Semester - I

Sl. No.	Subject Code	Subject Name/Activities	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1		Student Induction Programme							2 weeks
2	FE	Evolution of Indian Education	FE-I	4	100	40	--	60	4
3	DC (Major) Any one Subject	Physics/ Chemistry/ Mathematics Botany/Zoology	DC-I*	3+1	100	15	25	60	5
			DC-II	3+1	100	15	25	60	5
4	DCM (Minor) Other than Major	Physics/ Chemistry/ Mathematics Botany/Zoology	DCM-I*	3+1	100	15	25	60	5
5	AE & VAC-	Language – 1 (as per the 8th schedule of constitution of India)	AE & VAC-I	4	100	40	---	60	4
6	AE & VAC	Art Education (Performing and Visual)	AE & VAC-II	2	50	20	--	3 0	2
7	AE & VAC	Understanding India (Indian Ethos and Knowledge Systems)- I	AE&VAC -III	2	50	20	--	30	2
Total				**24**	**600**	**165**	**75**	**360**	**27**

*** The Practical of Subject Mathematics is Internal**

Semester – I
PHYSICS
DC- I: Mathematical Physics – I

Credits: 4 (3+1)
Contact Hours: 5 hrs Per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to

- Demonstrate a comprehensive understanding of single-variable calculus concepts
- Apply calculus concepts to multivariable functions
- Analyze and solve problems using multivariable calculus
- Analyze vibrations and harmonic motion
- Integrate theoretical knowledge with practical applications
- Utilize technology in calculus applications, in solving ODEs and Fourier series analysis
- Reflect on the broader significance of calculus and ODEs
- Understand the fundamentals of first-order ODEs and second-order linear ODEs
- Apply first-order ODEs in physics
- Understand the fundamentals of special functions
- Understand the Fourier transform and its properties
- Comprehend Fourier series representation
- Explore applications in physics
- Connect mathematical concepts to real-world scenarios

Unit 1: Fundamentals of Calculus (12 hours)
Review of single-variable calculus concepts (limits, derivatives, integrals), Multivariable calculus: partial derivatives, maxima and minima values, the total differential, multiple, integrals, gradients, divergence, curl, applications of calculus in physics.

Unit 2: Ordinary Differential Equations (ODEs) of First Order (12 hours)
Introduction to first-order ODEs, existence and uniqueness of solution, separable ODEs, exact ODEs, linear ODEs, applications of first-order ODEs in physics.

Unit 3: Ordinary Differential Equations of Second Order (12 hours)
Second-order linear ODEs with constant and variable coefficients, Homogeneous and non-homogeneous equations, singular points, solutions by characteristic equations, analytical solution, Applications in physics (e.g., simple harmonic motion, pendulum, spring-mass systems).

Unit 4: Special Functions and Fourier Series (12 hours)
Introduction to special functions, Bessel functions: Bessel differential equations, Frobenius series solution, generating function, recurrence relation, Rodriques representation, orthogonality, Legendre functions: Legendre differential equations, power series solution, generating function, recurrence relation, Rodriques representation, orthogonality, Applications of Fourier series in physics.

Unit 5: Fourier and Laplace Transforms (12 hours)
Introduction to Fourier series, Integral transforms, Development of Fourier Integral, Fourier transform-inverse theorem. Fourier transform of derivative, convolution theorem, transform and its properties. Laplace transform of elementary functions, basic theorem of Laplace transform, Inverse Laplace transform, its properties, convolution theorem. Introduction to Laplace transform. Applications of Fourier and Laplace transforms in physics (e.g., wave equations, heat conduction).

Suggested Readings:
H.K. Dass, Dr. Rama Verma, Mathematical Physics, S. Chand
Sadri Hassini, Mathematical Physics, Springer
Michael Stone and Paul Goldbart, Mathematics for Physics, Cambridge
Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.

Practicals
DC- I: Mathematical Physics – I

Credit: 01
Contact Hours: 2 hrs Per week
Max. Marks: 25
External: 25

Make simple projects by choosing from the topics given below
1. Application of calculus in Physics
2. Application of Ordinary Differential Equations in Physics
3. Application of Special Functions and Fourier Series in Physics
4. Application of Fourier and Laplace Transforms in Physics
5. Study of damp oscillator.
6. Study of coupled oscillator.
7. Mathematical modeling of compound pendulum.
8. Mathematical modeling of discharge of liquid through an orifice (solving problem using Laplace transform).
9. Fourier analysis of square wave.
10. Numerical evaluation of Fourier coefficients.

DC- II: Mechanics

Credits: 4 (3+1)
Contact Hours: 5 hrs Per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60
Learning Outcomes: This course will enable the students to

1. To solve problems on applications of Newton's laws of motion and finding the solution of a single particle under central force and system of particles
2. Solve problems of rigid and deformable bodies under gravitational, tensile and compressible force.
3. To understand Newtons's law of Gravitation and Kepler's law of planetary motion and generalise it to satellites.
4. To understand the principles of elasticity, basic equations of elasticity and solve two dimensional problems in Cartesian and polar coordinates
5. To understand the phenomena of relativity

Unit 1: Kinematics
Laws of Motion: Frames of reference, Newton's Laws of motion, free body diagram, vertical motion, Dynamics of a system of particles, Centre of Mass and laboratory coordinates.
Momentum and Energy: Conservation of linear and angular momentum, conservation of energy, motion of rockets, elastic and inelastic collisions (2d).

Unit 2: Rigid Bodies and Oscillations

Rigid body motion: Rotational Motion, moment of inertia, calculation of MI of some regular bodies (rod, lamina, disc and sphere)

Oscillations: Coupled oscillator (normalised coordinates, normalised energy and modes of vibrations), Total Energy and their time averages.

Unit 3: Gravitation

Motion in a uniform field, components of velocity and acceleration in different coordinate system (cartesian and polar only), Pseudo forces, Coriolis force and its applications, Foucault pendulum, Newton's Law of Gravitation, Motion of a particle in a central force field, Gravitational Potential, Kepler's Laws, Geosynchronous and polar orbits, Basic idea of global positioning system (GPS)

Unit 4: Elasticity

Small deformations**,** Hooke's law, elastic constants for an isotropic solid, Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searle's method

Unit 5: Special Theory of Relativity

Inertial frames, Galilean invariance and conservation laws, Michelson's Morley experiment, Postulates of Special Theory of Relativity, Lorentz transformations, Length contraction, Time dilation, Relativistic addition of velocities, four vector, mass energy equivalence, particle with zero rest mass, invariance of laws of physics

Suggested Readings:

1. Robert Resnick, Introduction to Special Relativity, John Wiley and sons Pvt. Ltd.
2. Morin, David, Introduction to Classical Mechanics: With Problems and Solutions. Cambridge University Press.
3. Taylor, John, Classical Mechanics. University Science Books.
4. Hand, Louis; Finch, Janet, Analytical Mechanics. Cambridge University Press

Practicals

DC- II: Mechanics

Credit: 01
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine **g** and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

MATHEMATICS

DC– I: Algebra and Trigonometry

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25
Learning Outcomes: This course will enable the students to:

- employ De Moivre's theorem in a number of applications to solve numerical problems.
- recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- find eigenvalues and corresponding eigenvectors for a square matrix.
- solve problems in the subject of algebra and Trigonometry.

Unit-I

- Matrices- symmetric, skew symmetric, Hermitian and skew Hermitian matrices.
- Elementary operations on matrices, Inverse of a matrix. Linear independence of row and column matrices,
- Row space of a matrix,coloum space of a matrix, rank of a matrix , Equivalence of column and row ranks.

Unit-II

- Eigenvalues, eigenvectors and the characteristics equation of a matrix.
- Cayley Hamilton theorem and its use in finding inverse of a matrix.
- Applications of matrices to a system of linear (both homogeneous and non-homogeneous) equations.
- Theorems on consistency of a system of linear equations.

Unit-III

- Relations between the roots and coefficients of general polynomial equation in one unknown, Transformation of equations, Descart's rule of signs.
- Solution of cubic equations (Cardon method)
- Biquadratic equations.

Unit-IV

- De-Moivre's theorem and its applications.
- Direct, Inverse, Circular and Hyperbolic functions.

Unit-V

- Logarithm of a complex quantity
- Expansion of trigonometrical functions
- Gregory's series, summation of series

Suggested Readings:

- S.L. Loney, Plane Trigonometry Part II, Mc Millan & Co.
- Dickson, Leonard Eugene (1922). *First Course in The Theory of Equations*. John Wiley & Sons, Inc. New York. The Project Gutenberg E-Book.
- Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

Practical

DC – I: Algebra and Trigonometry

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DC – II: Calculus

Credits: 4 (3+1)

Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25
Learning Outcomes: This course will enable the students to:

- sketch curves in a plane using its mathematical properties in the different coordinatesystems of reference.
- apply derivatives in Optimization, Social sciences, Physics and Life sciences etc.
- compute area of surfaces of revolution and the volume of solids by integrating overcross-sectional areas.

Unit-I

- Epsilon – Delta definition of the limit of a function. Basic properties of limits.
- Continuous functions and classification of discontinuities. Differentiability.

Unit-II

- Successive differentiation.
- Leibnitz's theorem.
- Maclaurin and Taylor series expansions.

Unit-III

- Asymptotes. Curvature. Tests for concavity and convexity. Points of inflexion, Multiple points.
- Integration of irrational algebraic functions, Hyperbolic functions and transcendental functions, Reduction formulae. Definite integrals.

Unit-IV

- Parametric representation of curves and tracing of parametric curves
- Polar coordinates and tracing of curves in polar coordinates
- Techniques of sketching conics,Reflection properties of conics, Rotation of axes and second-degree equation.

Unit-V

- Quadrature, Rectification.
- Volumes and surfaces of solids of revolution: Volumes by slicing disks and method of Washers, Volumes by cylindrical shells, Arc length, Arc length of parametric curves, Area of surface of revolution.

Suggested Readings:

- Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley& Sons Singapore Pte. Ltd. Indian Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
- Osborne, George. A. (1906). *Differential and Integral Calculus with Examples andApplications*. Revised Edition. D. C. Health & Co. Publishers. Boston, U.S.A.
- Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.).Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.
- Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas*' *Calculus* (13thed.). Pearson Education, Delhi. Indian Reprint 2017.

Practical
DC – II: Calculus

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

CHEMISTRY
DC- I: Inorganic Chemistry-I

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to:

1. realize the wave particle duality of microscopic particles like electron.
2. understand the significance of wave function ψ and ψ^2.
3. analyze the variation of certain physical parameter like atomic radius, ionization energy, electronegativity, etc. along a period and a group in a periodic table.
4. understand the quantum mechanical approach of chemical bonding.
5. appreciate the significance and importance of some weak chemical forces like hydrogen bonding, van der Waals interactions, etc.
6. learn the technique of simple acid base titration and redox titration.

Unit-I: Atomic Structure

- Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.
- Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions.
- Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals.
- Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations.

Unit-II: Periodicity of Elements

- Brief discussion of the following properties of the elements, with reference to s & p-block and the trends shown:
- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
- Atomic and ionic radii
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
- Electron gain enthalpy and trends in groups and periods.
- Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Unit-III: Chemical Bonding

- Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
- Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Pauling-Slater approach, hybridization, wave mechanics of hybidization, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, ICl_2^- ICl_4^- and SO_4^{2-}.

Unit-IV: Multiple bonding (ζ and π bond approach) and bond lengths

- Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.
- Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.
- **Metallic Bond:** Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Unit-V: Weak Chemical Forces

Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.

Suggested Readinngs:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010

- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Practicals

DC- I: Inorganic Chemistry- I (Lab Work)

Credit: 01
Total: 25
External: 25

(A) Titrimetric Analysis

(i) Calibration and use of apparatus
(ii) Preparation of solutions of titrants of different Molarity/Normality

(B) Acid-Base Titrations: Principles of acid-base titrations to be discussed

(i) Estimation of sodium carbonate using standardized HCl.
(ii) Estimation of carbonate and hydroxide present together in a mixture.
(iii) Estimation of carbonate and bicarbonate present together in a mixture.
(iv) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry: Principles of oxidation-reduction titrations (electrode potentials) to be discussed

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator.

Suggested Reading:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

DC-II: Physical Chemistry- I

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to:

1. know the importance of mathematical background to understand the complicated concepts of Chemistry.
2. understand the reason behind the deviation of gases from ideality and details of real gas equation.
3. understand surface tension as a major cause of condensed liquid phase.
4. know the x-ray diffraction method applicable to determine the details structure of ionic compounds like sodium chloride cesium chloride, potassium chloride, etc.
5. understand ionic equilibria involved in salt hydrolysis and in the determination of solubility and solubility product.
6. know the technique of surface tension, viscosity and pH determination using conventional apparatus.

Unit-I: Mathematics for Chemists

Logarithmic relations, curve sketching, linear graphs and calculations of slopes, differentiation of functions like $k, e^x, x^n, \sin x, \log x$; maxima and minima, partial differentiation and reciprocity relations. Integration of some useful/relevant functions; permutations and combinations. Factorial. Probability.

Unit-II: Gaseous state

- Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.
- Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases

and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit-III: Liquid state

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases, liquid crystals (classification and structure).

Unit-IV: Solid state

- Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen
- Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Unit-V: Ionic equilibria

- Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.
- Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid– base indicators; selection of indicators and their limitations.

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

Practicals

DC- II: Physical Chemistry – I (Lab Work)

Credit – 01

Total: 25

External: 25

1. Surface tension measurements using stalagmometer

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension with different concentration of detergent solutions.

Determination of CMC.

2. Viscosity measurement using Ostwald's viscometer

a. Determination of co-efficient of viscosity of an unknown aqueous solution.

b. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl

Alcohol (PVA) and determine molar of PVA.

b. Study the variation of viscosity with different concentration of sugar solutions.

3. Solid State:

a. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pH metry:

a. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH values

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.

Determination of dissociation constant of a weak acid.

Any other experiment carried out in the class.

Suggested Readings:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

BOTANY

DC- I: Biodiversity of Microbes, Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To gain understanding of classification, structural and functional organization of viruses, bacteria, Algae, Bryophytes, Fungi, Pteridophytes and Gymnosperms.

Unit 1: Microbes: Virus, Bacteria and Algae

Viruses – Discovery, general structure, Classification; RNA virus (TMV); DNA virus (Bacteriophages); Multiplication-Lytic and lysogenic cycle; Economic importance.

Bacteria – Discovery, General characteristics and cell structure, nutrition; Reproduction – vegetative, asexual and recombination-conjugation, transformation and transduction; Economic importance.

General characteristics of Mycoplasma and their pathological characteristics

General characteristics, structure, reproduction and significance of Cyanobacteria

Algae - General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification; Morphology and life-cycles: Volvox, Chlamydomonas, Oedogonium, Vaucheria, Ectocarpus, Fucus, Polysiphonia. Economic importance.

Unit 2: Fungi

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; General characteristics, ecology and significance and life cycle of Rhizopus (Zygomycota), Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota);

Symbiotic Associations-Lichens: General account, reproduction and significance.

Symbiotic Associations-Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 3: Bryophytes

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification, morphology, anatomy and reproduction of Marchantia, Anthoceros and Funaria, Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 4: Pteridophytes

General characteristics, classification, Early land plants (Cooksonia and Rhynia), Fossil and its types. Classification, morphology, anatomy and reproduction of Lycopodium, Selaginella, Equisetum and Pteris. Heterospory and seed habit, stelar evolution. Telome theory, Ecological and economic importance of Pteridophytes.

Unit 5: Gymnosperms

General characteristics, classification. Classification, morphology, anatomy and reproduction of Cycas, Pinus and Ephedra. Ecological and economic importance.

Practicals
DC- I:
Biodiversity of Microbes, Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 60

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus* and Polysiphonia through temporary preparations and permanent slides. (* Fucus - Specimen and permanent slides)
5. Rhizopus and Penicillium: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. Alternaria: Specimens/photographs and tease mounts.
7. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. Agaricus: Specimens of button stage and full-grown mushroom; Sectioning of gills of Agaricus.

9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs)
11. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemmacup,w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. Lycopodium, Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s rhizome (permanent slide).
15. Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. Cycas- morphology (coralloid roots, bulbil, and leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. 12microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Suggested Readings

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
7. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
8. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

DC- II: Biochemistry and Cell Biology

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To enable the students to have an understanding about structural, chemical and functional properties of biomolecules and cellular components and their role in cell division.

Unit 1: Biomolecules

Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Handerson equation

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacylglycerol, Phosphoglycerides, structure, functions and properties; Oxidation of fatty acids and biosynthesis of fatty acids.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

Nucleic acids DNA and RNA: Structure of nitrogenous bases; Structure and function of nucleosides and nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure and function of t-RNA.

Unit 2: Bioenergetics and Enzymes

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.

ATP: structure, its role as an energy currency molecule.

Structure of enzyme: Holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit 3: Cell wall and plasma membrane

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Chemistry, structure and function of plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 4: Cell organelles

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semi-autonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes.

Unit 5: Cell division

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Practicals

DC- II: Biochemistry and Cell Biology

Credit: 1

Contact Hours: 2 hours per week

Max. Marks: 25

External: 25

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of Haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

Suggested Readings

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Berg JM, Tymoczko JL and Stryer L (2011). Biochemistry, W.H. Freeman and Company
3. Campbell, MK (2012). Biochemistry, 7th ed., Published by Cengage Learning
4. Campbell, PN and Smith AD (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
7. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
8. Nelson DL and Cox MM (2008). Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
9. Tymoczko JL, Berg JM and Stryer L (2012). Biochemistry: A short course, 2nd ed., W.H. Freeman

ZOOLOGY

DC- I: NON-CHORDATES- I: PROTISTS TO PSEUDOCOELOMATES

Credits: 4(3 + 1)

Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)

Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
Unit 1: Protista, Parazoa and Metazoa
General characteristics and Classification up to classes
Study of *Paramecium*
Life cycle and pathogenicity of *Plasmodium vivax*
Evolution of symmetry and segmentation inMetazoa
Unit 2: Porifera
General characteristics and Classification up to classes
Canal systemin sponges
Spicules in Porifera
Unit 3: Cnidaria
General characteristics and Classification up to classes
Metagenesis in *Obelia*
Polymorphism in Cnidaria
Corals and coral reefs
Unit 4: Ctenophora and Platyhelminthes
General characteristics and Evolutionary significance
Platyhelminthes: General characteristics and Classification up to classes
Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*
Unit 5: Nemathelminthes
General characteristics and Classification up to classes
Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereriabancrofti*
Parasitic adaptations in helminthes

PRACTICALS
DC- I: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25
1. Study of whole mount of *Euglena, Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla*
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium,* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Suggested Readings:

- Barnes, R.D. (1982). Invertebrate Zoology, V Edition. Holt Saunders International Edition.
- 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 Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home

DC- II
NON-CHORDATES II: COELOMATES

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)

Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Introduction to Coelomates
Evolution of coelom and metamerism
Unit 2: Annelida
General characteristics and Classification up to classes
Excretion in Annelida
Unit 3: Arthropoda and Onychophora
General characteristics and Classification up to classes
Metamorphosis in Insects
Social life in bees and termites
Onychophora: General characteristics and Evolutionary significance
Unit 4: Mollusca
General characteristics and Classification up to classes
Respiration in Mollusca
Torsion and detorsion in Gastropoda
Evolutionary significance of trochophore larva
Unit 5: Echinodermata
General characteristics and Classification up to classes
Water-vascular system in Asteroidea
Larval forms in Echinodermata

PRACTICALS
DC- II: NON-CHORDATES II: COELOMATES

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of following specimens:
- Annelids - Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria
- Arthropods - Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees
- Onychophora - Peripatus
- Molluscs - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus
- Echinodermates- Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon

2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Suggested Readings:

- Barnes, R.D. (1982). Invertebrate Zoology, V Edition. Holt Saunders International
- Edition
- 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
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home

EDUCATION PART
FE- I: Evolution of Indian Education

Credits: 4
Contact Hours: 4 hrs. Per week

Maximum Marks: 100
Internal: 40
External: 60
About the Course
The course seeks to develop an understanding among student teachers of the evolution of education in India that would allow student teachers to locate themselves within the larger system of education. The course aims at orienting student teachers to the historical perspective of Indian education including the development and features of education in ancient India such as the Gurukuls, post-Vedic period, during Mauryan and Gupta empires, during colonial era and post-independence period, and future perspectives about education development in India, and progression from Education 1.0 to Education 4.0 etc. This course also provides an overview of the contribution of Indian thinkers to evolve Indian Education system – Savitribai and Jyotiba Phule, Rabindranath Tagore, Swami Vivekananda, Mahatma Gandhi, Sri Aurobindo, Gijubhai Badheka, Pt. Madanmohan Malaviya, Jiddu Krishnamurti, Dr. Bhima Rao Ambedkar and others.

