser, noble gas ion laser, carbon dioxide laser

Unit 3 – Applications of Laser **(10 Hours)**

Properties of laser light: Mono-chromaticity, directionality, line width, beam coherence, intensity, focussing

Applications: Measurement of distance (interferometry method, beam modulation telemetry), Holography (basic principle, coherence, recording and reconstruction method, white light reflection hologram, application in microscopy and character recognition), medical applications, laser tweezers, high energy applications, industrial applications, laser induced nuclear fusion

References:

Essential Readings:

1) Laser Physics, M. Sargent, M. O. Scully and W. E. Lamb Jr., 1974, Western Press
2) Laser Physics and Spectroscopy, P. N. Ghosh, 2016, Levant Books, India
3) Lasers: Fundametnals and applications, K. Thyagarajan and A. K. Ghatak, 2010, Tata McGraw Hill
4) Optical systems and processes, J. Shamir, 2009, PHI Learning Pvt. Ltd.
5) Fundamental of optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand and Co. Publications
6) Optics, E. Hecht, 4^{th} edition, 2014, Pearson Education
7) Laser applications, M. Ross, 1968, McGraw Hill

Additional Readings:

1) Physics for scientists and engineers with modern physics, Jewett and Serway, 2010, Cengage Learning
2) Optical Physics, A. Lispon, S. G. Lipson and H. Lipson, 4th edition, 1996, Cambridge University Press
3) Fibre optics through experiments, M. R. Shenoy, S. K. Khijwania, et.al. 2009, Viva Books
4) Industrial applications of lasers, J. F. Ready, 2^{nd} edition, 1997, Academic Press
5) Semiconductor optoelectronics, J. Singh, 1995, McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) To determine the wavelength and angular spread of laser light by using plane diffraction grating.
2) To determine the wavelength of laser source using diffraction of single slit.
3) To determine the wavelength of laser source using diffraction of double slits.

4) To determine the grating radial spacing of the compact disc by reflection using He-Ne or solid state laser.
5) To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
6) To find the polarization angle of laser light using polarizer and analyser
7) To measure the numerical aperture of an optical fibre
8) To study the variation of the bending loss in a multimode fibre
9) To study thermal expansion of quartz using laser
10) To study the characteristics of solid state laser

References for laboratory work:

1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, Asia Publishing
2) Optoelectronics: An introduction, 3rd edition, 1998, Pearson Education
3) Introduction to fibre optics, A. K. Ghatak and K. Thyagarajan, 1998, Cambridge University Press

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16d: RESEARCH METHODOLOGY

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Research Methodology PHYSICS DSE 16d	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	Basic ICT related skills

LEARNING OBJECTIVES

This course has been designed to explore the basic dimensions of research and to impart quantitative and qualitative knowledge for conducting meaningful research. Starting from the philosophy of research, through awareness about the publication ethics and misconducts, this course covers all the methodological and conceptual issues required for a successful conduct of research. It gives an overview of research techniques, data management and analysis, and commonly used statistical methods in physical sciences.

LEARNING OUTCOMES

After successful completion of this course, students will be sufficiently trained in the following.

- Skills to review literature and frame research problem
- Comprehend the relevance of the tools for data collection and analysis
- Writing a scientific report/research proposal
- Software tools for research in physical sciences
- Research integrity and publication ethics
- Importance of intellectual property rights
- Role of funding agencies in research

SYLLABUS OF Physics DSE 16d

THEORY COMPONENT

Unit - I - Introduction to research methodology (6 Hours)

Brief history of scientific method and research, role and objectives of research, basic tenets of qualitative research; research problem and review of literature: identifying a research problem (philosophy and meaning of research, identification and definition of research problem, formulation of research problem, sources of prejudice and bias); literature survey (open-source and paid tools for keeping track of the literature)

Unit - II - Data collection, analysis and interpretation (15 Hours)

Methods of data collection: survey, interview, observation, experimentation and case study;
Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation);
Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts of multiple linear regression analysis and theory of attributes);

Curve fitting using linear and nonlinear regression (parameter space, gradient search method and Marquardt method);
Role of simulation, calibration methods, error analysis, and background handling in experimental design