Learning Outcomes
After completion of this course, student teachers will be able to:
discuss genesis, vision, and evolution of education in ancient India to the contemporary India,
enable themselves to shape their educational perspective to act as an effective teacher.

UNIT – I: **Ancient Indian Education: Vedic Period**
- Understanding India of Ancient Times: Economic activities, cultural practices and social system
- Social Foundation of education during Vedic period
- Origin and development of formal education during the period
- Famous Educational institutions and Guru-Shishya Parampara
- Vedic education system: Critical understanding of aims, knowledge and educational practices and agencies.
- Relevance of Vedic educational practices to contemporary times

UNIT – II: **Ancient Indian Education: Buddhist and Jain Period**
- Social development during Buddhist Period: Economic activities, development of commerce, cultural practices and social system
- Social Foundation of education during Buddhist period
- Origin and development of formal education during the period
- Educational Institutions: Nalanda, Taxila, Vikramshila, Vallabhi, Nadia.
- Buddhist education system: Critical understanding of aims, knowledge and educational practices and agencies.
- Relevance of Buddhist educational practices to contemporary times
- Comparative study of Vedic and Buddhist education system

UNIT – III: Education during Medieval Period
- Understanding India of Middle Ages: Economic activities, cultural practices, social system and political formation.
- Social Foundation of education
- Origin and development of Islamic education during this period
- Teaching and Learning Process.

UNIT – IV: Education during Colonial Period: British Education
- Understanding Colonial India: Economic activities, cultural practices, social system and political formation.
- The Orientalist and Anglicist Conflict
- Colonial Education in India through 1813 Act, 1835 Macaulay Minutes, 1854 Woods Dispatch act, 1882 Hunter Commission, 1943-44 Sargent Report
- Understanding Westernization of Indian Education
- British education system: Critical understanding of aims, knowledge and educational practices and agencies.

UNIT- V: Indigenous efforts in Education: Pre-Independence
- Swadeshi and Nationalist attempts of educational reforms with special reference to general contribution of Indian thinkers:
- Dada Bai Naoroji
- Pt. Madan Mohan Malviya
- Sir Syed Ahamad Khan
- Savitribai and Jyotiba Phule
- Gopal Krishna Gokule
- B R Ambedkar

UNIT- VI: Education in Independent India
- Overview of Constitutional values and educational provisions.
- Evoluation of Education as a fundamental right in India: RTE act 2009.

- Overview of University Education Commission-1948, Secondary Education Commission-1952, Education Commission-1964
- Oerview of educationa commission: 1968 and 1986,
- NEP 2020: vision and implementation for a vibrant India.
- Samagra Shiksha Abhiyan

Suggestive Practicum

- Prepare a report highlighting educational reforms with special reference to school education in the light of NEP 2020.
- Critically analyze the concept of good citizen from the perspective of education for democratic citizenship.
- Compare vision, objectives, and salient features of education during different periods.
- Working out a plan to develop awareness, attitude and practices related to Fundamental Rights or fundamental duties or democratic citizenship qualities, execute it in the class and write the details in form of a report.
- Sharing of student experiences (in groups) related to Indian constitutional values, help them to reshape their concept and enable them to develop vision, mission and objectives for a school and their plan to accomplish the objectives in form of a group report.
- Analyses of current educational strengths and weaknesses of one's own locality and work out a critical report.
- Visit to places of educational significance and value centers and develop a project report.
- Observation of unity and diversity in a social locality and matching it with unity and diversity in the class and work out a plan for awareness for national-emotional integration for class to develop awareness, attitudes, skills, and participatory values, execute it in the class and report the details.

Suggestive Mode of Transactions

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

- Altekar, A.S. (1965). Education in ancient India. Varanasi: Nand
- Apple, M. W. (2008). Can schooling contribute to a more just society? Education, Citizenship and Social Justice, 3(3), 239–261.
- Arnold,D.(1993). Colonizing the body:State medicine and epidemic disease in nineteenth century India. Berkley: University of California Press.
- Balagopalan, S. (2003)Understanding educational innovation in India: the case of Ekalavya.Education Dialogue 1(1): 97-121.
- Chandra, B. (2004) Gandhiji, Secularism and Communalism.Social Scientist, Vol. 32, No. 1/2pp. 3-29
- Dharampal.(1993). The beautiful tree: Indigenous Indian education in eighteenth central. New Delhi: Bibliography implex
- Dube, S.C. (1990, 2005) Indian Society. New Delhi: National Book Trust
- Ghosh, S.C.(2009) . The history of education in modern India, 1757-2007 . New Delhi: Orient Blackswan
- GOI. (1966). Report of the education commission: Education and national development. New Delhi: Ministry of Education.
- GOI. (1986). National policy of education. GOI. GOI. (1992, 1998). National policy on education, 1986 (modified in 1992). Retrieved from http://mhrd.gov.in/sites/upload_files/mhrd/files/NPE86-mod92.pdf
- GOI. (2009). The right of children to free and compulsory education act, 2009. Retrieved from http://mhrd.gov.in/sites/upload_files/mhrd/files/rte.pdf
- Govinda, R. (ed). (2002)India education report: a profile of basic education. New Delhi: Oxford University Press.
- Ghosh, S. C. (2007). History of education in India. Rawat Publications.
- Hindustani Talimi Sangh. (1938). Basic national education: Report of the Zakir Hussain committee. Sagaon, Wardha: Hindustani Talimi Sangh.
- Letter to a teacher: By the school of Barbiana. (1970). Retrieved from http://www.arvindguptatoys.com/arvindgupta/letter.pdf
- Naik, J.P. (1979) Education Commission and After. A P H Publishing Corporation: New Delhi. Also available in Hindi

- Kothari, D. S. (1964). Education and national development: Report of the education commission, 1964-66. Available at www.mhrd.gov.in/
- National policy on Education (1986). Available at www.ncert.ac.in
- Acharya Ramamurthy Report (Programme of Action) (1990). Available at www.ncert.ac.in
- PROBE (1998) and PROBE 92011) Revisited available on www.academia.edu
- NCF-2005 available on www.ncert.ac.in 6. NCFTE: http://www.ncte-india.org/publicnotice/NCFTE_2010.pdf 7. Sachar Committee Report available at http://ncm.nic.in/pdf/compilation.pdf
- Savitribai Phule (2023). Reeta Ramamurthy Gupta, Harper Collins Publishers India.

AE&VAC- I: Language- I (As per the 8th Schedule of the Constitution of India)

Credits: 4
Contact Hours: 4 hrs. Per week
Maximum marks: 100
External: 60
Internal: 40

About the Course

Language has undeniable links with all kinds of learning. Language enables an individual to understand new concepts, exchange ideas and communicate thoughts with fellow beings. To appreciate fully the role of language in education, one must begin to develop a holistic perspective on language. Language needs to be examined in a multi-dimensional space, giving due importance to its structural, literary, sociological, cultural, psychological, and aesthetic aspects. The National Education Policy 2020 envisages imparting language skills as part of holistic education. It lays thrust on the need to enhance linguistic skills for better cognitive development and the development of a rounded personality of the learners. This course aims at enabling student teachers to enhance their ability to listen, speak, read, write and demonstrate linguistic skills in an effective manner. Linguistic skills - listening, speaking, reading, writing, speaking, effectively - are fundamental to constructing knowledge in all academic disciplines, and. participating effectively in the world of work and creating sense in the everyday life. Through this course, the students will be able to enhance proficiency in reading with comprehension, understanding, thinking, and conceptualizing. The course seeks to enhance critical thinking abilities and effective communication skills of student teachers. The course involves hands-on activities and practical sessions that help student teachers develop and use linguistic skills in a variety of situations.

Learning Outcomes

After completing the course, the student teachers will be able to:

- Demonstrate knowledge and capacity for effective listening, speaking, reading, writing and critical thinking.
- Recognize the link between language and cognition and using linguistic knowledge and skills for effective communication of ideas and thoughts.
- Build inter-personal relationships and enhance social skills.
- Develop the connection between Regional/Native language(L1) and Foreign Language(L2)
- Development of Vocabulary in respect to L1.

UNIT - I: Understanding Language, Communication and Cognition

- Language, communication, and cognition; Definitions and functions of language. Types of communication, Language, culture and society, Bi-/Multilingualism in India, Language learning, translation, formal and informal communication, verbal and non-verbal communication, gestures language skills (listening, speaking, reading, & writing) and the new-age technologies. Language as a means of communication and language as a medium of cognition.
- Nature and process of communication: principles, Definition, and types; Language: Definition, characteristics, functions; Language and society: language variation, language and dialect, language policy and language planning, language standardization; Multilingualism in Indian context, Language as a means of communication and language as a medium of cognition.
- The process of communication, barriers to communication, written and oral communication, the story of human communication from early times to new age; Language variation, Multilingualism.
- Context of communication, the role of decoder, face to face interaction, turn taking, conversation, politeness principles, opening and closing, regional variation, social variation, the standard language.

UNIT – II: Understanding Grammar& Phonetics

- Classification of speech sounds and letters, stress, pitch, tone, intonation and juncture, parts of speech, identification of morphemes, word formation processes, sentences- simple, complex, and compound, semantics and pragmatics, lexical semantics, speech acts.
- Production of speech sounds in languages; Suprasegmentals: stress, pitch, tone, intonation; Word formation

processes; Sentence formation, semantics, and pragmatics.

- Identification of morphemes, word formation processes; Sentence formation, vocabulary formation; Pragmatics and speech acts.
- Sound production in the language; Coining new words, Speech acts.
- Components of Grammar: parts of speech, its use, activities pertaining to the grammar of language in Indian Context.

UNIT – III: Reading Skills

- Reading comprehension, types of reading, text, meaning and context, reading as an interactive process; strategies for making students active readers and developing critical reading skills; Understanding denotative and connotative aspects of a text, Vocabulary development through reading.
- Features that make texts complex, reading as an interactive process; Strategies for making students active readers and developing critical reading skills; Understanding denotative and connotative aspects of a text, Vocabulary development through reading.
- Reading discipline-based texts; vocabulary development
- Reading of different types of texts and literature: literary, non-literary, expository, narrative texts; prose, poetry, drama, novel, novella.
- Reading with punctuations: Concept of punctuations, use of puncutations.

UNIT – IV: Writing Skills

- Writing; Types of writing; writing for specific purposes (essays, letters, and reports).
- Language and style of Writing; Dealing with New Words (Academic Vocabulary Building)
- Summarizing and Paraphrasing techniques.
- Academic writing components; development of academic language; Activities to develop answer writing skills.
- Developing Critical, analytical, and interpretive thinking skills.

UNIT – V: Speaking Skills

- Speaking to learn and learning to speak; situational conversations and role plays; tasks/activities for developing speaking (speech, elocution, discussion, debate, storytelling, illustrations).
- Activities for developing speaking, role play; The impact of culture on speaking.
- Presentation and speaking skills; Practicing narrative skills; Body language, voice, and pronunciation; Creating interest and establishing a relationship with the audience.

UNIT – VI: Listening Skills

- Why listening is important; Sub-skills of listening; kinds of listening; Listening strategies.
- Need for modelling good listening behaviour; Listening across the curriculum, note taking.
- Listening Comprehensions and Recorded speeches/texts; Understanding of various accents.

5.1.3 Suggestive Practicum

- How do you interpret every day and reflect what you read? Prepare a report.
- Analyze a recorded video from the perspective of voice and pronunciation and write a report.
- Observing, describing and frame a problem and evaluating it.

Suggestive Mode of Transaction

Teaching this course will involve a mix of interactive lectures, tutorials, and practical involves such as discussion, role plays, projects, simulations, workshops, and language-awareness activities. The teaching intends deeper approaches to learning involving in- class room discussion, developing the critical thinking/ problem solving abilities among the students and will also focus on situations where in our daily lives the one would be performing tasks that involve a natural integration of language skills. The students are expected to read assigned chapters/ articles before the session and the course requires active participation from the students.

Suggestive Mode of Assessment

The assessment of the learner will be primarily based on the assessment of both linguistic and communicative skills using a battery of tests and test types, group work and projects.

Suggestive Reading Materials

- Agrawal, V. (2015). *Sahi Hindi sundar Hindi.* Bhopal. Manjul Publishing House.
- Dabas, J. (2014). *Hindi Bhasha Shikshan.* New Delhi. Doaba House.
- IGNOU BES-145 *Hindi Shikshan Pravidhi (2017).* New Delhi. Gullybaba Publishing House.
- Mahiya, K.R., Sharma, V. (2020). *Hindi Vyakran Mala.* Ajmer. Gyaan Vitaan.
- Manzar, O. (2008). Teaching of Urdu language. New Delhi. Shipra Publications.
- *Prasidh Sahityakaro ki anmol kahaniyaan (2019).* Noida. Maple press.

- Rao, M. (2020). Teach yourself Hindi. New Delhi. Hindi Pocket Books.
- Wlimbe, R. (2014). *Sugam Marathi Vyakran.* Pune. Nitin Prakashan.

AE&VAC- II: Art Education (Performing and Visual) and Creative Expressions
Exemplar 1 - Puppetry

Credits: 2
Contact Hours: 2 hrs. Per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

Engagement with various forms of art as self-expression and need to develop sensibility to appreciate them has been an important concern in educational theory and practice. This concern is premised on the claim that forms of self-expression contribute immensely to the development of cognitive, affective, and psycho-motor dimensions among children, as well as that through one or another art form, children come to explore ways of expressing themselves. Further, it is also the case that critical appreciation of art enables children to form judgments of a very special kind, namely, aesthetic judgment. This enables students as they grow into adults to have focused attention on making sense of and appreciating cultural productions.

Children enjoy artwork a lot. They explore and find meaning in artwork. Their psycho-motor skills get developed through art. The huge element of socialization is acquired through different forms of art. They get to know each other and understand each other and make friends through art. They develop their peer group through getting involved in art forms. Learning to work with others is also achieved through art. It gives them space to think independently, create and reflect. It is one space where all the three are involved- hand, head, and heart.

Therefore, educational practitioners that the students of MA Education aim to be, will need to bring an element of art in practices that they engage in. To be able to do this, they need an appreciation of art in general, familiarity with one art form, and basic skills and capabilities to be creative and artful. Additionally, they should be familiar with some critical debates in art education, even if their work is in other subject areas.

To this end in the first semester students will do one course that aims to help them recognize and appreciate the importance of aesthetic judgment, develop familiarity with an art form and basic skills to be creative and artful in their expressions. Skills develop from practice, therefore hands-on training in doing art will be emphasized in this course. This course aims to help students develop a habit of performing skillful activities that are essentially aesthetic and artful which is expected to contribute to other educational practices that they develop in other courses in the programme. Therefore, this course will explicitly relate this skill to activities that practitioners of education engage in, like teaching, development of teaching-learning material, and content of other subject areas wherever possible.

Puppetry

Puppetry is an integrated art form, which takes into its fold everything from fine arts to performance. Puppetry is one of the oldest forms of performing art. Puppetry has evolved over the years into a sophisticated form of art. The journey was very interesting with a lot of ups and downs. There are thousands of forms of puppetry from simple finger puppets to highly complex puppets played by more than 3 people. Each country has a puppet form, why country, each area in a country has a puppet form. Hence, in India you will find many, many forms of puppetry.

In puppetry there are two main aspects. One the designing and creating of puppets and the other playing or performing puppetry. These two skills are different. Designing will need a lot of thinking, visualization, and technical skills while performance will need high level communication skills. Hence, together they make a consolidated a high range of skills. In this course, students are exposed to different forms of puppets and puppetry. There will be a discussion around the forms and the aesthetic sense of puppetry. Later the students are encouraged to prepare, design and create puppets. They then prepare script and play the puppets. This creation of the puppets together in small groups with a lot of discussions and give and take helps the students develop working together skills and conceptual understanding.

Learning Outcomes

After completion of this course, student teachers will be able to:

- articulate the importance of aesthetics and art in elementary education,
- demonstrate their familiarity with and appreciation of puppetry,
- design puppets,
- practice and create a short puppetry show.

UNIT – I: Importance of Aesthetics and Art education (2 Sessions)

In this unit the basic idea of aesthetics and art, and ways in which the aesthetic dimension manifests itself in human life will be discussed. Using various examples of art, students will engage in identifying aesthetic aspects of daily life, develop aesthetic judgment, and gain familiarity with the role of art in education. Students will also be introduced to three aspects of art in education: The value of art itself and its use as an instrument in education; moral dimensions of works of art and the controversial distinction between the value of Popular art and High art. Introduction of NAVARASA's and RASA theory.

UNIT – II: Designing Puppets (6 Sessions)

In this unit, students will learn about puppetry, its history and specifically about how puppets work. This unit will also discuss the imagination required to design puppets, visualize how puppets will be used and the technicalities of designing puppets. These will be learnt by designing puppets. Students will start with constructing finger puppets and move towards small shapes through papers, like Fish, birds, rat - then they will design masks, flat masks, and masks with dimensions. At the end they will design puppets with old newspaper. The puppets are designed with old newspapers and colour papers. They decorate it and design it in such a way that it can be played, performed. They prepare costumes and all other accessories.

UNIT – III: Performing the puppets (4 Sessions)

This unit will engage in performance of puppetry and the level of communication skills required to create a good engaging story and perform it with the help of puppets they have created. The performance will be expected to relate to some activity in the educational context. Students will perform the puppets they have designed. Initially each member will play their own puppets. Later they will play in pairs, later they will be formed into a small group and asked to prepare their own skits with the puppets. They conclude by performing in small groups. Their learning is consolidated and reflected.

Discussion is held on how different aspects of puppet making can be incorporated in class room processes of young children. Adapting the individual and group exercises done during the puppetry course will be discussed to be used in the classroom situation.

Pedagogy

The Pedagogy is basically hand-on training. More emphasis is given to experiential learning. They do things and through doing learn about art and its connection to education. The process takes you through different forms of art- fine arts, playing with colours, costume designing, facial make -up, script writing, music, and performance.

Suggestive Mode of Assessment

Details to be determined by the faculty member as per applicable UGC norms.

Week wise break up of sessions			
Sl. no	**Topics**	**Session flow**	**Remarks**
1	Aesthetics and art, art in everyday life.	Based on their experience	
2	Importance of art. Appreciation of art.	Discussion	
3	Art for art sake. Art with social responsibility. art for social change	Debate	
4	The world of puppetry. Different forms of puppetry.	Presentations	
5	History of puppetry	Lecture	
6	Preparation- finger puppets	Hands on	
7	Preparation of masks	Hands on	
8	Preparing puppets	Hands on	
9	Performing individually	Practice	
10	Performing in pairs	Practice	
11	Performing in groups – 3, 4, 5.	Practice	
12	Assignments	Written.	

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

AE&VAC- III: Understanding India (Indian Ethos and Knowledge Systems)- I

Credits: 2
Contact Hours: 2 hrs. Per week
Maximum marks: 50
External: 30
Internal: 20

About the Course

At a time when the world finds itself deep in dynamism, led by technological innovations and environmental changes, there is a need for an inward-looking approach to building the young minds of a country. By looking inwards, one not only finds a sociological belongingness but also a spiritual and intellectual rooting in these changing times. The course provides an overview of India's heritage and knowledge traditions across key themes of economy, society, polity, law, environment, culture, ethics, science & technology, and philosophy. It places special emphasis on the application of these knowledge traditions, helping students to not only know and appreciate India's heritage and knowledge traditions but also to independently evaluate them through a multidisciplinary lens. This evaluation would produce valuable lessons for obtaining transferable and 21st-century skills. The course requires no pre-requisite knowledge or understanding. Spread over two years, the course will establish foundational knowledge and build upon it. It will allow students to have a basic understanding of the traditions of India and how it has evolved over the years. The course is designed to enable student teachers to outline and interpret the processes and events of the formation & evolution of knowledge of India through a multidisciplinary lens; to evaluate the diverse traditions of India to distinguish its achievements and limitations, and to develop and articulate an ethics-based education rooted in Indian thought to their students in the classroom context.

Learning Outcomes

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

- Recognize the vast corpus of knowledge traditions of India, while developing an appreciation for it,
- Apply their acquired research and critical thinking skills in multidisciplinary themes,
- Summarize and pass on their learning to their students of different Indian traditions in an easily digestible manner.

UNIT – I: Understanding India: Historical Evolution

- India as ancient civilization: Unique characteristics
- India as seat of Higher Learning Centre
- India as Society: Geographical Diversity, Linguistic Diversity, Religious Plurality
- India as Ancient Culture: Art and Literature Characteristics
- Fine arts (traditional art forms, contemporary arts, arts & spirituality, arts and Identity, and art and globalization);
- Performing Arts (Indian dance systems, traditional Indian pieces of music, visual arts, folk arts, etc.,).
- Need to revisit our ancient knowledge, traditions, and culture

UNIT – II: Indian Polity and Economy

- Kingship & types of government (oligarchies, republics); Local administration (village administration).
- Basis of Law: Dharma & its sources; Criminal Justice: police, jails, and punishments; Lessons from Chanakyaniti; Lessons for modern-day India: Towards a tradition-driven equitable and just polity and law system.
- Overview of the Indian Economy from the Stone Age to the Guptas: The new culture of Urbanization (including castes, guilds, and other economic institutions; Harappan civilization economy; growth of agriculture and proliferation of new occupations; growth of writing).
- Internal & external trade and commerce, including trade routes, Indo-roman contacts, and maritime trade of South India; Temple economy.
- Land ownership - land grants & property rights, land revenue systems.
- Understanding Arthashastra: Ideas & Criticism; Locating relevance of ancient Indian economic thought in modern-day Indian Economy.

UNIT – III: Environment & Health

- Understanding Equilibrium between Society & Environment: Society's perceptions of natural resources like forests, land, water, and animals.
- Sustainable architecture & urban planning; Solving today's environmental challenges (best practices from indigenous knowledge, community-led efforts, etc.).
- India's Health Tradition: Ayurveda, Siddha, Ashtavaidya, Unani, and other schools of thought; Lessons from Sushruta Samhita and Charaka Samhita;
- Mental health in ancient India: towards time-tested concepts of mental wellness (concept of mind, dhyana, mind-body relationship, Ayurveda, yoga darshan, atman, etc.)

Suggestive Practicum

The modes of curriculum transaction will include lectures, Tutorials, and Practicum.

- Practicum will include organization of day trips that help student teachers watch events relating to visual and performing art; activities that enable student teachers to identify and record through photos, videos, etc. the elements of ancient architecture still existing in the city around them; organization of Individual and group presentations based on themes such as Polity, Law and Economy etc., organization of a 'Knowledge of India' day in the institution to celebrate the culture (food, clothes, etc.) that they would have been explored in lectures and tutorials; interactions with family members, elders, neighbors, and other members of society about the evolution of local systems and economy etc.

Suggestive Mode of Transaction

- Lectures will include learner-driven participatory sessions, and Guest lectures through experts and practitioners, such as fine arts and performing arts practitioners along with contemporary poets & writers of Indian literature.
- Tutorials will include Screening of documentaries and films followed by a discussion; Learner-driven discussions in the form of focus group discussions (FGDs), Socratic Discussions, etc.; Debate/discussion can be organized to explain India's Vaad tradition; discuss on how some of the ancient methods of teaching are relevant in today's time; discussions that help Identify ethical dilemmas in daily lives and understanding the importance of ancient ethics and values to resolve them.

Suggestive Mode of Assessment

The approaches to learning assessment will include, for example:

- Supporting the curiosity and interest of student teachers in the selected themes through a multi-modal approach, including regular assessments and actionable feedback that enable learners to outline and interpret the processes and events of the formation & evolution of knowledge of India through a multidisciplinary lens.
- Enabling the student teachers to demonstrate critical analysis and independent thinking of the processes and events in the formulation & evolution of different traditions that help student teachers evaluate the diverse traditions of India to distinguish its achievements and limitations.
- Use of first-hand or second-hand experiences that enable student-teachers to develop and articulate an ethics-based education rooted in Indian thought to their students in the classroom context.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

- Agrawal, P. K. (2020). *Indian culture art and heritage*.PrabhatPrakashan.
- Baliyan, S. (2000). *A compendium of Indian art and culture*. Oxford University Press.
- Bandhu, D. (1982). *Education for environmental planning and conservation*. Indian Environmental Society.
- Bedi, Y. (1967). *Handbook of Hygiene and public health*. Anand Publishing Comp.
- Bedy, Y. (1971). *Hygiene and Public Health*.Atma Tam & Sons.
- Botkin, D. B & Keller, E. A. (2000). *Environmental studies: The earth as a living plant*. Charles E. Merrill, Publishing Co.
- Davis, M. B.(1966). *Hygiene and Health Education*. Longmans green and company Ltd.
- Elizabeth, T. (2000) *Handbook of Hygiene*. Silver Shore Publication.
- Joseph, T. (2018) *Early Indians: The story of our ancestors and where we came from*. Juggernaut Books.
- NCF (2005). National focus group on Arts, music, dance and theatre. NCERT.
- NCF (2005). National focus group on heritage crafts. NCERT.
- Rathore, A.S. &Goswamy, G. (2018). *Rethinking Indian jurisprudence: An introduction to the philosophy of law*.Routledge.
- Sangroula, Y. (2012). *Jurisprudence the philosophy of law*.Loquiter Publishing Company PLC.
- Singh, U. (2021). *Ancient India: Culture of contradictions*. Rupa Publication.
- Singhania, N. (2021). *Indian art and culture*.McGrawhill.
- Tolba, M. K. (1982): *Development without destruction: Evolving environmental perception*.Tycooly International Publishing Ltd.
- White, M. (2009). *A philosophy of culture:The scope of holistic pragmatism*. Princeton University Press.
- https://byjus.com/free-ias-prep/prehistoric-india-important-points/
- https://byjus.com/free-ias-prep/life-under-guptas-and-vakatakas-ancient-history-notes/
- https://www.khanacademy.org/humanities/world-history/ancient-medieval/early-indian-empires/a/the-maurya-and-gupta-empires
- https://www.khanacademy.org/humanities/world-history/ancient-medieval/early-indian-empires/a/the-maurya-and-gupta-empires

Semester - II

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	DC (Major) Any one Group	Physics/ Chemistry/ Mathematics Botany/Zoology	DC-III*	3+1	100	15	25	60	5
			DC-IV	3+1	100	15	25	60	5
			SEC-I	2	50	10	--	40	2
			SEC-II	2	50	10	--	40	2
2	AE&VAC	Language – 2 (Other than Language – I)	AE & VAC -IV	4	100	40	--	60	4
3	AE&VAC	Understanding India (India Ethos and Knowledge Systems)- II	AE & VAC-V	2	50	20	--	30	2
4	AE&VAC	Teacher and Society	AE & VAC-VI	2	50	20	--	30	2
Total				**20**	**500**	**130**	**50**	**320**	**22**

***The practical of Subject mathematics is Internal**

SEMESTER – II

PHYSICS

DC- III: Mathematical Physics – II

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This chapter will enable the students to:

- Establish a Foundational Understanding of Vector Calculus and its Significance
- Master Fundamental Vector Operations and Coordinate Systems
- Understand and Apply Vector Calculus Operators

- Apply Vector Calculus Operators in Different Coordinate Systems
- acquire the ability to compute line integrals, understand their interpretation (such as work done along a curve), and apply them to real-world physics problems.
- understand Green's theorem, including its statement and applications, such as describing relationships between circulation and flux. They will also gain a geometric interpretation of both line and surface integrals, enhancing their ability to visualize and analyze vector fields in different contexts.
- Understanding and Applying the Divergence Theorem and Stoke's Theorem
- Advanced Applications and Geometric Significance
- Understanding the Laplacian Operator and Scalar Fields
- Application of Laplace's Equation in Electrostatics
- Review and Synthesis of Key Concepts and Applications

Unit 1: Introduction to Vector Calculus (12 hours)

Overview of vector calculus and its importance in physics, Introduction to vectors and vector operations (addition, subtraction, scalar multiplication), Coordinate systems: Cartesian, polar, cylindrical, and spherical, Vector algebra, dot product, and cross product.

Unit 2: Vector calculus operator (12 hours)

Definition and interpretation of gradient, divergence, and curl, Applications in physics: understanding fields (e.g., temperature, velocity, electric field), Calculation of gradient, divergence, and curl in different coordinate systems, Physical and geometrical significance of these operations.

Unit 3: Line and Surface Integrals (12 hours)

Line integrals: computation, interpretation (work done along a curve), and applications, Surface integrals: computation, interpretation (flux through a surface), and applications, Green's theorem: statement and applications (e.g., circulation and flux relationships), Geometric interpretation of line and surface integrals.

Unit 4: Divergence Theorem and Stoke's Theorem (12 hours)

Divergence theorem: statement and applications (e.g., relating volume and surface integrals), Stoke's theorem: statement and applications (e.g., connecting circulation and surface flux), Advanced applications in electromagnetism, fluid dynamics, or quantum mechanics, Geometric significance of divergence and Stoke's theorems.

Unit 5: Laplacian, Potential Theory, and Applications (12 hours)

Laplacian operator and its role in describing scalar fields, Laplace's equation and its applications in electrostatics, Poisson's equation and applications in potential theory, Real-world physics applications combining multiple vector calculus tools, Review and synthesis of the course's key concepts and applications.

Suugested Readings:

Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.22
An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.

Practicals

DC- III: Mathematical Physics – II

Credit: 01
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

Make simple projects by choosing from the topics given below

1. Use and application of gradient, divergence, and curl in physics
2. Use and application of line integral and surface integral in physics
3. Use and application of Green's theorem in physics
4. Use and application of Divergence Theorem and Stoke's Theorem in physics
5. Use of Laplacian operator in physics
6. Use of Poisson's equation in physics

DC- IV: Electromagnetic Theory

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)

Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to

- Understand the Concept of Electric Potential and Its Calculation
- Apply Gauss's Theorem to Analyze Electric Fields in Various Configurations
- Understand Dielectric Properties and Their Impact on Capacitors
- Analyze Capacitance Configurations and Energy Storage in Capacitors
- Understand Fundamental Concepts in Magnetostatics and Magnetic Fields
- Analyze Magnetic Fields Using Fundamental Laws and Properties
- Understand and Apply Maxwell's Equations in Electromagnetism
- Analyze Energy Aspects and Continuity of Current in Electromagnetic Systems
- Apply Maxwell's Equations to Analyze Electromagnetic Field Energy Density
- Understand the Characteristics of Electromagnetic Waves and Their Propagation
- Analyze the Propagation and Interaction of Electromagnetic Waves

Unit-1: Electrostatics

Electrostatic Field, Coulomb's law, work done on a charge in an electrostatic field expressed as a line integral, conservative nature of the electrostatic field, Laplace and Poisson equation in electrostatics and their applications, electric potential φ, $\mathbf{E}=-\nabla\varphi$, Torque on a dipole in a uniform electric field and its energy, electric flux, Gauss's theorem of electrostatics, Applications of Gauss theorem-(Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor), finding **E** for symmetric charge distributions, Gaussian pillbox, field at the surface of a conductor, screening of **E** field by conductor, energy of a system of charges. Electric potential (potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere).

Unit-2: Dielectrics and Capacitors

Dielectrics; parallel plate capacitor with a dielectric, dielectric constant, polarization, solution to boundary value problems, conducting and dielectric spheres in a uniform electric field, displacement vector **D**, molecular interpretation of Clausius-Mossotti equation, boundary conditions satisfied by **E** and **D** at the interface between two homogeneous dielectrics, illustration through a simple example. Capacitance of an isolated spherical conductor, spherical and cylindrical condenser, Energy per unit volume in electrostatic field.

Unit-3 Magnetism

Magnetostatics: Force on a moving charge, Lorentz force equation and definition of **B**, Force on a straight conductor carrying current in a uniform magnetic field, torque on a current loop, magnetic dipole moment, angular momentum and gyromagnetic ratio. Biot-Savart's law, Ampere's law and its applications, Field due to a magnetic dipole, solenoid carrying current, magnetization current, magnetization vector, magnetic permeability (linear cases). Divergence and curl of magnetic field. Magnetic vector potential.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.

Unit-4: Maxwell`s equations

Faradays law of electromagnetic induction, self and mutual inductance, energy in a static magnetic field, Equation of continuity of current, Maxwell's displacement current; Maxwell's equations; electromagnetic field energy density

Unit-5: Electromagnetic wave and its propagation

Electromagnetic wave, the wave equation satisfied by **E** and B; plane electromagnetic waves in vacuum and isotropic dielectric medium; Poynting vector; polarization by reflection; reflection and refraction coefficients at the boundary of two dielectrics (normal incidence only); and total internal reflection**,** waves in a conducting medium; reflection and refraction by the ionosphere, transverse nature of EM waves.

Suggested Readings:

• Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
• Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
• Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
• D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
• Electricity Principles and Application, Fowler; Tata McGraw Hills.
• Electricity and Magnetism, Mahajan; Tata McGraw Hill.
• Electromagnetic Waves and Radiating systems, Jordan Balman
• Electricity and Magnetism, K.K. Tewari

Practicals

DC- IV: Electromagnetic Theory

Credit:1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Conversion of galvanometer into ammeter of given range.
   I. To determine the resistance of a galvanometer by half deflection.
   II. To determine the figure of merit of galvanometer.
   III. To convert the galvanometer into an ammeter of a given range and to calibrate it.
2. To convert the galvanometer into a voltmeter of a given range and to calibrate it.
3. To determine the inductance of a given coil by Anderson bridge method.
4. To study the dependence of capacitance on separation of the plates of capacitor.
5. To study the variation of magnetic field along the axis of a current carrying circular coil.
6. Study of charging and discharging of capacitor.
7. To verify Kirchhoff's current law and voltage law.
8. To determine the high resistance by leakage method.
9. Calibration of voltmeter.
10. Calibration of ammeter.
11. To study ac wave form and to measure rms value of ac voltage using CRO.
12. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
13. Ballistic Galvanometer:
    (i) Measurement of charge and current sensitivity
    (ii) Measurement of CDR
    (iii) Determine a high resistance by Leakage Method
    (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
14. To compare capacitances using De'Sauty's bridge.
15. Measurement of field strength B and its variation in a Solenoid (Determine db/dx).
16. To study the Characteristics of a Series RC Circuit.
17. To study the series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
18. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
19. To determine a Low Resistance by Carey Foster's Bridge.

SEC- I: Introduction to Programming Language

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 50
Internal: 10
External: 40

Learning outcomes: This course will enable the students to

- Setup and Basic Navigation of Python Environment
- Grasp Fundamentals of Variables, Data Types, and Basic Operations in Python
- Implement Control Structures for Program Flow
- Understand and Apply Functions and Modules in Python
- Reinforce Programming Fundamentals Through Practical Exercises
- Develop a Fundamental Understanding of NumPy for Numerical Computing
- Master Array Manipulation, Operations, and Broadcasting in NumPy
- Understand the Basics of Data Visualization with Matplotlib
- Proficiently Create and Customize Plots with Matplotlib
- Develop a Foundational Understanding of Pandas for Data Manipulation
- Attain Proficiency in Data Cleaning, Filtering, and Aggregation with Pandas
- Familiarize Students with Advanced Scientific Libraries in Python
- Apply Python for Physics Problem Solving Through Simulations and Optimization

Unit 1: Introduction to Python

Getting started with Python: installation, basic syntax, and IDEs (PyCharm/Anaconda), Variables, data types, and basic operations, Control structures: if, elif statements, loops (for and while), break, continue statements, Functions and modules in Python, Practical exercises to reinforce programming fundamentals.

Unit 2: Scientific Computing with NumPy
Introduction to NumPy for numerical computing, working with arrays, array operations, and broadcasting, Mathematical functions and statistical operations with NumPy, Handling data sets and simulations using NumPy arrays, Hands-on exercises on numerical computing and data manipulation.
Unit 3: Data Visualization with Matplotlib
Introduction to Matplotlib, pyplot for data visualization, Creating various types of plots: line plots, scatter plots, histograms, etc., Customizing and annotating plots for scientific presentations, Plotting scientific data and simulations, Practical exercises in data visualization.
Unit 4: Data Analysis with Pandas
Introduction to Pandas for data manipulation and analysis, Working with data frames and series in Pandas, Data cleaning, filtering, and aggregation, Data analysis and exploration in scientific contexts, Hands-on projects involving data analysis in physics.
Unit 5: Advanced Topics and Scientific Applications
Introduction to scientific libraries like SciPy, SymPy, and scikit-learn, Solving physics problems using Python: simulations, optimization, and root finding, Integration of Python with data acquisition and analysis in experimental physics, Final project: students apply Python to solve a physics-related problem.

Suggested Readings:
Python for Everybody: Exploring Data in Python 3 by Charles R. Severance (Author)
PYTHON PROGRAMMING 2E Paperback , by Reema Thareja (Author)

Practical

1. Python program to add two numbers
2. Maximum of two numbers in Python
3. Python Program for factorial of a number
4. Python Program for simple interest
5. Python Program for compound interest
6. Python Program to check Armstrong Number
7. Python Program for Program to find area of a circle
8. Python program to print all Prime numbers in an Interval
9. Python program to check whether a number is Prime or not
10. Python Program for n-th Fibonacci number
11. Python Program for how to check if a given number is Fibonacci number?
12. Python Program for n\'th multiple of a number in Fibonacci Series
13. Program to print ASCII Value of a character
14. Python Program for Sum of squares of first n natural numbers
15. Python Program for cube sum of first n natural number

SEC- II: Numerical Techniques

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes: This course will enable the students to

- Comprehend the Role and Significance of Numerical Analysis in Scientific Computing
- Develop Proficiency in Error Analysis and Management in Numerical Computations
- Apply Root Finding Methods, Including Bisection and Newton-Raphson
- Develop Proficiency in Interpolation Techniques, Particularly Polynomial Interpolation
- Understand and Apply Numerical Differentiation, Integration, and Least-Squares Approximation
- Apply Interpolation and Approximation Techniques in Practical Scenarios
- Acquire Proficiency in Numerical Integration Techniques
- Master Trapezoidal Rule, Simpson's Rule, and Composite Integration
- Conduct Error Analysis and Apply Numerical Integration in Physics
- Understand the Significance of Ordinary Differential Equations (ODEs)
- Apply ODEs in Physics for Modeling Physical Systems
- Utilize Python or Other Tools for Numerical Solutions of ODEs
- Attain a Fundamental Understanding of Linear Algebra and Matrix Operations
- Apply Linear Algebra Techniques in Physics for Problem Solving

Unit 1: Introduction to Numerical Analysis (12 hours)
Overview of numerical analysis and its importance in scientific computing, Error analysis: understanding sources of errors in numerical computations, Taylor series approximation and round-off errors, Root finding methods: bisection method and Newton-Raphson method.
Unit 2: Interpolation and Approximation (12 hours)
Interpolation and polynomial interpolation methods (Newton formula), Numerical differentiation, Least-squares approximation, fitting a straight line, Non-linear curve, Applications in physics and engineering: curve fitting and data analysis.
Unit 3: Numerical Integration (12 hours)
Introduction to numerical integration techniques, Trapezoidal rule and Simpson's rule.
\Error analysis and composite integration, Applications in physics: numerical solutions of differential equations and finding areas/volumes.
Unit 4: Ordinary Differential Equations (ODEs) (12 hours)
Introduction to ODEs and their significance in science and engineering, Euler's method and the Runge-Kutta method, Stability and convergence analysis**,** Applications in physics: modeling physical systems, Numerical solutions of ODEs like heat conduction equation.
Unit 5: Linear Algebra and Matrix Methods (12 hours)
Introduction to linear algebra and matrix operations, methods of matrix factorization, Gaussian elimination and LU decomposition. Eigenvectors, tridiagonal equations. Applications in physics: solving linear systems, quantum mechanics, and vibration analysis.
Suggested Readings:

• Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

Practical
1. To find the roots of non-linear equation using bisection method.
2. To find the roots of non-linear equation using Newton's method.
3. Curve fitting by least – square approximations.
4. To solve the system of linear equations using gauss elimination method.
5. To integrate numerically using trapezoidal rule.
6. To integrate numerically using Simpson's rules.
7. To find the largest eigen value of a matrix by power - method.
8. To find numerical solution of ordinary differential equations by Euler's method.
9. To find numerical solution of ordinary differential equations by Runge- Kutta method.
10. To find the numerical solution of Laplace equation.
11. To find the numerical solution of wave equation.
12. To find the numerical solution of heat equation

MATHEMATICS
DC – III: Real Analysis

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- understand properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$.
- recognize bounded, convergent, divergent, Cauchy and monotonic sequences and tocalculate their limit superior, limit inferior, and the limit of a bounded sequence.
- apply the ratio, root, alternating series and limit comparison tests for convergence andabsolute convergence of an infinite series of real numbers.