Unit - III – Journals, Database and Research Metrics (7 Hours)
Journals: Free, open source and paid journals, concept of peer reviewed journals, predatory and fake journals
Databases: Indexing databases; citation databases (Web of science, Scopus); experimental physics databases (astrophysics (ADS, NED, SIMBAD, VizieR), biophysics (PubMed), particle physics (INSPIRE, CDS), condensed matter physics (X-ray database))
Research Metrics: Journal impact factor, SNIP, SJR, IPP, cite score; metrics (h-index, g index, i10 index, altmetrics), variations in research metrics across various disciplines, other limitations of the research metrics and impact factors

Unit - IV – Scientific Conduct and Publication Ethics (8 Hours)
Current understanding of ethics; intellectual honesty and research integrity; communicating errors (erratum, correction and withdrawal); records and logs (maintaining records of samples, raw data, experimental protocols, observation logs, analysis calculations, and codes); scientific publication misconducts: plagiarism (concept, importance, methods and ways to detect and avoid plagiarism) and redundant publications (salami slicing, duplicate and overlapping publications, selective reporting and misrepresentation of data); environmental and other clearances (waste management, disposal of hazardous waste).
COPE guidelines on best practices in publication ethics

Unit V – Scientific Writing and Software Tools (5 Hours)
Writing a research paper and report: introduction, motivation, scientific problem, its methodology, any experimental set up, data analysis, discussion of results, conclusions
Referencing formats (APA, MLA) and bibliography management
Graphical software (open source, magic plot, gnu plot, origin); presentation tools (beamer)

Unit VI - Intellectual Property Right and Research Funding (4 Hours)
Basic concepts and types of intellectual property (patent, copyright and trademark)
Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships

References:
Essential Readings:

1) Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M. Mathirajan, 2006, Pearson Education, New Delhi.
2) Research Methodology, Methods and Techniques, C. R. Kothari, 2nd edition, 2008, New Age International Publication.
3) Research Methodology, A step by step guide for beginners, R. Kumar, 6th edition, 2009, Pearson Education
4) Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill
5) Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland, 2007, Entrepreneur Press

Additional Readings:

1) Research Methods, R. Ahuja, 2001, Rawat Publications, New Delhi.
2) Research design: Qualitative, quantitative, and mixed methods approaches, J. W. Creswell, and J. D. Creswell, 2017, Sage Publications.
3) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, A. R. Miller and M. H. Davis, 2000, West Group Publishers

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)
Students should perform at least six practicals from the following list, such that all the units mentioned below are covered.

Unit 1:

1) Identify a research problem, write its brief summary and make a corresponding flow chart
2) Identify a survey-based research problem in physics and create a questionnaire to collect data to perform meaningful research.
3) Write a literature review for a research problem.
4) Create a list of research topics (at least three) and read at least one research paper in each topic.

Unit 2:

1) Attend a research seminar and write a brief summary in 1000 words. Check the extent of plagiarism in this summary by using on-line plagiarism detection tools
2) Read a research paper based on the use of statistics in experimental physics and summarise its importance.
3) Collect publicly available experimental physics data. Identify the independent, dependent and control variables. Fit at least two mathematical models that can describe the data and compare their statistical significance.

Unit 3:

1) Review any three research papers.
    a) List the major strengths and weakness of all of them.
    b) For any one of these, create a referee report assuming you are a reviewer of the paper. Also draft a response to the referee's report assuming you are the author.
2) Review any research paper. Rewrite it as if the work has been done by you for the first time. Use two different referencing and bibliography styles

Unit 4:

1) Take data from any publicly available experimental physics database. Use Microsoft Office tools (such as chart/bar diagrams, equation editor etc. in Word, PowerPoint or Excel) to present, plot and infer relevant information from the data.
2) Write a scientific synopsis of a research paper using LaTeX.
3) Create a presentation using LaTeX and Beamer on any research topic
4) Select a funding agency and any two schemes or fellowships offered by them. Make a report (using LaTeX) describing the objectives, areas of research support and various components of grants offered by them.

Category II

Physical Science Courses (with Electronics)
with Physics and Electronics discipline as Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 10: SOLID STATE PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Solid State Physics PHYSICS DSC 10	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Understanding of basic concepts of Physics

LEARNING OBJECTIVES

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. It also communicates the importance of solid state physics in modern society.