Unit-I
- Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number.

- Bounded above and bounded below sets, Supremum and Infimum of a nonempty subset of $\mathbb{R}$.
- Countable and Uncountable set
- Completeness property of $\mathbb{R}$, Archimedean property of $\mathbb{R}$, Definition and types of intervals, Nested intervals and its properties.
- Neighborhood of a point in Open and closed sets in $\mathbb{R}$, Conceptof cluster points and Bolzano-Weierstrass theorem, Density of rational numbers.

Unit-II

- Sequences, Theorems on limits of sequences. Bounded and monotonic sequences., limit superior and limit inferior.
- Convergence and Divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence.
- Series of positive terms, Integral test, Comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Alternating series, Leibniz test, Absolute and conditional convergence.

Unit-III

- Continuity, sequential continuity. Properties of continuous functions.
- Uniform continuity.
- Chain rule of differentiability.
- Rolle`s Theorem, Lagrange`s Mean Value Theorem and Cauchy Mean Value Theorem and their geometrical interpretations.
- Darboux's intermediate value theorem for derivatives.
- Taylor's theorem with various forms of remainders.

Unit-IV

- Riemann integral. Integrability of continuous and monotonic functions.
- The fundamental theorem of integral calculus.
- Improper integrals and their convergence, comparison tests, Abel's and Dirichlet's tests.
- Frullani's integral. Integral as a function of a parameter.

Unit-V

- Sequences and series of functions, Pointwise and uniform convergence.
- M_n-test, M-test, Uniform convergence, integrability and differentiability of functions.
- Power series and radius of convergence.

Suggested Readings:

- Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.). Wiley India Edition. New Delhi.
- Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
- Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
- Ross, Kenneth A. (2013). *Elementary Analysis*: *The theory of calculus* (2nd ed.).Undergraduate Texts in Mathematics, Springer. Indian Reprint.
- Thomson, Brian S., Bruckner, Andrew. M., & Bruckner, Judith B. (2001). *ElementaryReal Analysis.* Prentice Hall.

Practical
DC – III: Real Analysis

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEMESTER – II

DC-IV: Ordinary differential Equations and Vector Calculus

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25

Learning Outcomes: This course will enable the students to:

- formulate Differential Equations for various Mathematical models.
- solve first order non-linear differential equation, linear differential equations of higher order etc. using various techniques.
- apply these techniques to solve and analyze various mathematical models.
- understand the basic concepts of Vector Integration and to solve the problems based on Green, Gauss and Stokes theorems.

Unit-I

- Order and Degree of differential equations.
- Equations of first order and first degree, separation of variables, Homogeneous equations.
- Linear equations and equations reducible to the linear form.
- Linear differential equations with constant coefficients.

Unit-II

- Exact differential equations. First order and higher degree equations solvable for p, x, y. Clairaut's form and singular solutions.
- Geometrical meaning of a differential equation. Orthogonal trajectories.
- Homogeneous linear ordinary differential equations.
- Linear differential equations of second order.
- Transformation of the equation by changing the dependent variable and independent variable.

Unit- III

- Method of variation of parameters.
- Ordinary simultaneous differential equations.

Unit-IV

- Series solutions of differential equations by power series method.
- Bessel, Legendre and Hypergeometric functions and their properties.
- Recurrence and generating relations.

Unit-V

- Scalar and vector product of three vectors, Product of four vectors,
- Reciprocal Vectors. Vector differentiation,
- Gradient, divergence and curl.

Suggested Readings:

- Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
- Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India.
- Manglik and Seth; Vector Calculus.
- P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.
- B. R. Thakur, Nigam, Sinha and Saren - Vector Analysis.

Practical

DC-IV: Ordinary differential Equations and Vector Calculus

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEC-I: Analytic Geometry-I

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes: This course will enable the students to:

- understand the mechanism of deriving equations of surfaces in 2 and 3 dimensions.
- develop the ability to solve real life geometric problems.

Unit-I

- Projections, direction cosines and direction ratios. The straight line, the plane, sphere, cone and cylinder.

Unit-II

- General equation of second degree, Tracing of conics, system of conics, confocal conics.

Unit-III

- The Sign of the Polar Co-ordinate, Relation between Cartesian and Polar Co-ordinates, The Distance Between the Points (r_1, θ_1) and (r_2, θ_2), Polar Equation of a Straight Line

Unit-IV

- The Polar Equation of the Straight Line in Normal Form, Polar Equation of a Circle, Polar Equation of a Conic, Equations of the Directrices, Equation of the Chord

Unit-V

- The Tangent to a Conic, Asymptotes, the Equation of Normal, The Equation of Polar
- Central Conicoid: The standard Equation, The ellipsoid, the hyperboloids of one sheet, the Hyperboloids of two sheets, Paraboloids, Elliptical paraboloid, Hyperbolic paraboloid

Suggested Readings:

- S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
- R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillanIndia Ltd., 1994.

SEC-II: Analytic Geometry-II

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40
Learning Outcomes: This course will enable the students to:

- understand the mechanism of deriving equations of surfaces in 2 and 3 dimensions.
- apply the techniques to reduce second degree equation in 3-Dimensions.
- develop the ability to solve real life geometric problems.

Unit-I

- Tangent line and Tangent plane, Director sphere, General Equation of the conicoid through the six feet of the normal, diameter planes, plane of contact
  Polar Plane and Lines, conjugates point and conjugate plane, Enveloping Cone and Cylinder to a conicoid, Diametral Plane, Conjugate semi-diameters and conjugate plane,

Unit-II

- Plane sections of conicoid: Parallel plane sections, Nature of the plane section of a central, nature of the plane section of a paraboloid

Unit-III

- Axes of a central section of the central conicoid, Axes of any section of the central conicoid, Axes of a plane section of the paraboloid, circular sections, Circular sections of the ellipsoids, Circular sections of the hyperboloids, Sphere through two circular sections of the ellipsoid, Circular sections of the paraboloids, umbilics, umbilics of the ellipsoid, umbilics of the paraboloid

Unit-IV

- Reduction of Second-Degree Equations: Discriminating Cubic, The Principal Directions are at Right Angle, Existence of the Principal Direction, Center, Determination of the Center

Unit-V

- Reduction of general equation: Case I: if all values of discriminating cube are λ different and no one are 0; Case II: If two roots of discriminating cube are λ different and third root =0; Case III: If two roots of discriminating cube are λ different and third root =0 and k=0; Case IV: if two roots of discriminating cube are λ are same and third root is not equal to 0; Case V: reduction when terms of second degree forms a perfect square

Suggested Readings:

- S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
- R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillanIndia Ltd., 1994.

CHEMISTRY

DC- III: Organic Chemistry- I

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. know the basic concepts involved in understanding organic chemistry like electron displacement around carbon-carbon bond, bond fission, reactive intermediates, etc.
2. differentiate the structural and stereo isomerism.
3. investigate the cause of higher reactivity shown by alkenes and alkynes due to the presence of π −bonds.
4. understand the strain caused due to deviation in normal tetrahedral bond angle in cyclic compounds.
5. establish a relation between molecular orbital overlapping and stability in the aromatic compounds.
6. learn the technique of determining m.p. and b.p. of organic compounds and detection of elements other than carbon and hydrogen.

Unit-I: Basics of Organic Chemistry

Hybridization, Shapes of molecules Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation Dipole moment; Hydrogen bonding (Applications to be discussed with relevant topics) Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

Unit-II: Stereochemistry

Fischer,Newmann and Sawhorse Projection formulae and their interconversions;

Isomerism: Structural and Stereo isomerism. Geometrical isomerism: cis–trans , syn-anti and E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations.

Unit-III: Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds General methods of prepareation , physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds: General methods of preparation, physical and chemical properties of alkenes and alkynes, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms

(Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit-IV: Cycloalkanes and Conformational Analysis

Conformational analysis of alkanes: Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory: Chair, Boat and Twist boat forms of cyclohexane with energy diagrams; Relative stability of mono substituted cycloalkanes. Sache-Mohr's theory.

Unit-V: Aromatic Hydrocarbons

Introduction of Aromatic Hydrocarbons, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups. Heterocyclic compounds-Pyridine, Pyrrole, Furans.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Practicals

DC- III: Organic Chemistry- I

Credit: 01
Total: 25
External: 25

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
7. Detection of extra elements
8. Organic Preparations
   (i) Bromination of acetanilide / aniline / phenol
   (ii) Nitration of nitrobenzene / toluene.

Suggested Readings:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

DC- IV: Physical Chemistry- II

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25

External: 60

Learning Outcomes: After completing the course the students will be able to:

1. calculate work, heat and change in internal energy employing first law of thermodynamics.
2. realize the need of second law of thermodynamics and will access the feasibility of chemical reactions by the help of work function and free energy.
3. correlate the extent of chemical reaction and product formation by the help of equilibrium constant.
4. differentiate between ideal and real solutions and will correlate vapour pressure with colligative properties like elevation in boiling point, depression in freezing point & osmotic pressure.
5. understand the reason behind the formation of colloidal solution and formation of mono and multiplayers on the solid surfaces.
6. learn the technique of determining heat capacity, heat of neutralization, ionization, etc. employing conventional techniques.

Unit-I: Chemical Thermodynamics (Part- I)

Intensive and extensive variables; state and path functions; isolated, closed and open systems. First law: Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, 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.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Unit-II: Chemical Thermodynamics (Part- II)

Second Law: Concept of entropy; Carnot Cycle, thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Systems of Variable Composition: Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-III: Chemical Equilibrium

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively)). Free energy of mixing and spontaneity. equilibrium between ideal gases and a pure condensed phase.

Unit-IV: Solutions and Colligative Properties

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Unit-V: Surface chemistry

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). nature of adsorbed state. Qualitative discussion of BET.

Colloidal State: Definition of Colloids, Classification of colloids, sols (Electrical and optical properties, Hardy-Schulze law, gold number), emulsions, gels.

Suggested Readings:

- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010). • Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

Practicals

DC- IV: Physical Chemistry - II (Practical)

Credit: 01
Total: 25

External: 25

Thermochemistry:

(a) Determination of heat capacity of a calorimeter for different volumes using
(i) 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), and
(ii) heat gained equal to heat lost by cold water and hot water respectively.
(b) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
(c) Determination of the enthalpy of ionization of ethanoic acid.
(d) Determination of integral enthalpy (endothermic and exothermic) solution of salts.
(e) 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.
(f) Determination of enthalpy of hydration of salt.
(g) Study of the solubility of benzoic acid in water and determination of ΔH.
(h) Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Suggested Readings:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

SEC- I (Choose any one)

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes: After completing the course the students will be able to:

1. expose themselves in learning the techniques to enhance their skill to understand the basic concepts of chemistry.
2. learn the technique of preparing common cosmetics talcum powder, nail chemical, creams, artificial flavors, etc.
3. explore the importance of cosmetic industries with reference to sandalwood oil, eucalyptus, Jasmine, etc.
4. know the uses of coal and its composition.
5. understand the details of petroleum and petrochemical industries and recovery of various petroleum products by fractional distillation.

1. Chemistry of Cosmetics & Perfumes

Unit-I: A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

Unit-II: Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Unit-III: Preparation of talcum powder, Preparation of shampoo, Preparation of enamels, Preparation of hair remover, Preparation of face cream, Preparation of nail polish and nail polish remover.

Suggested Readings:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

2. Fuel Chemistry

Unit-I: Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Unit-II: Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit-III: Petroleum and Petrochemical Industry: 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, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

SEC- II

Choose any one:

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 50
Internal: 10
External: 20

1. Chemical Technology & Society

Unit-I: Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquidextraction, separation by absorption and adsorption.

Unit-II: An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Unit-III: Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Book:

- John W. Hill, Terry W. McCreary & Doris K. Kolb, Chemistry for changing times 13th Ed.

2. Analytical Clinical Biochemistry

Unit-I: Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins: Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides. Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins:α -helixβ and - pleated sheets, Isolation, characterization, denaturation of proteins.
Unit-II: Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in ―Green Chemistry‖ and Chemical Industry. Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins. Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones. Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.
Unit-III: Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Identification and estimation of the following:
Carbohydrates – qualitative and quantitative, Lipids – qualitative, Determination of the iodine number of oil, Determination of the saponification number of oil, Determination of cholesterol using Liebermann- Burchard reaction, Proteins – qualitative, Isolation of protein, Determination of protein by the Biuret reaction, Determination of nucleic acids.

Suggested Readings:

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
- G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
- A.L. Lehninger: Biochemistry.
- O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

BOTANY
DC- III: Anatomy of Angiosperms

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
Students are expected to gain understanding in internal structural organization of various parts and tissues of dicots and monocots.

Unit 1: Introduction Plant Anatomy
Internal organization of plant body: The three tissue systems, types of cells and tissues.
Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 2: Tissues
Classification of tissues; Simple and complex tissues; cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 3: Apical meristems
Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf in relation to photosynthesis and waterloss, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent center; Root cap; Structure of dicot and monocot root, origin of lateral roots and interaction with microbes.

Unit 4: Vascular Cambium and Wood
Structure, function and seasonal activity of cambium; Secondary growth in root and stem.
Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Unit 5: Adaptive and Protective Systems
Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Practicals
DC- III: Anatomy of Angiosperms

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.

3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Examination of Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Observation of Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Study of Phloem using given plant material: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Study of Epidermal system using given plant material: Cell types, stomata types; trichomes: non-glandular and glandular.
8. Study of Root using given plant material: Monocot, dicot, secondary growth.
9. Study of Stem using given plant material: Monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Study of Leaf: Isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Demonstration of adaptive Anatomy: Xerophytes and hydrophytes.
12. Observation of secretory tissues: Cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

DC- IV: Economic Botany

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Students are expected to gain knowledge in the various crop plants and cash crops along with the focus in silvicultural species.

Unit 1: Origin of Cultivated Plants

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals, Legumes and Spices

Wheat, Rice and maize (origin, morphology, processing & uses); Brief account of millets.

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, cinnamon, clove and black pepper.

Unit 3: Sources of sugars and starches, oils and fats and Biofuel

Morphology and processing of sugarcane, products and by-products of sugarcane industry.

Potato – Morphology, propagation, diseases & uses.

General description, classification, extraction, their uses and health implications groundnut, Sesame, linseed (flax), soybean, mustard and coconut (Botanical name, family & uses). Essential Oils:General account, extraction methods, comparison with fatty oils & their uses.Biofuel

Unit 4: Beverages, Natural Rubber and Drug-yielding plants

Tea, Coffee and Cocoa (morphology, processing & uses)

Para-rubber: tapping, processing and uses.

Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis; Tobacco (Morphology, processing, uses and health hazards).

Unit 5: Timber and fiber yielding plants

General account with special reference to Teak and Pine.

Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practicals
DC- IV: Economic Botany

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Cereals: Wheat (habit sketch, L.S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sources of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests),
4. Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
5. Spices: Black pepper, Fennel and Clove (habit and sections).
6. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
7. Sources of oils and fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
8. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).
9. Rubber: specimen, photograph/model of tapping, samples of rubber products.
10. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.
11. Tobacco: specimen and products of Tobacco.
12. Woods: Tectona, Pinus: Specimen, Section of young stem.
13. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin presence in transverse section of stem and fiber).

Suggested Readings

1. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
2. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
3. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

SEC- I

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Choose any one:

1. Medicinal Botany

Learning Outcomes

Students are expected to gain knowledge in the various medicinal plants used in Ethno and traditional medicines and their conservation measures.

Unit 1:

History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences.
Definition and Scope-Ayurveda: History, origin, Panchamahabhutas, Saptadhatu and Tridosha concepts, Rasayana, plants used in Ayurvedic treatments.

Unit 2:

Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine.
Unani: History, concept: Umoor-e-tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 3:

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; in-situ conservation: Biosphere reserves, sacred groves, National Parks; ex-situ conservation: Botanical gardens, Ethno-medicinal plant gardens.

Unit 4:

Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 5:

Ethno medicines and Folk medicines.
Folk medicines of Ethno-botany, ethno-medicine, ethno-ecology, ethnic communities of India.
Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethno-botanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

2. Plant Diversity and Human Welfare

Learning Outcomes

By going through the following topics students are expected to gain knowledge in the use of bioresources in the common life and various organizations involvement in conservation with respect to diversity measures.

Unit 1:

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro-biodiversity and cultivated plant taxa, wild taxa.

Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

Unit 2:

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agro-biodiversity, projected scenario for biodiversity loss.

Management of Plant Biodiversity: Organizations associated with Biodiversity Management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR.

Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 3:

Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, in-situ and ex-situ conservation, Social approaches to conservation.

Biodiversity awareness programmes, Sustainable development.

Unit 4:

Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India, d) Commercial plant species.

Unit 5:

Fruits and nuts: Important fruit crops their commercial importance.

Wood and its uses.

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

SEC- II

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Choose any one:

1. Ethno-botany

Learning Outcomes

Students are expected to gain knowledge in the herbarium preparation and maintenance, field surveying and data generation, literature involved in Medicoethnobotanical practices in India along with IPR.

Unit 1: Ethnobotany

Introduction, concept, scope and objectives; Ethno-botany as an interdisciplinary science; Relevance of Ethno-botany in the present context; Ethno-botany in India: Methods to study Ethno-botany; Applications of Ethno-botany: Major and minor ethnic groups of India, and their life styles.

Plants used by the tribal: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and f) sacred places.

Unit 3: Plants used in Ethnobotany in modern Medicine

Medicoethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology):

a) Azadiracta indica b) Ocimum sanctum c) Vitex negundo d) Gloriosa superba e) Tribulus terrestris f) Pongamia pinnata g) Cassia auriculata h) Indigo feratinctoria.

Unit 4: Role of Ethnobotany in modern medicine

Role of Ethnobotany in modern medicine with special example Terminalia bellirica, Terminalia arjuna, Emblica officinalis, Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: Ethnobotany and legal aspects

Ethno-botany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Bio-piracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings:

1. S.K. Jain, Manual of Ethno-botany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethno-botany, Oxford and I B H, New Delhi – 1981 Lone et al,.PalaeoEthno-botany
3. S.K. Jain (ed.) 1989. Methods and approaches in Ethno-botany. Society of ethno-botanists, Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian Ethno-botany. Scientific publishers, Jodhpur.
5. Colton C.M. (1997). Ethno-botany – Principles and applications. John Wiley and sons –Chichester.
6. Rama Ro, N and A.N. Henry (1996). The Ethno-botany of Eastern Ghats in Andhra Pradesh, India, Botanical Survey of India. Howrah.
7. Rajiv K. Sinha (1996) – Ethno-botany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur.
8. Faulks, P.J. (1958). An introduction to Ethno-botany, Moredale pub. Ltd.

2. Bio-fertilizers

Learning Outcomes

Students will understand the use of plants and microbes as biofertilizers, biofertilizer production, use of blue green algae as cattlefeed etc. and organic farming techniques

Unit 1:

General account about the microbes used as bio-fertilizer – Rhizobium – isolation, identification, mass multiplication, and carrier based inoculants, Actinorrhizal symbiosis.