LEARNING OUTCOMES

On successful completion of the module students should be able to,

- Elucidate the concept of lattice, crystals and its planes
- Understand the elementary lattice dynamics and its influence on the properties of materials
- Understanding about origin of energy bands, and their influence on electronic behaviour
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids
- Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability
- In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

SYLLABUS OF PHYSICS DSC – 10

THEORY COMPONENT

Unit – I - Crystal Structure (10 Hours)

Solids: amorphous and crystalline materials, lattice translation vectors, lattice with a basis, unit cell, types of lattices, Miller indices, reciprocal lattice, Ewald's construction (geometrical approach), Brillouin zones, diffraction of X-rays by crystals. Bragg's law

Unit – II - Elementary Lattice Dynamics (6 Hours)

Lattice vibrations and phonons: linear monoatomic and diatomic chains, acoustical and optical phonons, Dulong and Petit's law, qualitative discussion of Einstein and Debye theories, T^3 law.

Unit – III - Elementary Band Theory **(5 Hours)**
Qualitative understanding of Kronig and Penny model (without derivation) and formation of bands in solids, concept of effective mass, Hall effect in semiconductor, Hall coefficient, application of Hall effect, basic introduction to superconductivity

Unit – IV - Magnetic Properties of Matter **(6 Hours)**
dia-, para-, and ferro- magnetic materials, classical Langevin theory of dia– and para-magnetism (no quantum mechanical treatment), qualitative discussion about Weiss's theory of ferromagnetism and formation of ferromagnetic domains, B-H curve hysteresis and energy loss

Unit – V - Dielectric Properties of Materials **(3 Hours)**
Polarization, local electric field in solids, electric susceptibility, polarizability, Clausius Mossoti equation, qualitative discussion about ferroelectricity and PE hysteresis loop

References:
Essential Readings:

1) Introduction to Solid State Physics, C. Kittel, 8th edition, 2004, Wiley India Pvt. Ltd.
2) Elements of Solid-State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
3) Introduction to Solids, L. V. Azaroff, 2004, Tata Mc-Graw Hill
4) Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976, Cengage Learning
5) Solid State Physics, M. A. Wahab, 2011, Narosa Publications

Additional Readings:

1) Elementary Solid State Physics, M. Ali Omar, 2006, Pearson
2) Solid State Physics, R. John, 2014, McGraw Hill
3) Superconductivity: A Very short Introduction – Stephen J Blundell - Audiobook

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Measurement of susceptibility of paramagnetic solution (Quinck's tube method)
2) To measure the magnetic susceptibility of solids
3) To determine the coupling coefficient of a piezoelectric crystal
4) To study the dielectric response of materials with frequency
5) To determine the complex dielectric constant and plasma frequency of a metal using Surface Plasmon Resonance (SPR) technique
6) To determine the refractive index of a dielectric layer using SPR technique
7) To study the PE Hysteresis loop of a ferroelectric crystal
8) To draw the BH curve of iron (Fe) using a solenoid and determine the energy loss from hysteresis loop
9) To measure the resistivity of a semiconductor (Ge) crystal with temperature (up to 150^{o} C) by four-probe method and determine its band gap
10) To determine the Hall coefficient of a semiconductor sample
11) Analysis of X-ray diffraction data in terms of unit cell parameters and estimation of particle size

12) Measurement of change in resistance of a semiconductor with magnetic field.

References for laboratory work:

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) Advanced level Physics Practicals, M. Nelson and J. M. Ogborn, 4th edition, reprinted 1985, Heinemann Educational Publishers
3) Elements of Solid-State Physics, J. P. Srivastava, 2nd edition, 2006, Prentice-Hall of India
4) An Advanced Course in Practical Physics, D. Chattopadhyay and P. C. Rakshit, 2013, New Book Agency (P) Ltd.
5) Practical Physics, G. L. Squires, 4th edition, 2015
6) Practical Physics, C. L. Arora, 19th edition, 2015, S. Chand

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 13: RESEARCH METHODOLOGY

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Research Methodology PHYSICS DSE 13	4	3	0	1	Class XII pass with Physics and Mathematics as main subjects	Basic ICT related skills

LEARNING OBJECTIVES

This course has been designed to explore the basic dimensions of research and to impart quantitative and qualitative knowledge for conducting meaningful research. Starting from the philosophy of research, through awareness about the publication ethics and misconducts, this course covers all the methodological and conceptual issues required for a successful conduct of research. It gives an overview of research techniques, data management and analysis, and commonly used statistical methods in physical sciences.

LEARNING OUTCOMES

After successful completion of this course, students will be trained in the following.

- Skills to review literature and frame research problem
- Comprehend the relevance of the tools for data collection and analysis
- Writing a scientific report/research proposal
- Software tools for research in physical sciences
- Research integrity and publication ethics
- Importance of intellectual property rights
- Role of funding agencies in research

SYLLABUS OF Physics DSE - 13

THEORY COMPONENT

Unit - I - Introduction to research methodology (6 Hours)

Brief history of scientific method and research, role and objectives of research, basic tenets of qualitative research; research problem and review of literature: identifying a research problem (philosophy and meaning of research, identification and definition of research problem, formulation of research problem, sources of prejudice and bias); literature survey (open-source and paid tools for keeping track of the literature)

Unit - II - Data collection, analysis and interpretation (15 Hours)

Methods of data collection: survey, interview, observation, experimentation and case study;
Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation);
Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts of multiple linear regression analysis and theory of attributes);

Curve fitting using linear and nonlinear regression (parameter space, gradient search method and Marquardt method);
Role of simulation, calibration methods, error analysis, and background handling in experimental design

Unit - III – Journals, Database and Research Metrics (7 Hours)
Journals: Free, open source and paid journals, concept of peer reviewed journals, predatory and fake journals
Databases: Indexing databases; citation databases (Web of science, Scopus); experimental physics databases (astrophysics (ADS, NED, SIMBAD, VizieR), biophysics (PubMed), particle physics (INSPIRE, CDS), condensed matter physics (X-ray database))
Research Metrics: Journal impact factor, SNIP, SJR, IPP, cite score; metrics (h-index, g index, i10 index, altmetrics), variations in research metrics across various disciplines, other limitations of the research metrics and impact factors

Unit - IV – Scientific Conduct and Publication Ethics (8 Hours)
Current understanding of ethics; intellectual honesty and research integrity; communicating errors (erratum, correction and withdrawal); records and logs (maintaining records of samples, raw data, experimental protocols, observation logs, analysis calculations, and codes); scientific publication misconducts: plagiarism (concept, importance, methods and ways to detect and avoid plagiarism) and redundant publications (salami slicing, duplicate and overlapping publications, selective reporting and misrepresentation of data); environmental and other clearances (waste management, disposal of hazardous waste).
COPE guidelines on best practices in publication ethics

Unit V – Scientific Writing and Software Tools (5 Hours)
Writing a research paper and report: introduction, motivation, scientific problem, its methodology, any experimental set up, data analysis, discussion of results, conclusions
Referencing formats (APA, MLA) and bibliography management
Graphical software (open source, magic plot, gnu plot, origin); presentation tools (beamer)

Unit VI - Intellectual Property Right and Research Funding (4 Hours)
Basic concepts and types of intellectual property (patent, copyright and trademark); Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships

References:
Essential Readings:
1) Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M. Mathirajan, 2006, Pearson Education, New Delhi.
2) Research Methodology, Methods and Techniques, C. R. Kothari, 2nd edition, 2008, New Age International Publication.
3) Research Methodology, A step by step guide for beginners, R. Kumar, 6th edition, 2009, Pearson Education
4) Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill
5) Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland, 2007, Entrepreneur Press

Additional Readings:

1) Research Methods, R. Ahuja, 2001, Rawat Publications, New Delhi.
2) Research design: Qualitative, quantitative, and mixed methods approaches, J. W. Creswell, and J. D. Creswell, 2017, Sage Publications.
3) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, A. R. Miller and M. H. Davis, 2000, West Group Publishers

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)
Students should perform at least six practicals from the following list, such that all the units mentioned below are covered.

Unit 1:
1) Identify a research problem, write its brief summary and make a corresponding flow chart
2) Identify a survey-based research problem in physics and create a questionnaire to collect data to perform meaningful research.
3) Write a literature review for a research problem.
4) Create a list of research topics (at least three) and read at least one research paper in each topic.

Unit 2:
1) Attend a research seminar and write a brief summary in 1000 words. Check the extent of plagiarism in this summary by using on-line plagiarism detection tools
2) Read a research paper based on the use of statistics in experimental physics and summarise its importance.
3) Collect publicly available experimental physics data. Identify the independent, dependent and control variables. Fit at least two mathematical models that can describe the data and compare their statistical significance.