Unit 2:

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

Unit 3:

Cyanobacteria (blue green algae), Azolla and Anabaena-Azolla association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

Unit 4:

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5:

Organic farming – Green manure and organic fertilizers, recycling of biodegradable municipal, agricultural and Industrial wastes, bio-compost making methods, types and method of vermicomposting.

Suggested Readings:

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. EmkayPublication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

ZOOLOGY
DC- III: DIVERSITY OF CHORDATA

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Introduction to Chordata and Protochordata

General characteristics and outline classification
Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata;
Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

Unit 2: Origin of Chordata and Agnatha

Dipleurula concept and the Echinoderm theory of origin of chordates.
Advanced features of vertebrates over Protochordata.
Agnatha : General characteristics and classification of cyclostomes up to class

Unit 3: Pisces and Amphibia

General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration, Osmoregulation and Parental care in fishes.
Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians.

Unit 4: Reptilia and Aves

General characteristics and classification up to order; Poison apparatus and Biting mechanism in snakes.
Aves: General characteristics and classification up to order *Archaeopteryx*—a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds

Unit 5: Mammals and Zoogeography

General characters and classification up to order;
Adaptive radiation with reference to locomotory appendages.
Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms.

PRACTICALS
DC- III: DIVERSITY OF CHORDATA

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Protochordata

Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata, Sections of Balanoglossus through proboscis and branchiogenital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmaniaspicules

2. Agnatha

Petromyzon, Myxine

3. Fishes

Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes,
Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon,
Anabas, Flat fish

4. Amphibia

Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra

5. Reptilia

Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon,
Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus
Key for Identification of poisonous and non-poisonous snakes

6. Aves

Study of six common birds from different orders. Types of beaks and claws

7. Mammalia

Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes,
Erinaceous.
Power point presentation on study of any two animals from two different classes by students

Suggested Readings:

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

DC-IV: COMPARATIVE ANATOMY OF VERTEBRATES

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)

Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Comparative study of Integumentary System and Skeletal System
Anatomy of integument
Pectoral and Pelvic girdle
Unit 2: Comparative study of Digestive System and Respiratory System
Alimentary canal and associated glands
Respiratory organs
Unit 3: Comparative study of Circulatory System and Urinogenital System
Anatomy of heart and aortic arches
Anatomy of testis, ovary and kidney
Unit 4: Comparative study of Nervous System
Comparative account of brain
Comparative account of Spinal cord, Cranial nerves
Unit 5: Comparative study of Sense Organs
Sense Organs: Classification of receptors
Visual and Auditory receptors

PRACTICALS
DC- IV: COMPARATIVE ANATOMY OF VERTEBRATES

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of integument, placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit through photographs
3. Study of Carapace and plastron of turtle /tortoise through photographs
4. Study of Mammalian skulls: One herbivorous and one carnivorous animal through photographs
5. Study of structure of heart, lung, kidney, eye and ear from video recording (any 3)

Suggested Readings:

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
- Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

SEC- I

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

SEC-I: SERICULTURE

Learning Outcomes

Unit 1: Introduction
Sericulture: Definition, history and present status; Silk route
Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture
Unit 2: Biology of Silkworm
Life cycle of Bombyx mori
Structure of silk gland and secretion of silk
Unit 3: Rearing of Silkworms
Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, Resham Keet Oushadh
Silkworm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons
Unit 4: Pests and Diseases
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
Control and prevention of pests and diseases
Unit 5: Entrepreneurship in Sericulture
Prospects of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

Suggested Readings:

- Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

SEC-II: MEDICAL DIAGNOSTICS

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Introduction and Diagnostics Methods Used for Analysis of Blood
Introduction to Medical Diagnostics and its Importance. Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.).
Unit 2: Diagnostic Methods Used for Urine Analysis
Urine Analysis: Physical characteristics; Abnormal constituents
Unit 3: Non-infectious Diseases
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and TypeII), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit
Unit 4: Infectious Diseases
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis
Unit 5: Tumour
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).
Suggested Readings:

- Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
- Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
- Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
- Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders
- Robbins and Cortan, Pathologic Basis of Disease, VIIIEdition, Saunders
- Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

EDUCATION PART

AE&VAC- IV: Language- 2 (Other than L1)

Credits: 4
Contact Hours: 4 hours per week
Maximum marks: 100
Internal: 40
External: 60

About the Course

The course aims to prepare the students to teach language at the school level. It focuses on training the students to the sounds systems of languages, word formation processes, sentence formation, semantic and pragmatic aspects of languages. The course intends to enable the learners to integrate all the four language skills using different genres. The major aim of this course is to empower the learners to contribute to the discourses on various issues and themes. The course also orients the students to the use of different technology and digital media for developing their own communicative skills as well as the school students they would teach in the future. The course helps improve basic communication skills such as listening, speaking, reading, and writing skills among L2 language learners. The course is designed to enhance knowledge of grammar of L2 and enable the students to formulate grammatically correct and contextually appropriate sentences and words and empower the students with summarizing skills, oral presentations skills effectively. The course also seeks to enhance students' critical thinking capacities and demonstrate effective communication skills and provide hands-on activities to student teachers to develop their linguistic skills through practical sessions.

Learning Outcomes

After completing the course, student teachers will be able to:

- demonstrate reading, writing, listening, speaking, and thinking abilities in L2,
- recognize the link between language and mental skills and demonstrate their knowledge and skills effectively for all purposes,
- build inter-personal relationships and enhance social skills.

UNIT – I: Language, Society, and Learning

- Bi-/Multilingualism and scholastic achievements; need to promote multilingualism; Language variation and social variation; languages, dialects and varieties, cultural transmission of language, language, and gender; language and identity; language and power; constitutional provisions and National Education Policy 2020.
- Language acquisition and Language learning; language learning from mother tongues to other tongues; advantages of learning other languages; language and education; notion of first language, second language and others.
- Understanding English language through Sign Language.

UNIT – II: Listening Skills

- Listening: concept of listening in second language
- Phonectic elements involved in listening at the receptive level (Monothongs, dipthongs, pause, juncture, stress, accent, beat, intonation, rhythm).
- Authentic listening vs Graded listening.

UNIT – III: Understanding Grammar and Phonetics

- Word and meaning; parts of speech, grammatical categories; word formation: affixation, compounding, reduplication, vocabulary building.
- Sentence and its constituents: simple, complex, and compound sentences; Semantics and pragmatics: lexical meaning-synonymy, antonymy, meronymy, grammatical meaning, speech acts.
- Language and Punctuations: Concept and use of punctuations
- Phonetics: Organs of Speech, Classification of Speech sounds, Various Accents of English, Sounds of English: Vowels and Consonants,
- Implementation of Phonetics in the daily classroom: ways, methodologies and teaching aids.

UNIT – IV: Basic Communication Skills in L2

- Listening comprehension skills and Speaking skills.

- Reading and reading comprehension skills.
- Effective writing skills; effective presentation; summarizing and paraphrasing skills.
- Creative writing skills: essay writing, short story writing, letter writing, paragraph writing.

UNIT – V: Speech and Writing

- Writing Systems: Speech and writing; arbitrariness in language; types of writing systems.
- Classification sessions of speech sounds: vowels, consonants, and others; suprasegmental: stress, pitch, tone, intonation, and juncture; Acoustic phonetics.

UNIT- VI: Critical thinking skills

- Enhancing crtical thinking abilities; crtical interpretation, questioning and challenging your beliefs and value; developing ideas and evaluating on argument.
- Observing a problem, describing the problem, framing the problem, comparing and evaluating a problem.
- Componentas of crtical thinking and reading; high order congnition development; critical thinking and problem sloving rational inquiry.

Suggestive Practicum

- Listen to a recorded speech and classify it based on sounds: vowels, consonants, and others; suprasegmental: stress, pitch, tone, intonation, and juncture; Acoustic phonetics.
- Analyze sentences and their constituents as simple, complex, and compound sentences from written work.

Suggestive Mode of Transaction

Teaching this course will involve a mix of interactive lectures, tutorials, and practical involves such as discussion, role plays, projects, simulations, workshops and language-awareness activities. The teaching intends deeper approaches to learning involving in- class room discussion, developing the critical thinking/ problem solving abilities among the students and will also focus on situations where in our daily lives the one would be performing tasks that involve a natural integration of language skills. The students are expected to read assigned chapters/ articles before the session and the course requires active participation from the students.

Suggestive Mode of Assessment

The assessment of the learner will be primarily based on the assessment of both linguistic and communicative skills using a battery of tests and test types, group work and projects.

Suggestive Reading Materials

- Bansal, R.K., Harrison, J.B. (1972). Spoken English for India. Madras. Orient Longman Ltd.
- Baruah, T.C. (1985). The English Teacher's Handbook. New Delhi. Sterling Publishing Pvt. Ltd.
- Bright, J.A., McGregor, G.P. (1970). Teaching English as second language. London. Longman.
- Dave, M. (2021). Teaching English Language and Literature. New Delhi. Notion Press.
- Dhamija, P.V., Sethi, J. (2015). Acourse in Phonetics and Spoken English. Delhi. PHI learning Pvt. Ltd.
- Gimson, A.C. (1980). An Introduction to the pronunciation of English. London. Edward Arnold.
- Jamdan, R. (2021). Pedagogy of teaching English subject. New Delhi. Notion Press.
- Kohli, A.L. (2013). Techniques of teaching English. New Delhi. Dhanpat Rai Publishing Company.
- Krishnaswamy, N., Krishnaswamy, L. (2008). Story of English in India. New Delhi. Foundation Books.
- Palmer, H.L. (1965). The principles of Language Study. London. Oxford University Press.
- Position paper National Focus Group on Teaching of English (1928). New Delhi. NCERT.
- Ray, M. (2021). English Language Teaching: Recent Approaches. New Delhi. Atlantic.
- Tomkins, W. (1969). Indian Sign Language. New York. Dover Publications Inc.

AE&VAC- V: Understanding India (Indian Ethos and Knowledge Systems)-II

Credits: 2
Contact Hours: 2 hours per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

At a time when the world finds itself deep in dynamism, led by technological innovations and environmental changes, there is a need for an inward-looking approach to building the young minds of a country. By looking inwards, one not only finds

a sociological belongingness but also a spiritual and intellectual rooting in these changing times. The course provides an overview of India's heritage and knowledge traditions across key themes of economy, society, polity, law, environment, culture, ethics, science & technology, and philosophy. It places special emphasis on the application of these knowledge traditions, helping students to not only know and appreciate India's heritage and knowledge traditions but also to independently evaluate them through a multidisciplinary lens. This evaluation would produce valuable lessons for obtaining transferable and 21st-century skills. The course requires no pre-requisite knowledge or understanding. Spread over two years, the course will establish foundational knowledge and build upon it. It will allow students to have a basic understanding of the traditions of India and how it has evolved over the years. The course is designed to enable student teachers to outline and interpret the processes and events of the formation & evolution of knowledge of India through a multidisciplinary lens; to evaluate the diverse traditions of India to distinguish its achievements and limitations, and to develop and articulate an ethics-based education rooted in Indian thought to their students in the classroom context.

Learning Outcomes

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

- Recognize the vast corpus of knowledge traditions of India, while developing an appreciation for it,
- Apply their acquired research and critical thinking skills in multidisciplinary themes,
- Summarize and pass on their learning to their students of different Indian traditions in an easily digestible manner.

UNIT – I: Philosophy, Ethics & Values: Schools of Philosophy

- Brahmana and Shramana Sampradayas
- Vaishesika, Nyaya, Samkhya, Yoga, Purva Mimansa and Vedanta or Uttara Mimansa (theory and the major thinkers)
- Ajivikas, Jain, Buddhist, and Charvak philosophies.
- Vedanta: philosophical systems (Advaita, Vishishtadvaita, Dvaita).
- Ethics, morality, and social dilemma (including self-leadership) and their relevance in today's time.
- Spirituality and Social Responsibility; Importance of Spirituality in current times.
- Using ethics in a technologically volatile world: leading an ethical and modern life.
- Practical Vedanta for well-being (mindfulness, inter-connectedness, society-self relationship, etc.).

UNIT – II: Culture and Linguistic Traditions

- Food (regional cuisines, ayurvedic diet, food and festival, vegetarianism, Jainism in food, food and hospitality, and globalization).
- Clothes (traditional Indian clothing, textile arts, religious costumes, clothing status, clothing, gender, globalization in clothing).
- The lifestyle of Yoga; adapting ancient lifestyle – A path towards longevity.
- History of linguistics in India (conceptualizing ancient Indian linguistics, oral traditions, etc.).
- Language as Culture: Evolution of Languages over the years & language as building blocks to different cultures and society
- Language: Identity, culture, and History.

UNIT – III: Science & Technology

- Arithmetic and logic.
- Natural sciences: math, physics, metallurgy, and chemistry.
- Astronomy: India's contributions to the world of knowledge
- Indian notions of time and space.
- Technology in the economy: agriculture, transportation, etc.

Suggestive Practicum

The modes of curriculum transaction will include lectures, Tutorials, and Practicum.

Practicum will include organization of day trips that help student teachers watch events relating to visual and performing art; activities that enable student teachers to identify and record through photos, videos, etc. the elements of ancient architecture still existing in the city around them; organization of Individual and group presentations based on themes such as Polity, Law and Economy etc., organization of a 'Knowledge of India' day in the institution to celebrate the culture (food, clothes, etc.) that they would have been explored in lectures and tutorials; interactions with family members, elders, neighbors, and other members of society about the evolution of local systems and economy etc.

Suggestive Mode of Transaction

- Lectures will include learner-driven participatory sessions, and Guest lectures through experts and practitioners, such as fine arts and performing arts practitioners along with contemporary poets & writers of Indian literature.
- Tutorials will include Screening of documentaries and films followed by a discussion; Learner-driven discussions in the form of focus group discussions (FGDs), Socratic Discussions, etc.; Debate/discussion can be organized to explain India's Vaad tradition; discuss on how some of the ancient methods of teaching are relevant in today's time; discussions that help Identify ethical dilemmas in daily lives and understanding the importance of ancient ethics and values to resolve them.

Suggestive Mode of Assessment

The approaches to learning assessment will include, for example:

- Supporting the curiosity and interest of student teachers in the selected themes through a multi-modal approach, including regular assessments and actionable feedback that enable learners to outline and interpret the processes and events of the formation & evolution of knowledge of India through a multidisciplinary lens.
- Enabling the student teachers to demonstrate critical analysis and independent thinking of the processes and events in the formulation & evolution of different traditions that help student teachers evaluate the diverse traditions of India to distinguish its achievements and limitations.
- Use of first-hand or second-hand experiences that enable student teachers to develop and articulate an ethics-based education rooted in Indian thought to their students in the classroom context.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

1. Altekar, (1975). *Education in Ancient India(7th Ed.)*. MonoharPrakashan.
2. Anca&Alexendra (2021). *Food Cultures across time: Flavours and endeavours*.Cambridge Scholars Publishing.
3. Best, R. (2000). *Education for spiritual, moral, social and cultural development*.Bloomsburry Publishing.
4. Bhatnagar, P. (2009). *Traditional Indian customs & textile.*Abhishek Publication.
5. Chatterjee. S &Datta, D. (1939).*An introduction to Indian Philosophy*.MotilalBanarasidass.
6. Furstenao, N. M. &SeAnne (2023). *Food and culture*. Cenege learning.
7. Joseph, T. (2018) Early Indians: The story of our ancestors and where we came from. Juggernaut Books.
8. Kabir, H. (1964). *Indian Philosophy of Education*. Asia Publishing House.
9. Mohammed, G. (1998). *The sacred origin of sports and culture*.Fons Vitae.
10. Mookerji, R.K. (1947). *Ancient Indian Education*. MacMillan and Co. Ltd.
11. NCF (2005). National focus group on Arts, music, dance and theatre. NCERT.
12. NCF (2005). National focus group on heritage crafts. NCERT.
13. Radhakrishnan, S. (2008). *Indain Philosophy*. Oxford.
14. Roche, Daneil (1996). *The culture of clothing: Dress and fashion in ancien Regime*. Cambridge University Press.
15. Sharma, R. P. &Srivastva, A. (2013). *Aspects of Spirituality and Education*.Kaveri Books.
16. Sharma, T. R. (2017).*The original philosophy of yoga*. VijyakumarGovindramHasanand
17. Singh, U. (2021). Ancient India: Culture of contradictions. Rupa Publication.
18. Walker, B. J. (2014). *Ethics and the autonomy of philosophy*. Pickwick Publications.

AE&VAC- VI: Teacher and Society

Credits: 2
Contact Hours: 2 hours per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

Teachers unarguably have the key role in nurturing young lives and shaping positive and inspired future generations. Emphasizing on the crucial role of teachers NEP 2020 states "teachers truly shape the future of our children - and, therefore, the future of our nation.". "The high respect for teachers and the high status of the teaching profession must be restored to inspire the best to enter the teaching profession. The motivation and empowerment of teachers is required to ensure the best possible future for our children and our nation." (NEP Para 5.1). The NEP in its introductory section states, "the teacher must be at the center of the fundamental reforms in the education system" and highlights the need to "help re-establish teachers, at all levels, as the most respected and essential members of our society, because they truly shape our next generation of citizens". (NEP 2020, Introduction). The policy also stresses the need to "do everything to empower teachers and help them to do their job as effectively as possible." It is recognized that teachers are second to mothers in having the opportunity to work with children during the most impressionable years in their life and shape opinions, form ideas about personal and social goals and about society and life, contributing so much to the development of both individuals and society.

The focus of the course on 'Teacher & Society' is on developing an understanding among student teachers of the roles of teachers in the emerging Indian society, including the changing roles of teachers in the context of the global flows of people, culture and resources that are shaping society, and the application of technologies that are constantly redefining not only the educational landscape but also the human relationships and social norms which are continuously undergoing change which entails a recalibration of the teacher roles aligned to the current and future realities and preparing teachers for the volatile, uncertain, complex and ambiguous world. The course enables the students to understand the roles and obligations of teachers as an architect of the society based upon the cultural ethos, traditions, and diversity. The student teachers shall be equipped with the knowledge, capacities and value system that enables them to act as an agent for fostering national integration, a feeling of pride in the cultural heritage and achievements of India. This course also aims to ensure that student teachers understand their responsibility for producing a future generation that undertakes its responsibility as an awakened citizen who avoids wastage of national resources and takes up a proactive role for the emergence of India as a strong and disciplined nation.

In addition to these, the course also seeks to enable each of the student teachers to respond to the needs of students from diverse cultural, linguistic, social and economic backgrounds; to be sensitive to gender issues, promote tolerance and social cohesion, provide special attention to students with learning disabilities, learn and apply new pedagogies and technologies, keep pace with current educational developments and initiatives; and keep oneself professionally engaged to update/upgrade knowledge and practice. Student teachers will be encouraged to comprehend how societal structures, context and historical patterns shape teacher identities on one hand and how teacher identities, beliefs, values, convictions and commitment shape the ethics, culture, norms and values on the other; thus, impacting the larger societal thoughts and actions. The course also explores the relationship of the teacher with education development, community and society through different course units that talk of the teacher as a person and as a professional, the socio-cultural and technological contexts of the teacher and how they impact the teaching-learning process, the multiple roles, identities and expectations of a teacher. It invites the student teachers to be reflexive of one's thoughts, beliefs and actions and continuously take a gaze inside out so as to unbiasedly engage children in a reflective dialogue.

The course explores the agentic role of a teacher, how it gets influenced and how it influences the education system. It concludes with the re-calibrating of roles of teacher and teaching beyond the curricular boundaries as an architect of an inclusive, harmonious, and developing India.

Learning Outcomes

After completion of the course, student teachers will be able to:

- examine the relationship between teacher beliefs, values, character, life history, social and cultural context and teaching critically,
- explain the teacher roles and characteristics; the personal and professional self; the teacher as a communicator, the charismatic influencer, the reflective practitioner, competent, learner and much more and their significant role in nurturing the posterity.
- differentiate between the narrow curricular aims of education and the broader educational aims and their role in shaping self, school, and society,
- demonstrate an ability to develop positive classrooms through engaging in the ethic of care,
- demonstrate an ability to critically reflect on personal and collective practice so as to improve learning and teaching,
- conceptualize teacher agency, its individual, contextual, and structural dimensions and how it gets impacted and in turn shapes education.