Unit 3:
1) Review any three research papers.
    a) List the major strengths and weakness of all of them.
    b) For any one of these, create a referee report assuming you are a reviewer of the paper. Also draft a response to the referee's report assuming you are the author.
2) Review any research paper. Rewrite it as if the work has been done by you for the first time. Use two different referencing and bibliography styles

Unit 4:
1) Take data from any publicly available experimental physics database. Use Microsoft Office tools (such as chart/bar diagrams, equation editor etc. in Word, PowerPoint or Excel) to present, plot and infer relevant information from the data.
2) Write a scientific synopsis of a research paper using LaTeX.
3) Create a presentation using LaTeX and Beamer on any research topic
4) Select a funding agency and any two schemes or fellowships offered by them. Make a report (using LaTeX) describing the objectives, areas of research support and various components of grants offered by them.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 14: VERILOG AND FPGA BASED SYSTEM DESIGN

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Verilog and FPGA based System Design Physics DSE 14	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital electronics

LEARNING OBJECTIVES

This course trains the students to use VLSI design methodologies and simulate simple digital systems. Students will understand the HDL design flow and the fundamental Verilog concepts in-lieu of today's most advanced digital design techniques. The emphasis of this course is to enhance the understanding of Programmable Logic Devices so as to implement the Digital Designs on FPGAs using Verilog HDL

LEARNING OUTCOMES

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

- Write synthesizable Verilog code.
- Write a Verilog test bench to test Digital Logic Design.
- Design and simulate digital circuits using Verilog modules.
- Understand various types of programmable logic building blocks such as PAL, PLA, CPLDs and FPGAs and their trade-offs.
- Design and implement digital systems on programmable logic device FPGA using Verilog HDL.

SYLLABUS OF PHYSICS DSE 14

THEORY COMPONENT

Unit – I **(20 Hours)**

Introduction to Verilog: Introduction to HDL, importance of HDL, popularity of Verilog HDL, design flow, structure of HDL module, Verilog modules (design and stimulus), introduction to language elements - keywords, identifiers, white space, comments, format, integers, real and strings, logic values, data types, scalars and vector nets, parameters, system tasks, compiler directives

Gate level modelling: Introduction, built in primitive gates, buffers, multiple input gates, gate delays.

Data flow modelling: Continuous assignment, net declaration assignments, net delays, operator types and operators precedence

Behavioral modelling: Always and initial constructs, procedural assignment (blocking and non-blocking statements), If-else, case statements, loop structures (while, for, repeat and forever), sequential and parallel Blocks

Modelling of combinational and sequential digital circuits using different levels of abstraction

Hierarchical modelling concepts: Design methodologies, design a 4-bit adder using four 1-bit full adders

Unit – II **(10 Hours)**

Look up Tables: 2-input, 3-input and 4-input LUTs, Implement logic functions with LUT, advantages and disadvantages of lookup tables

Programmable Logic Devices: Difference between PAL and PLA, Realize simple logic functions using PAL and PLA, CPLD and FPGA architectures, types of FPGA, logic cell structure, programmable interconnects, logic blocks and I/O Ports, placement and routing, applications of FPGAs

References:

Essential Readings:

1) Verilog HDL. Pearson Education, S. Palnitkar, 2nd edition, 2003
2) FPGA Based System Design. W. Wolf, Pearson Education
3) Digital Signal processing, S. K. Mitra, 1998, McGraw Hill
4) VLSI design, D. P. Das, 2nd edition, 2015, Oxford University Press.
5) Digital Signal Processing with FPGAs, U. Meyer Baese, Springer, 2004

Additional Readings:

1) Fundamentals of Digital Logic with Verilog Design, S. B. Zvonko Vranesic, 2016, McGraw Hill

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

- Session on how to write the design module and test benches using required software and simulate the combinational and sequential circuits.
- Sessions on how to configure FPGA using Verilog HDL for the final implementation of the logic design.

At least six experiments to be performed from the following list

1) Half adder, Full Adder using basic and derived gates.
2) Half subtractor and Full Subtractor using basic and derived gates.
3) Design and simulate 4-bit Adder using Data Flow Modeling.
4) Multiplexer (4x1) and Demultiplexer(1X4) using Data Flow Modeling.
5) Decoder and Encoder using case structure/gates.
6) Clocked D, JK and T Flip flops (with Reset inputs)
7) 4-bit Synchronous up/downCounter
8) To design and study switching circuits (LED blink shift)
9) To interface LCD using FPGA
10) To interface a multiplexed seven segment display.
11) To interface a stepper motor and DC motor.

References for laboratory work:

1) Digital System Designs and Practices: Using Verilog HDL and FPGAs, Ming-Bo Lin, Wiley India Pvt Ltd.

2) Verilog Digital System Design, Z. Navabi, 2nd edition, TMH
3) Designing Digital Computer Systems with Verilog, D. J. Laja and S. Sapatnekar, 2015, Cambridge University Press
4) Verilog HDL primer, J. Bhasker. BSP, 2nd edition, 2003

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 15: PHOTONIC DEVICES AND POWER ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Photonic Devices and Power Electronics Physics DSE 15	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	Analog electronics

LEARNING OBJECTIVES

This paper aims to provide students with in-depth understanding of the principles, concepts, and applications of photonic devices and power electronics. The course covers a range of topics, including, semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications. Students will develop the necessary knowledge and skills to design and analyse various photonic and power electronic devices and systems. The course also emphasizes the practical aspects of device design, fabrication, and characterization, preparing students for real-world challenges and opportunities in these fields.

LEARNING OUTCOMES

Upon completion of the course on Photonic Devices and Power Electronics, students are expected to achieve the following learning outcomes.

- Understand the basic principles and concepts of photonic devices and power electronics, including semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications.
- Develop the necessary knowledge and skills to design and analyse various photonic and power electronic devices and systems.
- Gain practical experience in device design, fabrication, and characterization.
- Apply the knowledge and skills learned in the course to real-world challenges and opportunities in the fields of photonics and power electronics.
- Develop problem-solving skills, critical thinking skills, and the ability to apply scientific and engineering principles to practical problems.
- Understand the ethical considerations and professional responsibilities associated with the development and use of photonic and power electronic devices and systems.
- Overall, students will gain a comprehensive understanding of photonic devices and power electronics and be well-equipped to pursue careers in these fields or continue their studies at the graduate level.

SYLLABUS OF PHYSICS DSE 15

THEORY COMPONENT

Unit – I **(4 Hours)**

Classification of photonic devices: Radiative transition and optical absorption. Light Emitting Diodes (Construction, materials and operation)

Semiconductor LASER: Condition for amplification, laser cavity, LASER diode.

Unit – II **(8 Hours)**
Photodetectors: Photoconductor, photodiodes (p-i-n, avalanche) and photo transistors, quantum efficiency and responsivity
Solar Cell: Construction, working and characteristics.
LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Unit – III **(4 Hours)**
Introduction to Fiber Optics: Element of an Optical Fiber Transmission link- Optical Fiber Modes and Configurations, Overview of Modes -Single Mode Fibers-Graded Index fiber structure.

Unit – IV **(8 Hours)**
Power Devices: Need for semiconductor power devices, Power MOSFET (qualitative); introduction to family of thyristors; Silicon Controlled Rectifier (SCR) - structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits; DIAC and TRIAC- Basic structure, working and V-I characteristics
Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA)

Unit – V **(6 Hours)**
Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, dc link invertors, Parallel capacitor commutated invertors.

References:
Essential Readings:
1) Optoelectronics, J. Wilson and J. F. B. Hawkes, 1996, Prentice Hall India
2) Optoelectronics and Photonics, S. O. Kasap, 2009, Pearson Education
3) Electronic Devices and Circuits, D. A. Bell, 2015, Oxford University Press
4) Introduction to fibre optics, A. K. Ghatak and K. Thyagarajan, 1998, Cambridge University Press
5) Power Electronics, M. D. Singh and K. B. Khanchandani, Tata McGraw Hill.

Additional Readings:
1) Power Electronics, J. S. Chitode, Technical Publications
2) Basic Electrical and Electronics Engineering, R. Saravanakumar V. Jegathesan and K. V. Kumar, Wiley
3) Power Electronics: Essentials & Applications, L. Umanand, Wiley

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)
At least six experiments to be performed from the following list

1) Diffraction experiments using a LASER.
2) To determine characteristics of (a) LEDs, (b) Photovoltaic cell and (c) Photodiode.
3) To study the Characteristics of LDR and Photodiode with (i) Variable Illumination

intensity, and (ii) Linear Displacement of source.
4) To measure the numerical aperture of an optical fiber.
5) Output and transfer characteristics of a power MOSFET.
6) Study of I-V characteristics of SCR.
7) SCR as a half wave and full wave rectifier with R and R - L loads.
8) AC voltage controller using TRIAC with UJT triggering.
9) Study of I-V characteristics of DIAC.
10) Study of I-V characteristics of TRIAC