UNIT – I: Understanding the Teacher: Exploring the Personal and Professional Teacher

- Exploring the wider Personal and General Social Context of Teacher: Biography of any eminent Teacher, Teacher Beliefs, Values and Aspirations, Diverse Identities, Social Contexts and Commitment to Learning and Education of a teacher.
- Exploring the Professional Teacher: Teachers' Qualifications, Attitude, Aptitude, Experience and Exposure.
- Qualities of teacher; The good Communicator, The vissionary, The Reflective Practitioner and teacher as a life long learner.

UNIT – II: Nurturing the Teacher: A Dialogue beyond the curricular goals, for Life and Posterity

- Teaching: One profession, many roles
- Teaching Character: Nurturing Teachers for Human Flourishing.
- Holistic Teacher Development: Nurturing the Panchakoshas.
- Current Philosophy of Teaching: A Reflective Dialogue.
- Developing an Ethic of Care in Teacher Education: Nurturing Teachers towards a pedagogy of care.
- Taxonomy of teacher behavior, performance appraisal of teachers.
- Concept, Determinants, Identification and Characteristics of teacher Effectiveness.

UNIT – III: Teacher as an Architect of the New India: Shaping the Society of Tomorrow

- Engaging in Critical Education: Dialogues on power relations associated with Gender, Class, Caste, Ethnicity; the

reproduction of disadvantage and realizing the true human potential.

- Being a Critical Teacher: Raising debates around rapid technological advancement and impact on individual, family and social life.
- The growing use of technogy education changes in teachres role and relations. changing relationships between the 'state' and the 'market' and their impact on formal education; the conceptualization of teacher, teaching and teacher roles,
- Globalization' and the reconstructed nationalism shaping the socio-political milieu and impact on social psyche, growing materialistic urge, sensory drives and the gradual deterioration of the individual and societal character.

Suggestive Practicum

- Take up a case study of any one teacher education Institution.
- Write a biography of any one of your favourite teachers/ Educationists.
- Select any one current practice in teacher education and trace the background of its formulation as a policy.

Suggestive Mode of Transaction

Lecture-cum-discussion, Assignment, Presentation by Student

Interaction through Multimedia Resources, Web based interaction etc

Teacher and Society is a reformatory course that invites teachers to re-think teachers and teaching. It awakens and inspires teachers to realize broader educational aims through an action and reflection cycle. The approach therefore would include a blend of lectures, in-class seminars, thinking exercises, critical reflections, group-work, case-based approaches, and enquiry-based learning.

- Learners would also be exposed to case studies featuring teachers from a representative cross-section of Schools in India and critically analyse their exercise of agentic force in school improvement and the improvement of teaching practice.
- Situating themselves in the geo-political context, the learners will get to critically engage in some of the policy dialogues.
- Learners would reflect on their practice as pre-service interns, knowledge, skills, and understandings—and identify opportunities to apply course learnings to their school context.

Suggestive Mode of Assessment

Being a very thought-provoking course, the assessment would largely include critical thinking kind of assignments. The following are some exemplars.

- Write your current teaching philosophy based on your beliefs and values.
- Choose any one area of immediate societal concern like environmental degradation, increasing crime against women, cybercrimes, bullying or any other and draw an action plan that you as a teacher would undertake to mobilize self, school and society towards betterment.
- 3Critical Reflections on popular debates around power relations associated with Gender, Ethnicity, Culture, Disability, Class, Poverty, and such others

These are just prototypes and institutes may choose either of these or think of other innovative assignments that would inculcate in the future teachers a sense of belonging for society.

Suggestive Reading Materials

- Education in emerging India society. N.R. Swaroop/AartiShashi Dorgan
- Education in Emerging India 2nd Edition. S. Gupta
- Principles of education and Education in the emerging India Society. B.N. Dash
- Ritika Chauhan (2013) Education and society, Sublime Publications.
- Sahoo P.K. et al (eds) (2010), Professionalism in Teacher Education, new Delhi, concept.
- Passi B.K. (eds) (1976), Becoming better Teacher, Ahmedabad, Sahitya Mudranalaya
- Flanders N.A. (1970) Analysing Teaching Behaviour, Reading Mass, Addison–Wesley
- Arora, G.L (2005) Teachers and their Teaching: Need for New Perspectives. Ravi Book, Delhi
- Cohen Louis, Minion Lawrence & Morrison, Keith (2004), A guide to teaching Practice (5th edition). Rout ledge Falmer. London and New York
- NCTE (1998). Competency based and commitment-oriented teacher education for quality education: pre service education, NCTE, New Delhi.

SEMESTER - III

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	FE	Child Development & Educational Psychology	FE-II	4	100	40	--	60	4
2	DC (Major) Any one Group	Physics/Chemistry/ Mathematics Botany/Zoology	DC-V*	3+1	100	15	25	24	5
			DC-VI*	3+1	100	15	25	24	5
			DC-VII	3+1	100	15	25	24	5
3	DCM (Minor) Other than Major	Physics/Chemistry/ Mathematics Botany/Zoology	DCM-II*	4	100	15	25	60	5
4	CP	Content-cum-Pedagogy-Secondary Courses: General	CP-I	4	100	40	--	60	4
Total				**24**	**600**	**140**	**100**	**360**	**28**

***The practical of Subject mathematics is Internal**

SEMESTER – III
PHYSICS
DC- V: Waves and Optics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
This course will enable the students to

1. Explain the phenomena pertaining to the concept of waves, their relationship with various forms and wave propagation.
2. Explain formation of images and various defects of images.
3. Discuss the phenomena of interference, diffraction and polarization.
4. Design experiments to observe different optical phenomena and relate them with daily life.

Unit-1: Oscillations
Free Oscillations of simple system; small oscillation approximation solutions; damped oscillation, forced oscillation and resonance; linear and transverse oscillations of a mass between two springs; Diatomic molecule; reduced mass concept. Free oscillations of system with two degrees of freedom; normal modes, Waves in media: propagation of longitudinal waves in an elastic solid and in a fluid.
Lissajous Figures (1:1 and 1:2)
Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.
Unit-2: Geometrical Optics
Fermat's Principle; principle of extremum path, general theory of image formation; cardinal points of an optical system, general relationships, thick lens and lens combinations; Lagrange equation of magnification, comparison between Huygens and Ramsden eyepiece. Aberration in images: Chromatic aberration, achromatic combination of lenses in contact and separated lenses, Monochromatic aberrations and their reductions, the aplanatic points of a sphere and other applications, aspherical mirrors, oil immersion objectives, meniscus lens.

Unit-3: Wave Optics & Interference of Light:
Huygens Principle, the principle of superposition, interference from n sources, spatial and temporal coherence, optical path retardations, lateral shift of fringes, localized fringes; thin films, Newton's rings and its applications, Michelson interferometer, its application for precision determination of wavelength, wavelength difference and width of spectral lines
Unit-4: Diffraction
Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating, diffraction at a circular aperture and a circular disc.
Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.
Unit-5: Resolving Power and Polarization
Resolution of images, Rayleigh criterion, resolving power of telescope, grating and prism. Double refraction and optical rotation: Refraction in uni-axial crystals, its theory, Nicol Prism; rotation of plane of polarization, origin of optical rotation in liquid and in crystals; optical activity; production and detection of linearly and circularly polarised light; Fresnel theory; Faraday rotation; Lorentz half shade polarimeter

Suggested Readings:

• Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
• Principles of Optics, B.K. Mathur, 1995, Gopal Printing
• Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
• University Physics, FWSears, M W Zemansky and H D Young 13/e, 1986, AddisonWesley

Practicals
DC- V: Waves and Optics

Credit: 01
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25
1. To investigate the motion of coupled oscillators.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focusing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light
8. To determine the value of Cauchy Constants of a material of a prism.

9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium & (2) Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.
16. To determine the wavelength of laser light by grating.
17. To determine radius of curvature of given plano convex lens by Newton's ring apparatus.
18. To determine wavelength of different colours by using transmission grating.
19. To verify Newton's law of combination of lenses by Nodal light assembly.
20. To study the optical rotation by cello tape.
21. To determine the specific rotation of sugar using Laurent's half shade polarimeter.
22. To determine Brewster's angle for a glass surface.
23. To determine resolving power of a telescope.
24. To determine the refractive index of water by Boy's method.
25. Find the frequency of ac mains by Melde's apparatus.
26. To determine the wavelength of sodium light by Michelson Interferometer
27. To detect linearly, circularly and elliptically polarizes light using Babinet compensator.

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Ghatak, Physical Optics
- Sears and Zemanski, Optics and Atomic Physics
- Goyal, R.P., Unified Physics, Shivlal Agrawal and Co.
- Waves and Vibration, J. Pain

DC- VI: Electronic Devices and Circuits

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

This course will enable the students to
1) To understand the theory of semiconductors devices and its applications
2) To analyze PN junctions in semiconductor devices under various conditions.
3) To design and analyze simple rectifiers and voltage regulators using diodes
4) To describe the behavior of special purpose diodes
5) To design and analyze simple BJT and MOSFET circuits.
6) To understand the benefits of feedback in amplifier
7) To compare and classify oscillators
8) To understand the working of operational amplifiers and their different applications in different circuits.
9) To apply their knowledge in analyzing Circuits by using network theorems

Unit -1: Solid State Devices

Semiconductors ; intrinsic semiconductors, Fermi level, temperature dependence of electron and hole concentrations; extrinsic semiconductors: doping, impurity states, electronic transport in semiconductor, PN Junction, Diode equation and diode equivalent circuit, Junction Breakdown- Zener breakdown, Zener diodes, Tunnel diode, Diode Rectifiers and rectification, light emitting diode, Schottky diode, photovoltaic cell, Hall effect and its uses.

Unit- 2: Transistors

Bipolar Junction transistors: n-p-n and p-n-p Transistors, Characteristics of CB, CE and CC Configurations, Current gains α, β and γ. Relations between α, β and γ. Voltage Divider, EMITTER FOLLOWER, Bias Circuit for CE Amplifier, h-parameter Equivalent Circuit. Impedance, FET, MOSFET and their characteristics.

Unit-3: Amplifiers and Oscillators

Single stage amplifiers, Multistage amplifiers, RC coupled amplifier, gain frequency response, input and output impedance, transformer coupled amplifiers, Feedback in amplifiers, types of feedback, voltage gain of feedback amplifier, advantages of negative feedback, oscillators, Barkhausen criteria for oscillations, classification of oscillators.

Unit 4: Operational Amplifiers (Black Box approach):

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop& Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero Crossing Detector.

Unit 5: Circuit and Network Analysis

Circuit Elements and Kirchoff's Laws, Methods of analyzing circuits, Thevenin's Theorem, Superposition Theorem, Maximum Power Transfer Theorem, Introduction to Laplace Transform, Application of Laplace Transform in Circuit Analysis

Practicals

DC- VI: Electronic Devices and Circuits

Credit: 01
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. To study I-V characteristics of PN diode,
2. To study I-V characteristics Zener and
3. To study I-V characteristics Light emitting diode
4. To study the characteristics of a Transistor in CE configuration.
5. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
6. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
7. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
8. To study a precision Differential Amplifier of given I/O specification using Opamp.
9. To investigate the use of an op-amp as a Differentiator
10. To design a Wien Bridge Oscillator using an op-amp.

Suggested Readings:

1. Robert L Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Eleventh Edition, Pearson India Education Services Pv Ltd., 2015.
2. Donald A Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.
3. Albert Malvino and David Bates, Electronic Principles, Eighth Edition, McGraw Hill Education, 2016.
4. Electronics Devices And Circuits by J B Gupta, Katson Books, 2012.

DC- VII: Solid State Physics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

This course will enable the students to:

1. Understand amorphous and crystalline solids and various types of crystal structures.
2. Derive expressions for packing fractions of simple cubic, body centered cubic and face centered cubic lattices as well as their coordination numbers.
3. Understand the use of X-rays in studying the crystal structures.
4. Understanding various types of bonding in solids as well as calculate the binding energy of ionic crystals.
5. Understand the concept of lattice vibrations, phonons and specific heat of solids.
6. Understand Einstein and Debye's theory of specific heat of solids.
7. Understand electrical phenomena in solids and the role of quantum mechanics to study the electronic transport in metals, semiconductors and superconductors.
8. Explain the concept of photoelectric effect and the Heisenberg Uncertainty Principle
9. Apply Schrodinger's equation for solving problems of harmonic oscillator and hydrogen atom

10. Explain electrical and magnetic properties of crystals.

Unit-1: Crystal Structure:
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Symmetry operation in lattices, Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice.
Types of Lattices. Symmetry operation in lattice, why fivefold symmetry does not exist? Bravais lattices, seven crystal systems, cubic lattices, coordination number, packing fraction of SC, BCC and FCC structures, simple crystal structures like sodium chloride, calcium chloride and diamond, Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Laues equation for X-Ray diffraction, X-ray diffraction methods, Reciprocal lattice, Bragg's law in reciprocal lattice, Brillouin zones.

Unit-2: Theory of Solids
Inter atomic forces and types of bonding, ionic, covalent, Vanderwall, metallic, hydrogen cohesive energy of a solid, binding energy of ionic crystals, Madelung constant, Free electron theory of metals (Classical and Quantum theory), Nearly Free electron theory, Kronig Penny model (only qualitative analysis). Band Gaps. Conductors, Semiconductors and insulators.

Unit-3: Elementary Lattice Dynamics
Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Dispersion relations, Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

Unit-4 Magnetic Properties of Matter
Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit-5: **Superconductivity**: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth, Flux quantization, Josephson's effect (DC and AC), Application of superconductivity, SQUID, High temperature super conductivity (HTSC).

Suggested Readings:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Basic Quantum Mechanics, Ajoy Ghatak
- Quantum Mechanics, Peebles
- Quantum Mechanics, Agarwal / Hari Prakash
- Introduction to Quantum Mechanics, Pauling / Wilson
- Quantum Mechanics, Schiff
- Quantum Mechanics, Powell and Crasemann
- Quantum Mechanics, Eisberg / Resnick
- Advanced Quantum Mechanics, J. J. Sakurai
- Kittel, C., Introduction to Solid State Physics, John Wiley and Sons, Newyork
- Pillai, S.O., Solid State Physics, New Age International, New Delhi.
- Gupta, S.L. and Kumar, V., Solid State Physics, K. Nath and Co., Meerut.

Practicals
DC- VII: Solid State Physics

Credit: 01
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Measurement of susceptibility of paramagnetic solution (Quick's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.

8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe method (from room temperature to 150^0 C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11. To find the value of e/m for electron by Thomson method.
12. To determine the Planck's constant (h) by measuring radiation in a fixed spectral range.
13. To calibrate constant deviation spectrometer.
14. To find dielectric constant of a glass plate with the help of parallel plate capacitor.
15. To study the effect of temperature on the reverse current in junction diode and hence to determine the forbidden energy gap.
16. To determine power factor by joule's calorimeter.
17. To determine the height of a distant object using sextant.
18. To determine Rydberg's constant with the help of diffraction grating and hydrogen discharge tube.
19. To find the wavelength of sodium D1 and D2 line by spectrometer.
20. To determine the charge of an electron by Millikan's oil drop method.
21. To study the absorption spectra of KMnO4 using diffraction grating.
22. Study of Hysteresis loss using B-H curve.

Suggested Readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

MATHEMATICS
DC – V: Group Theory

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.;
- Link the fundamental concepts of Groups and symmetrical figures;
- Analyze the subgroups of cyclic groups;
- Explain the significance of the notion of cosets, normal subgroups, and factor groups.

Unit-I

- Group: Definition, examples, properties of groups.
- Subgroup: Definition, examples, algebra of subgroups, Centralizer, Normalizer, Center of a group.
- Order of a group. Order of an element of a group.

Cyclic group: Definition, examples and properties. Classification of subgroups of cyclic groups, Generator of cyclic groups.

Unit-II

- Coset decomposition, Lagrange's theorem and its consequences.
- Fermat's and Euler's theorems.

Unit-III

- Homomorphism, Automorphisms and inner automorphism, Isomorphism and their computations.
- Normal-subgroups, Quotient groups.
- Conjugacy relation, Counting principle and the Class equation of a finite group.
- Fundamental theorem of Homomorphism.

Unit-IV

- Permutations, Permutation groups and its properties.
- Even and Odd permutations, Alternating groups, Cayley's theorem.

Unit-V

- Abelianizing of a group and its universal property.
- Sylow's theorems, p-Sylow subgroups.
- Cauchy's theorem for finite abelian groups. Structure theorem for finite abelian groups.

Suggested Readings:

- J.N. Heirstein, Topics in Algebra wiley Eastern limited
- John B Fraleigh, A First Course in Abstract Algebra,Pearson
- Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
- Dummit, David S., & Foote, Richard M. (2016). *Abstract Algebra* (3rd ed.). StudentEdition. Wiley India.

Practical

DC – V: Group Theory

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:
The learner will be able to-
- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DC – VI: Partial Differential Equations

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:
- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.

Unit-I
- Partial differential equations of the first order.
- Lagrange's method, Standard forms- I, II, III and IV.
- Charpit`s method.

Unit-II
- Partial differential equations of second and higher orders.
- Classification of linear partial differential equations of second order. Homogenous and non-homogenous equations with constant coefficients.
    - Partial differential equations reducible to equations with constant coefficients. Monge's methods.

Unit-III
- Wave Equations: Method of separation of variables, Initial and Boundary Value Problems, Vibrating string problem, Existence and uniqueness of solution of vibrating string problem.

Unit-IV
- Cauchy problem for second order PDE, Homogeneous and Non-Homogeneous wave equation.

Unit-V
- One Dimensional Heat Equation: Derivation, solution and its applications.

Suggested Readings:

- Myint-U, Tyn & Debnath, Lokenath. (2007). *Linear Partial Differential Equation forScientists and Engineers* (4th

ed.). Springer, Third Indian Reprint, 2013.
- Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, DoverPublications. Indian Reprint.
- Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introduction with Mathematica and MAPLE* (2nd ed.). World Scientific.

Practical
DC – VI: Partial Differential Equations

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to-
- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DC – VII: Multivariate Calculus

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25

Learning Outcomes: This course will enable the students to:
- the conceptual variations when advancing in calculus from one variable to multivariable discussions.
- inter-relationship amongst the line integral, double and triple integral formulations.
- applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

Unit-I
- Functions of several variables: Level curves and surfaces, Limits and continuity.
- Partial differentiation, Higher order partial derivatives.

Unit-II
- Tangent planes, Total differential and differentiability, Chain rule and Directional derivatives, Gradient, Tangent planes and normal lines.

Unit-III
- Extrema of functions of two variables, Constrained optimization problems.
- Maxima, minima and saddle points of functions of two variables, Lagrange's multiplier method.
- Euler's theorem on homogenous functions.
- Taylor's theorem for functions of two variables.
- Jacobians, Indeterminate forms.

Unit-IV
- Double integration over rectangular and non-rectangular regions, Double integrals in polar co-ordinates,
- Triple integral over a parallelopiped and solid regions, Volume by triple integrals, triple integration in cylindrical and spherical coordinates, Dirichlet's integrals.

Unit-V
- Change of order of integration.

- Beta and Gamma functions.

Suggested Readings:

- Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.).Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.
- Marsden, J. E., Tromba, A., & Weinstein, A. (2004). *Basic Multivariable Calculus*.Springer (SIE). First Indian Reprint.
- S.C. Mallick - Mathematical Analysis, Wiley Eastern Limited

Practical

DC – VII: Multivariate Calculus

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in Mathematics papers CC-MT-302 and CC-MT-303 by using Mathematical software or computer programming languages.
- connect basic concepts of Mathematics papers CC-MT-302 and CC-MT-303 with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the Mathematics papers CC-MT-302 and CC-MT-303 using Mathematical software or computer programming languages.
- use various applications of Mathematics papers CC-MT-302 and CC-MT-303 with daily life problems.

CHEMISTRY

DC- V: Inorganic Chemistry- II

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. learn general metallurgical process of metals along with thermodynamic aspects involved in the process.
2. obtain detailed knowledge of the chemistry of s-block elements and their complex formation tendency.
3. differentiate the chemistry of s-block and p-block elements.
4. investigate the detailed chemistry of oxide, oxoacids and halides of group 13 and 14 elements.
5. learn the technique of preparation, properties and structure of borazine silicates, silicones, clatherates and compounds of Xenon.
6. estimate Cu (II), Mg (II), Ca (II) by iodometric and complexometric titration along with preparation of certain important inorganic compounds like Cu_2Cl_2, $MnPO_4\ H_2O$ and Alums.

Unit-I: General Principles of Metallurgy

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 and Mond's process, Zone refining.

Unit-II: Chemistry of s Block Elements

(i) General characteristics: Electronic configuration, General Physical and Chemical Characteristics, diagonal relationships and anomalous behavior of first member of each group.
(ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.

(iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates and halides.
(iv) 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.
(v) Solutions of alkali metals in liquid ammonia and their properties.

Unit-III: Chemistry of p Block Elements

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, 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: Structure, bonding and properties

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

- Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E=N, P, As, Sb, Bi), Group 16 and Group 17.
- Oxides: oxides of phosphorus, sulphur and chlorine
- Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur
- Halides: halides of silicon and phosphorus

Unit-V: Preparation, properties, structure and uses of the following compounds:

- Borazine
- Silicates, silicones,
- Phosphonitrilic halides {$(PNCl_2)n$ where n = 3 and 4}
- Interhalogen and pseudohalogen compounds
- Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF_2)
- Compounds of Xenon with fluoride and oxygen.

Suggested Readings:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann. 1997.
- +Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009
- Shriver, D.F., Atkins P.W and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.

Practicals

DC- V: Inorganic Chemistry- II

Credit: 01
Max. Marks: 25
External: 25

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
(ii) Estimation of antimony in tartar-emetic iodimetrically

(B) Complexometric titrations using disodium salt of EDTA

(i) Estimation of $Mg2^+$, $Zn2^+$
(ii) Estimation of $Ca2^+$ by substitution method

(C) Inorganic preparations

(i) Cuprous Chloride, Cu_2Cl_2
(ii) Manganese(III) phosphate, $MnPO_4.H_2O$
(iii) Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Suggested Readings:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978
- Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

DC- VI: Organic Chemistry- II

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. understand the detailed chemistry of alkyl and aryl halides along with chemistry of Grignard reagent.
2. differentiate the nature of alcohol and phenols and their reactivity.
3. correlate structure of carbonyl compounds with their reactivity.
4. compare the acidic behavior of mono, di and tri carboxylic acids.
5. distinguish the chemistry of $1^{\circ}, 2^{\circ}$ and 3° amines.
6. prepare some important organic compounds employing conventional and green methods.

Unit-I: Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

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

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

Unit-II: Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-BlancReduction; Oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4

Unit-III: Carbonyl Compounds

Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner,LiAlH4, NaBH4, MPV, PDC)

Addition reactions of α, β- unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit-IV: Carboxylic Acids and their Derivatives

General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids , hydroxy acids and unsaturated acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilicsustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.

Unit-V: Nitrogen Containing Functional Groups

Preparation and important reactions of nitro compounds, nitriles and isonitriles.

Amines: Preparation and properties: Effect of substituent and solvent on basicity; Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

Suggested Readings:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

Practicals
DC- VI: Organic Chemistry- II

Credit: 1
Max. Marks: 25
External: 25

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:

i. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β -naphthol, vanillin, salicylic acid) by any one method:

a. Using conventional method.

b. Using green approach
ii. Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction.
iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
iv. Selective reduction of meta dinitrobenzene to m-nitroaniline.
v. Hydrolysis of amides and esters.
vi. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
vii. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
viii. Aldol condensation using either conventional or green method.
The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Suggested Readings:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

DC- VII: Physical Chemistry- III

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. construct and to analyze phase diagram of one component and two component systems.
2. differentiate between specific equivalent and molar conductance and will analyze the variation of conductance of weak and strong electrolysis with concentration.
3. know the construction and working of galvanic and concentration sells.
4. differentiate between order and molecularity its, kinetics of fast and slow reaction, parallel and consecutive reactions, collision and transition state theory.
5. categorize catalysts and investigate various types of catalyzed reactions like solid phase catalysis, enzyme and acid-base catalysis.
6. determine critical solution temperature of some common system like phenol-water system.
7. perform potentiometric and conductometric titration and study kinetics of hydrolysis of ester in various media.

Unit-I: Phase Equilibria

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Three component systems: triangular plots, water-chloroform-acetic acid system. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit-II: Conductance

Quantitative aspects of Faraday's laws of electrolysis Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution, Ostwald's dilution law.

Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of

conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit-III: Electrochemical Cells

Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Unit-IV: Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, 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) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit-V: Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Suggested Readings:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
- Ball, D. W. Physical Chemistry Cengage India (2012).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

Practicals
DC- VII: Physical Chemistry- III

Credit: 1
Max. Marks: 25
External: 25

Phase Equibria:

I. Determination of critical solution temperature and composition at CST of the phenol-water system and to study the effect of impurities of sodium chloride and succinic acid on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I-(aq) \rightarrow I_3^-(aq)$

(ii) $Cu_2{+}(aq) + nNH_3 \rightarrow Cu(NH_3)\ n^{2+}$

Potentiometry:

V. Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Potassium dichromate vs. Mohr's salt

Conductometry: Conductometric titrations i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base.

Chemical Kinetics:

Hydrolysis of ester in acid and alkaline medium, inversion of cane sugar.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 25

- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)

BOTANY
DC- V: Genetics

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
To enable the students to have an understanding about origin of life types, genetic diversity and gene flow rules and regulatory phenomenon's etc.

Unit 1: Mendelian genetics and its extension
Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Complementary gene, Epistasis, Duplicate gene, Inhibitory gene, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.
Unit 2: Extrachromosomal Inheritance, linkage, Sex linked inheritance and crossing over Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;
Resistance: Streptomycin resistance in Chlamydomonas; Deficiency: Pocky strain in Neurospora and Petite strain in Yeast
Maternal effects-Male sterility in Maize; Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numerical based on gene mapping; Sex Linkage.

Unit 3: Variation in chromosome number and structure and gene mutations
Chromosomal aberrations: Deletion, Duplication, Inversion, Translocation, Position effect, Ploidy changes: Euploidy and Aneuploidy.
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method.
Role of Transposons in mutation, DNA damage and repair mechanisms.
Unit 4: Fine structure of gene
Concept of Gene: Fine structure of gene and classical vs molecular, concepts of gene, Human Genome Projects, features and implications.
Unit 5: Population and Evolutionary Genetics
Genetic variation and Speciation; Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Practicals
DC- V: Genetics

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.

7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, XerodermaPigmentosum, Albinism, red-green Color blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

DC- VI: Molecular Biology

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To enable the students to have an understanding about genetic material, role and replication and protein synthesis etc.

Unit 1: Nucleic acids and Central Dogma

Historical perspective; DNA as the carrier of genetic information- Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel- Conrat's experiment).

Central Dogma- Adaptor hypothesis and discovery of mRNA template, Genetic code- deciphering, HarGobind Khorana, s contribution and salient features

Unit 2. The Structures of DNA and RNA/Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and re-naturation, C-value paradox, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes; Organization of mitochondria DNA and chloroplast DNA, Nucleosome, chromatin structure- euchromatin, heterochromatin.

RNA Structure and types of RNA.

Unit 3: The replication of DNA

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, Meselson and Stahl's experiment, RNA priming.

DNA replication in prokaryotes, theta (θ), omega(σ) and linear mode of replication. Replication in Eucaryotes, enzymes involved in DNA replication, events at replication forks, significance of replication.

Unit 4: Transcription and Processing of RNA

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation;

Split genes-concept of introns and exons, removal of introns, splicing mechanism, alternative splicing, eukaryotic mRNA processing, Ribozymes; RNA editing and mRNA transport.

Regulation of gene expression in Prokaryotes: Operon concept- lac operon, trp operon in E. coli.

Regulation of gene expression in Eukaryotes: Role of gene regulatory proteins, transcription factors, gene activator and repressor proteins, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit 5: Translation

Ribosome structure and assembly, mRNA; Charging of tRNA.

Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; post-translational modifications of proteins.

Practicals
DC- VI: Molecular Biology

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25

External: 25

1. Preparation of LB medium and raising E. coli
2. Isolation of genomic DNA from E. coli
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Meselson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel&Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

DC- VII: Plant Ecology and Phytogeography

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To enable the students to have an understanding about plants and their interaction with environment, biotic and abiotic components of ecosystems etc.

Unit 1: Introduction to ecology, soil and water

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.
Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components;
Soil profile; Role of climate in soil development.
Water: Importance, States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 2: Light, temperature, wind and fire and biotic interactions

Variations; adaptations of plants to variation of light, temperature, wind and fire.
Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Unit 3: Population ecology and Plant communities

Characteristics and Dynamics, Ecological Speciation, Concept of ecological amplitude; Habitat and niche; Community characters: analytical and synthetic; ecotone and edge effect, ecotype and ecads.
Dynamics: succession –hydrosere, xerosere, processes, types; climax concepts.

Unit 4: Ecosystems and its functional aspects

Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids.
Principles and models of energy flow; Ecosystem services; Production and productivity.
Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit 5: Phytogeography

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra).
Phytogeographical regions of India; Local Vegetation of concerned area.

Practicals
DC- VII: Plant Ecology and Phytogeography

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper).
2. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley& Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of Hydrophytes and Xerophytes (four each).

(b). Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).

9. Determination of minimal quadrant size for the study of herbaceous vegetation in the Institute campus, by species area curve method (species to be listed).
10. Quantitative analysis of herbaceous vegetation in the Institute campus for frequency and comparison with Raunkiaer's frequency distribution law.
11. Quantitative analysis of herbaceous vegetation for density and abundance in the Institute campus.
12. Field visit to familiarize students with ecology of different sites.

Suggested readings:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach, Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of Ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

ZOOLOGY
DC- V: BIOCHEMISTRY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Carbohydrates and Lipids

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

Lipids: Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids,

Steroids

Unit 2: Proteins and Nucleic Acids

Amino acids: Structure, Classification and General properties of α-aminoacids; Physiological importance of essential and non-essential α-amino acids

Proteins: Bonds stabilizing protein structure; Levels of organization inproteins; Denaturation; Introduction to simple and conjugate proteins

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hypo and Hyperchromaticity of DNA

Unit 3: Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action;

Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affectingrate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation,

Unit 4: Overview of Metabolism and Carbohydrate Metabolism

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy currency of cell";

Sequence of reactions and regulation of glycolysis, Citric acid cycle

Unit 5: Lipid Metabolism, Protein Metabolism and Oxidative Phosphorylation

β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms

Protein Metabolism: Catabolism of amino acids: Transamination, Deamination,

Oxidative Phosphorylation: Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

PRACTICALS
DC- V: BIOCHEMISTRY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE.
6. Estimation of total protein in given solutions by Lowry's method.
7. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
8. To study the enzymatic activity of Trypsin and Lipase.
9. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab.Press, Pearson Pub.

DC- VI: ANIMAL PHYSIOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Tissues, Bone and Cartilage

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Structure and types of bones and cartilages, Ossification, bone growth andResorption

Unit 2: Nervous System and Muscle

Structure of neuron, nerve impulse and its conduction across the myelinated and unmyelinated nerve fibers; Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc.

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction.

Unit 3: Reproductive System and Endocrine System

Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female; Histology and functions of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal.

Unit 4: Physiology of Digestion and Respiration

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins;

Histology of lung; Mechanism of respiration, Pulmonaryventilation; Respiratory volumes and capacities; Transport of oxygen andcarbon dioxide in blood; Respiratory pigments, Dissociation curves and thefactors influencing it;

Unit 5: Renal Physiology, Blood and Physiology of Heart

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance.

Components of blood and their functions; Structure and functions of Haemoglobin; Blood clotting system, lood groups: Rh factor, ABO and MN.

Structure of mammalian heart. Origin and conduction of cardiac impulsesCardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram.

PRACTICALS
DC- VI: ANIMAL PHYSIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
4. Determination of Blood group (ABO and Rh factor)
5. Enumeration of red blood cells (total count) and white blood cells differential count using haemocytometer
6. Estimation of haemoglobin using Sahli's haemoglobinometer
7. Preparation of haemin and haemochromogen crystals
8. Recording of blood pressure using a sphygmomanometer

Suggested Readings:

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott W. & Wilkins.
- Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.

DC- VII: PRINCIPLES OF ECOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Introduction to Ecology

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit 2: Population

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion
Exponential and logistic growth, equation and patterns,
Population regulation - density-dependent and independent factors

Unit 3: Community

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification,
Ecotone and edge effect; Ecological succession with oneexample
Theories pertaining to climax community

Unit 4: Ecosystem

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies.

Unit 5: Biogeochemical cycles and Applied Ecology

Nutrient and biogeochemical cycle with one example of Nitrogen cycle
Human modified ecosystem
Ecology in Wildlife Conservation and Management

PRACTICALS
DC- VII: PRINCIPLES OF ECOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

Suggested Readings:

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press

EDUCATION PART

FE- II: Child Development & Educational Psychology

Credits: 4
Contact Hours: 4
Maximum marks: 100
Internal: 40
External: 60

About the Course

To enable student teachers to understand the interplay of three different processes namely biological processes, cognitive processes, and socio-emotional processes that influence development of a Learner. Biological, cognitive, and socio-emotional processes are intricatelyinterwoven with each other. Each of these processes plays a role in the development of a learnerwhose body and mind are interdependent.

The course seeks to provide an understanding of the developmental characteristics of a learner:

- during Infancy that ranges from birth to 24 months of age,
- during Early Childhood stage which begins around age 3 and usually extends up to 6-7years of age,
- Middle to Late Childhood stage which begins around 6-7 years to 10-11 years of age, and

- Adolescence stage which begins at approximately the age of 12 years, and which is a period of transition from childhood to early adulthood.

The course will introduce development across domains – physical development, cognitivedevelopment, language development, socio-emotional development, aesthetic development,moral development – during each of the above-mentioned developmental stages of a learner.

Educational Psychology component of the course:

Informs student teachers about the various theories of learning and motivational states for learning and their implications for pedagogy. It includes the study of how people learn, pedagogical approaches that are required to improve student learning, teaching-learning processes that enable learners to attain the defined learning outcomes, and individual differences in learning. It provides opportunities to student teachers to explore the behavioral,cognitive and constructivist approach to facilitating student learning, and the emotional and social factors that influence the learning process.

Learning Outcomes

After completion of this course, student teachers will be able to:

describe the meaning, concept, characteristics, and factors affecting growth anddevelopment, use the knowledge of indian concept of self, apply various problem solving and learning strategies in real classroom settings, identify the various approaches of the process of learning, explain group dynamics and apply strategies to facilitate group learning.

UNIT – I: Learner Development

- Understanding the process of growth and Development of Learner (Five-fold development) : Meaning and significance
- Developmental characteristics of a learner during:
  - Infancy stage
  - Early Childhood stage
  - Middle to Late Childhood stage
  - Adolescence stage
- The Indian concept of self: Mind (manas), Intellect (buddhi), Memory (Smriti), Panch- koshiya Vikas.
- Educational Implications of Development

UNIT – II: Understanding Developmental Process at Infancy and Childhood Stage

- Development across domains:
  - Physical Development
  - Cognitive Development
  - Language Development
  - Socio-Emotional Development
  - Aesthetic Development
  - Moral Development.
- Factors affecting development of the child
- Holistic development of the child and role of education

UNIT – III: Understanding Developmental Process at Adolescence stage

- Development across domains:
  - Physical Development
  - Cognitive Development
  - Language Development
  - Socio-Emotional Development
  - Aesthetic Development
  - Moral Development
- Experiences of adolescents in different Indian socio-cultural contexts
- Holistic development of the adolescents and role of education

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UNIT – IV: Process of Learning

- Concept, meaning and significance of learning
- Approaches of learning and related Theories:
  - Behaviorist
  - Gestalt
  - Cognitivist
  - Constructivist
- How to Learn: Significance and Strategies

UNIT – V: Motivation and Classroom Management

- Concept, nature, and significance of motivation, Role of Motivation inlearning, Intrinsic and Extrinsic Motivation, Strategies for Motivation.
- Classroom management:
  - Creating a positive learning environment
  - Planning space for learning
  - Managing behavioral problems in the classroom and school
- Group dynamics:
  - Classroom as a social group
  - Characteristics of group
  - Understanding group interaction-sociometry
  - Strategies to facilitate group learning.
- Involvement of Parents and community in the management of learning.

UNIT – VI: Pyscholigical practicum

- Personality test
- Intelligence test
- Aptitude test

Suggestive Practicum

- Spending day with a child and preparing a report based on our observations of childrenfor:
- A day from different economic status (low and affluent)
- Focus on various factors: Physical, emotional, social, language, cultural andreligious influencing the child on daily basis.
- Observing children to understand the styles of children learning process.
- Identifying the Learning Difficulties of Students in Different learning areas and thePossible Reason for them-Case Study Report.
- Preparing Personalized Intervention plan for Students with Learning Difficulties.
- Plan to use advanced technology to encourage talented / gifted children.
- Encouraging gifted / talented students beyond the general school curriculum.
- Familiarization and Reporting of Individual Psychological Tests.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
  Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work, library study etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials/ References:

- Aggarwal, J.C. (2009). Child Development and the process of Learning, Shipra Publication,Delhi.
- Chaube, S.P. (2007). Developmental Psychology, Neelkamal Publications, Pvt. Ltd,Hyderabad.
- Chauhan, S.S. (2007). Advance Educational Psychology, Vikas Publication, Delhi.
- Dandpani, S. (2001). Advance Educational Psychology, N. Delhi, Anmol Publications. Ainscow, M. (1999). Understanding the Development of Inclusive Schools, London, Falmer Press.
- Hegarty, S. and Mithu Alur (2002). Education and Children with Special Educational Needs -Segregation to Inclusion, N. Delhi, Sage Publication India Pvt. Ltd.
- Hurlock, E.B. (2009). Child Development, Tata McGraw-Hill Publishing Co. Ltd, New Delhi.Mangal, S.K. (2012). Advance Educational Psychology, PHI Learning Pvt Ltd. New Delhi.
- Nambissan, G.B. (2009). Exclusion and Discrimination in Schools: Experience of Dalit Children. Indian Institute of Dalit Students and UNICEF.
- NEP 2020
- Santrock, J.W. (2007). Educational Psychology, Tata McGraw-Hill Publishing Co. Ltd, NewDelhi.
- Saraswathi, T.S. (Ed) 1999, Culture, Socialization and Human Development - Theory,Research and Application in India, Sage Publication, New Delhi.

- Sharma, N. (2003), Understanding Adolescence, NBT India.
- Sprinthal, N. and Sprinthal, R.C. (1990) Educational Psychology, McGraw-Hill, New Delhi.Woolfolk, A. (2013), Educational Psychology, Pearson Education, N. Delhi.
- Venkatesan, S. (2004), Children with Developmental Disabilities: A Training Guide forParents, Teachers and Caregivers, Sage Publication, New Delhi.
- Whitebread, D. (2012) Developmental Psychology and Early Childhood Education, SagePublication, New Delhi.
- Ysseldyke, JE, Algozzzine, B. (1998), Special Education - A Practical Approach for Teachers, New Delhi, Kanishka Publishers Distributors.

Concern Teachers may also suggest books/ readings as per the need of the learners and learningcontent.