References for laboratory work:
1) Power Electronics, P. C. Sen, Tata McGraw Hill.
2) Power Electronics Circuits, Devices & Applications, 3rd edition, M. H. Rashid, Pearson Education
3) A Textbook of Electrical Technology, Vol-II, B. L. Thareja and A. K. Thareja, S. Chand.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 16: ANTENNA THEORY AND WIRELESS NETWORK

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Antenna Theory and Wireless Network Physics DSE 16	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital and analog electronics and communication systems

LEARNING OBJECTIVES
This course gives an overview of wireless communication elements and networks. Students will develop an understanding of basics of antenna, its various parameters, its usage as a transmitter and receiver. Cellular concept and system design fundamentals are described and the evolution of current wireless systems in real world such as 2G, 3G, 4G and LTE networks is discussed.

LEARNING OUTCOMES
At the end of this course, students will be able to achieve the following learning outcomes.
- Identify basic antenna parameter (radiating wire structures).
- Determine directions of maximum signal radiations and the nulls in the radiation patterns.
- Design array antenna systems from specifications.
- Identify the characteristics of radio-wave propagation.
- Identify wireless networks 4G and LTE, and 5G.
- Design cellular systems

SYLLABUS OF PHYSICS DSE 16

THEORY COMPONENT

Unit – I **(14 Hours)**
ANTENNA THEORY
Introduction: Antenna as an element of wireless communication system, antenna radiation mechanism, types of antennas, fundamentals of EMFT: Maxwell's equations and their applications to antennas
Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, field and phase patterns), field regions around antenna, radiation parameters (general idea): intensity, beam width, gain, directivity, polarization, bandwidth, efficiency and antenna temperature

Unit – II **(5 Hours)**
Antenna as a transmitter/receiver: Effective height and aperture, power delivered to antenna, input impedance, general idea of radiation from an infinitesimal small current element and radiation from an elementary dipole (Hertzian dipole)

Unit – III **(5 Hours)**

WIRELESS NETWORKS:
Introduction: General idea of cellular and wireless systems, current wireless systems, examples of wireless communication systems, idea about global mobile communication system

Unit – IV **(3 Hours)**
Modern wireless communication systems: General idea 2G,3G and wi-fi, 4G and LTE, and 5G wireless networks, wireless local area networks (WLANs), bluetooth and personal area networks (PANs).

Unit – V **(3 Hours)**
Cellular Concept and System Design Fundamentals: Cellular concept and cellular system fundamentals, cellular systems design considerations (qualitative idea only)

References:
Essential Readings:

1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Electro Magnetic Waves and Radiating Systems, Jordan and Balmain, E. C., 3rd edition, 1968, Reprint (2003), PHI
3) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
4) Wireless communication and Networks, U. Dalal, 2015, Oxford University Press.
5) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4th edition, 1999

Additional Readings:

1) Wireless communications, A. Goldsmith, 2015, Cambridge University Press
2) Modern Wireless Communication, H. S. and M. M. Pearson, 3rd edition, 2005

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Study of simple dipole and folded dipole (l/2) antenna, plot and compare the radiation pattern of both antennas.
2) Study of simple dipole 5 element Yagi-UDA and folded dipole 5 element Yagi Uda antenna, plot and compare the radiation pattern of both antennas
3) Study of loop antenna and slot antennas and plot their radiation patterns
4) Study the radiation pattern of ground plane antenna and observe the difference in radiation pattern with single element rod, detector and reflector rods
5) To study the variation of radiated field with distance from transmitting antenna.
6) To study modulation of sine wave on RF transmitted and observe the demodulated wave on detector receiver
7) Study of the reciprocity theorem for antennas
8) Study the role of matching stub in antenna transmission.
9) To study working of current sensor and measurement of current in various elements of antenna.
10) To study and measure SWR using various types of antennas.
11) To study different parts of a 4G Volte mobile phone and observe constellation diagram

for transmitter and receiver IQ signals
12) To study various types of faults in a 4G volte mobile phone.

References for laboratory work:

1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
3) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4th edition, 1999