CP-I: Content-cum-Pedagogy (Secondary): General Pedagogy

Credits: 4
Contact Hours: 4 hrs per week
Maximum marks: 100
Internal: 40
External: 60

About the Course

This course deals with diverse range of topics of basics of pedagogy at secondary sage that will equip student teachers with valuable knowledge, capacities and competencies. This course comprises four units and a practicum. This course prepares student teachers to understand secondary-stage learners and design teaching accordingly. This course also aims to equip teachers with the necessary tools, knowledge, and competencies to continuously evolve as professionals and create a positive and transformative impact on their students and society as a whole. In this course a strong foundation will be established by exploring the fundamental principles and concepts that support basics of pedagogy in the light aims and objectives of the curriculum. This course emphasizes understanding learners and their backgrounds comprehensively so that an engaging and supportive learning environment, that fosters a need for learning, can be created for facilitating learner's holistic development. This course is designed to equip student teachers with a wide array of teaching learning strategies. It also focuses on innovative and transformative approaches to education, aiming to create lifelong learners equipped to thrive in an ever-changing world. Through professional development opportunities, student teachers will be better prepared to meet the ever-changing demands of the educational landscape and inspire the next generation of learners.

Learning Outcomes

After completion of this course, student teachers will be able to:

- build comprehensive understanding of secondary stage learners,
- assess the physical, mental, social, and emotional growth of secondary stage learners,
- develop skills to observe and recognize the unique capabilities and strengths of secondary stage learner,
- discuss the necessary knowledge and skills to implement effective teaching and learning strategies,
- create enriching and inclusive learning environments to foster values-based education,
- develop a deeper understanding of various pedagogical approaches and their impact on learners,
- determine the knowledge to make informed decisions about instructional practices,
- explain the crucial role of pedagogy in facilitating effective learning experiences for students,
- outline knowledge and skills necessary for continuous professional development.

UNIT – I: Understanding Secondary Stage Learners

A. Understanding the learners and learner background
   i. The physical, mental, social, and emotional growth of learners
   ii. Thought processes and cognitive skills of learners.
   iii. Psychological and social orientations of learners
   iv. Social and academic lives of learners
   v. Conflicts and challenges of secondary learners
   vi. Characteristics of secondary stage learners
B. Observing the unique capabilities of a child

UNIT – II: Strategies of Teaching and Learning

A. Understanding teaching and learning strategies:
   i. Concept, characteristics and functions of teaching

ii. Making abstract concepts enjoyable by relating them to real-life situations,
iii. Promoting multidisciplinary learning through integration of different disciplines
iv. Promoting learner participation and engagement in learning
v. Building values through art integrated activities, community engagement etc.
vi. Promoting multidisciplinary learning through integration of different disciplines
vii. Promoting health and social sensitivities
viii. Developing respect toward cultural heritage
ix. Making classrooms inclusive and joyful learning spaces

B. Relationship between Aims and Values of Education, Curriculum and Pedagogy

UNIT – III: Pedagogical Approaches

A. Pedagogical approaches: constructivist approach; collaborative approach; reflective approach; integrative approach, inquiry- based approach; other contemporary approaches, art-integrated learning, sports- integrated learning.
B. Types of pedagogy: social pedagogy; critical pedagogy; culturally responsive pedagogy; Socratic pedagogy in inclusive setup.
C. Role of pedagogy in effective learning: how does pedagogy impact the learner?

UNIT – IV: Continuous Professional Development of Teacher

A. Meaning and need, professional and ethical competencies and need for updating content and pedagogical competencies to develop their professional competencies.
B. Professional development activities: seminars, conferences, orientation programmes, workshops, online and offline courses, competitions, publications, development of teaching portfolio, capacity building programmes, and teacher exchange programmes.
C. Development of professional competencies to deal with gender issues, equity and inclusion, ethical issues, environmental issues, human health and well-being, population, human rights, and various issues (emotional, mental, physical issues related to pandemic (for example covid-19).

Suggestive Practicum (Any Three)

1. Analyze NEP 2020 with reference to pedagogical aspects of the concerned subject.
2. Analyze and reflect on the qualities of an 'Innovative Teacher' in Context of National Professional Standards for Teachers (NPST) and National Mentoring Mission (NMM).
3. Explore different platforms such as National Teacher's Portal, NISHTHA, DIKSHA, and SWAYAM for an online course and prepare a report.
4. Participate in a workshop or seminar to explore the concept of Continuous Professional Development (CPD), its significance in lifelong learning and prepare a write up on the findings.
5. Develop teaching learning strategies to address the needs of diverse learners in context of gender, equity and inclusion and prepare a PowerPoint presentation.
6. Raise awareness on the ethical and social challenges in education through field trip and create an e-portfolio.
7. Any other project assigned by HEI.

Suggestive Mode of Transaction

Lecture cum discussion, project-based method, problem solving method, experiential learning, art integrated learning, sports integrated learning, ICT integrated learning, interactive methods such as group discussions, peer tutoring, workshops, observations, and presentations.

Suggestive Mode of Assessment

Portfolio creation, written tests, classroom presentations, seminars, assignments, practicum, sessional, terminal semester examinations (As per UGC norms).

Suggestive Reading Materials

- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India (English and Hindi)
- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
- National Policy on Education 1968, 1986 and 2020.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

SEMESTER – IV

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	FE	Philosophical & Sociological Perspectives of Education – I	FE-III	4	100	40	--	60	4

2	DC (Major) Any one Group	Physics/ Chemistry/ Mathematics Botany/Zoology	DC-VIII*	3+1	100	15	25	60	5
			DC-IX	3+1	100	15	25	60	5
			SEC-III	2	50	10	--	40	2
			SEC-IV	2	50	10	--	40	2
3	DCM (Minor) Other than Major	Physics/Mathematics/Chemistry/Botany/Zoology	DCM-III*	4	100	15	25	60	5
	CP	Content-cum-Pedagogy Courses (Secondary): Physical Science-I	CP-II	2	50	20	--	30	2
		Content-cum-Pedagogy Courses (Secondary): Mathematics- I/ Biological Science- II	CP-III	2	50	20	--	30	2
Total				**24**	**600**	**145**	**75**	**380**	**27**

***The practical of Subject mathematics is Internal**

SEMESTER - IV
PHYSICS
DC- VIII: Statistical Physics and Thermodynamics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to:

- Understand Fundamental Concepts and Laws in Thermodynamics
- Explore Advanced Thermodynamic Concepts and Practical Applications
- Develop Proficiency in Thermodynamic Relationships and Variables
- Apply Maxwell's relations to analyze and derive important thermodynamic relationships, and applications of these potentials in various scenarios such as the Joule-Thompson effect and the Clausius-Clapeyron equation.
- Understand the Behavior of Ideal Gases and the Fundamentals of Thermodynamics
- Explore Transport Phenomena in Gases and Real Gas Behavior
- Establish a Statistical Basis for Thermodynamics
- Apply Statistical Mechanics to Equilibrium and Entropy
- Grasp the Maxwellian Distribution of Speeds in Ideal Gases
- Understand Transition to Quantum Statistics and Understand the Implications

Unit-1: Laws of Thermodynamics:
Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various thermodynamical Processes, Applications of First Law: Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Second law & Entropy, Carnot's cycle & theorem, different versions of the second law; practical cycles used in internal combustion engines; entropy; principle of increase of entropy; The thermodynamic scale of temperature; its identity with the perfect gas scale; impossibility of attaining the absolute zero; third law of thermodynamics.

UNIT-2: Thermodynamic Relationships and Potentials:
Thermodynamic relationships, thermodynamic variables; extensive and intensive, various indicator diagrams; work done by and on the system; internal energy as a state function and other applications
Thermodynamic potentials and equilibrium of thermo dynamical systems. Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V, TdS equations.

Unit-3: Kinetic Theory of Gases:
Ideal and Real Gases, Brownian motion; estimation of the Avogadro number; specific heat of monoatomic gas; extension to di- and tri- atomic gases; behavior of gases at low temperatures; adiabatic expansion of an ideal gas, applications to atmospheric physics, Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Transport phenomenon in gases; mean free path; collision cross sections; estimates of molecular diameter, transport of mass momentum and energy, dependence of mean free path on temperature and pressure.
Real and Van der waals gas; equation of state; reduced equation of state; nature of Van der waals forces; comparision with experimental P-V curve; the critical constants gas and vapour; J-T cooling, Boyle temperature and inversion temperature.

Unit-4: Statistical Mechanics:

The Statistical Basis of Thermodynamics, Probability and thermodynamic probability; principle of equal a priory probability; probability distribution and its narrowing with increase in number of particles; the expressions for average properties; accessible and inaccessible states; distribution of particles with a given total energy into a discrete set of energy states.
Equilibrium before and after two systems in thermal contact, bridge with macroscopic physics; probability and entropy; Boltzmann canonical distribution law and its applications; law of equipartition of energy.

Unit-5: Maxwellian Distribution of Speeds in an Ideal Gas

Distribution of speeds and of velocities, distinction between mean, rms and most probable speed values, Doppler broadening of spectral lines. Transition to quantum statistics, 'h' as a natural constant and its implications, cases of particles in a one – dimensional box and one dimensional harmonic oscillator , Indistinguishability of particles and its consequences; Bose- Einstein, and Fermi-Dirac statistics; Fermi level and Fermi energy, thermodynamic behaviour of an ideal Fermi gas, photon gas, comparison of three statistics.

Reference Books:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Laud, Introduction to Statistical Mechanics, Macmillan publication.
- F. Reif, Statistical Physics, McGraw-Hill publications.
- Sears& Salingers, Thermodynamics, Kinetic theory and Statistical thermodynamics, Narosa publishing house, New Delhi.
- Thermodynamics and Statistical Mechanics, Loknathan and Gambhir

Practicals
DC- VIII: Statistical Physics and Thermodynamics

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Learning Outcomes:

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 copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge
11. To study the characteristics of photovoltaic cell.
12. To simulate the decay probability curve.
13. To determine the mechanical equivalent of heat by Joule's calorimeter.
14. To verify Newton's law of cooling.
15. To find the temperature of Hot metal bob using calorimeter.
16. To verify the Stefan's law of radiation by using an incandescent lamp.
17. To determine latent heat of ice.
18. To study thermo e.m.f of Fe-Cu junction.
19. To determine thermal conductivity of rubber tube.
20. To determine specific heat ratio of air by clement and desormes apparatus.
21. To determine efficiency of an electric kettel.

Suggested Readings:

• Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
• A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication.

DC- IX: Digital Electronics and Analog Circuits

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
After completion of the course students will be able to

1. To understand and examine the structure of various number systems and its application in digital design
2. To understand the simplification of boolean statements by using boolean rules and theorems which are adding , subtracting, combining, complementing and cancellation, forms circuits that have following functions : AND,OR,NOT,NAND,NOR,XOR XNOR gates by only using NAND Gates
3. To develop and analyse K-map to solve the Boolean function to the simplest form for the implementation of compact digital circuits and Design various combinational circuits using gates.
4. To understand, analyze and design various combinational and sequential circuits.
5. To assess the nomenclature and technology in the area of multiplexers and memory devices and apply their application in different types of digital circuits for real world application.
6. To understand and describe the architecture & organization of 8086 Microprocessor

7. To understand and classify the instruction set of 8086 microprocessor and distinguish the use of different instructions and apply it in assembly language programming and relate the addressing modes used in the instructions.

Unit1: Number System:

Analog System, digital system, numbering system, binary number system, octal number system, hexadecimal number system, conversion from one number system to another, floating point numbers, weighted codes binary coded decimal, non-weighted codes Excess – 3 code, Gray code, Alphanumeric codes – ASCII Code, ISCII Code, Universal Product Code, Code conversion.

Binary Arithmetic: Binary addition, Binary subtraction, Negative number representation, Subtraction using 1's complement and 2's complement, Binary multiplication and division, Arithmetic in octal number system, Arithmetic in hexadecimal number system, BCD and Excess – 3 arithmetic.

Unit-2: Boolean Algebra and Logic Gates

AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra. Fundamental Products, Min-terms and Max-terms, Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map with 2,3 and 4 variables.

Unit-3: Combinational Logic Circuits:

Introduction, Multi-input, multi-output Combinational circuits, Code converters design and implementations Arithmetic Circuits: Introduction, Adder, BCD Adder, Excess – 3 Adder, Binary Subtractors, BCD Subtractor, Multiplier, Comparator.

Unit-4: Multiplexer, Demultiplexer, Arithmetic Logic Unit, Encoder and Decoder: Introduction, Multiplexer, Demultiplexer, Decoder, ALU, Encoders, Sequential Circuits: Flip-Flop: Introduction, Terminologies used, S-R flipflop, D flip-fop, JK flipflop, Race-around condition, concept of Preset and Clear, Master – slave JK flip-flop, Application of flipflops.

Unit-5: Introduction of Microprocessor 8086

Architectural diagram of 8086-Bus Interface Unit (BIU) and Execution Unit (EU). Instruction types, Register organization of 8086. General purpose registers, Pointers, Index registers, Segment registers, Instruction pointer and Flag registers.
PIN diagram: Functional PIN diagram of 8086, PIN description, for minimum and maximum modes.
Addressing modes: Immediate addressing mode, Register addressing mode, memory addressing, Direct addressing and indirect addressing.
Instruction Set: Data transfer instructions, Arithmetic instructions & Logical instructions.

Suggested Readings:
1. Donald P Leach , Albert Paul Malvino , Goutam Saha , DIGITAL PRINCIPLES AND APPLICATIONS , Tata Mc Graw Hill Education
2. Anil K. Maini, Digital Electronics, Principles and Integrated Circuits, Wiley India Pvt. Ltd.
3. Anant Agrawal and Jefferey H. Lang , Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann, 2005
4. M. Morris Mano, Digital Logic and Computer Design , Pearson Education India..
5. Sunil Mathur, Microprocessor 8086: Architecture, Programming and Interfacing, PHI
6. Walter A. Triebel, Avtar Singh , The 8086 Microprocessor: Architecture, Software, and Interfacing Techniques, Prentice-Hall, 1985

Practicals
DC- IX: Digital Electronics and Analog Circuits

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To minimize a given logic circuit.
3. Half adder, Full adder and 4-bit Binary Adder.
4. Adder-Subtractor using Full Adder I.C.
5. Study of flip-flops and counters.
6. Study of counter ICs and designing Mod-N counters.
7. Design of shift registers and shift register counters.
8. Implementation of digits using seven segment displays.

SEC- III: Electronics Tool Skills and Integration

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes:
After completion of the course students will be able to
1. Use basic electrical tools
2. Understand the concept of 3D printing and make simple 3D printing projects
3. Read datasheets of various devices
3. Use various electronic sensors
4. Understand the basics of arduino programming
5. Undertake projects in electrical and electronics

Unit 1: Introduction to Basic Tools and 3D Printing

- Soldering technique: Introduction to soldering equipment, safety precautions, and hands-on soldering practice.
- Drilling machine: Basics of using a drilling machine, drill bit selection, and practical drilling exercises.
- Cutting machine: Safe operation of cutting tools, types of cutting machines, and cutting demonstrations.
- Hot air gun: Overview of hot air guns and their uses, temperature control, and practical exercises.
- 3D printing: Introduction to 3D printing technology, printer operation, and printing small projects.

Unit 2: Reading Datasheets and Electronics Basics (12 hours)

- Introduction to datasheets: Understanding datasheet structure and components, common data parameters.

- IC datasheets: Reading and interpreting integrated circuit datasheets, pinouts, and specifications.
- Arduino: Overview of Arduino boards, reading datasheets for Arduino-compatible microcontrollers.
- Analog and digital sensors: Understanding sensor datasheets, calibration, and interfacing.
- Actuators and motor drives: Motor types, motor drive ICs, and interpreting motor datasheets.

Unit 3: Arduino Programming and Sensor Integration (12 hours)

- Arduino programming: Basics of the Arduino IDE, coding, and debugging.
- Sensor integration: Interfacing analog and digital sensors with Arduino.
- Actuator control: Writing code to control actuators (e.g., servos, motors).
- Hands-on Arduino projects: Building and programming simple circuits and systems.

Unit 4: Advanced Electronics and Display Technologies (12 hours)

- 16x2 LCD displays: Understanding 16x2 LCD technology, different types of displays, and display controllers.
- Interfacing LCDs with microcontrollers: Reading 16x2 LCD datasheets, programming displays.
- Communication protocols: Introduction to I2C, SPI, and UART communication.
- Advanced projects: Creating projects with displays, sensors, and actuators.

Unit 5: Final Projects and Practical Applications (12 hours)

- Students work on individual or group projects that combine the skills learned in previous units.
- Emphasis on reading datasheets, selecting components, and practical application.
- Project presentations and demonstrations.
- Course review, additional resources, and next steps in electronics and fabrication.

Suggested Readings:

Modern Electronics Soldering Techniques Paperback by Andrew Singmi(Author)

Arduino Programming Projects: Learn how to build cool, fun, and easy Arduino Projects Paperback by Rohan Barnwal (Author)

3D Printing for Dummies, 2ed Paperback by Richard Horne (Author), Kalani Kirk Hausman (Author)

Practical

1. Use of arduino to study variation of resistance of LDR
2 Interference phenomenon using arduino and tone
3. Blink LED using arduino
4. Using stepper motor and ULTRASONIC SENSOR make circuit diagram and write a program to change the speed of stepper motor
5. Make a project to run motor, Buzzer and LED depending upon value of the LDR using arduino

SEC- IV: ELECTRICAL CIRCUITS AND NETWORK SKILLS

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 100
Internal: 10
External: 40

Learning Outcomes: After completion of the course students will be able to

1. Understand basic electricity parameters and associated laws
2. Analyze DC and AC electrical circuits
3. Understand the concept of generators and transformers
4. Understand Electrical Protection
5. Understand various network theorems

Unit-1: Basic Electricity Principles

Voltage, Current, Resistance, and Power. Ohm's law, Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter, CRO (measurement of voltage and frequency)

Unit-2 : Electrical Circuits

Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

Unit-3: Generators and Transformers

DC Power sources. AC/DC generators, Battery, Inductance, capacitance, and impedance, Operation of transformers.

Electric Motors: Single-phase, DC motors. Basic design. Interfacing DC or AC sources to control heaters and motors. Speed & power of ac motor.

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers, Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources

Unit-4: Electrical Protection

Relays. Fuses and disconnect switches. Circuit breakers, MCB, Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device.

Electrical Wiring: Different types of conductors and cables. Basics of wiring, Voltage drop and losses across cables and conductors. Solid and stranded cable. Conduit. Cable duct, DIN rail . Splices: wirenuts, crimps, terminal blocks, and solder. Preparation of extension board.

Unit-5: Network Theorems

Kirchoffs laws **(**1) Thevenin theorem (2) Norton theorem (3) Superposition theorem (4) Maximum Power Transfer theorem

Suggested Readings:

Fundamentals of Electric Circuits | 7th Edition Paperback , Charles K. Alexander (Author), Matthew N. O. Sadiku (Author)

Electric Circuits and Network Analysis by R.M Chandrashekharaiah (Author)

Practical

1. Identification of resistors on the basis of colour coding and verification using digital multimeter
2. Verification of Ohms law using breadboard
3. Analysis of AC and DC circuits
4. Use of transformer in voltage regulator circuit
5. Simple diode circuits using breadboard
6. Verification of network theorems

MATHEMATICS
DC – VIII: Ring Theory

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- understand concept of Rings, Fields, subrings, integral domains and thecorresponding morphisms.
- appreciate the significance of unique factorization in rings and integral domains.

Unit-I

- Ring: Definition and examples and its properties.
- Subring: Definition and examples and its properties.
- Characteristics of rings.

Unit-II

- Ideals, Ideal generated by a subset of a ring, Factor rings. Operations on ideals, Prime and maximal ideals.
- Integral domains and fields: Definition and examples and its properties.

Unit-III

- Ring homomorphisms, Properties of ring homomorphism,
- First, Second and Third Isomorphism theorems for rings,
- Quotient ring and Fundamental theorem of Homomorphism of rings.

Unit-IV

- Polynomials: Polynomials over a ring, Rational field.
- Division algorithm and consequences.
- Unique factorization domain, Principal Ideal domain and Euclidean Domain, Unique factorization in Z[x].

Unit-V

- Factorization of polynomials, Reducibility and Irreducibility.
- Einestein Criterion.

Suggested Readings:

- I.N. Heirstein, Topics in Algebra wiley Eastern limited
- John B Fraleigh, A First Course in Abstract Algebra,Pearson
- Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
- Dummit, David S., & Foote, Richard M. (2016). *Abstract Algebra* (3rd ed.). StudentEdition. Wiley India.

Practical

DC – VIII: Ring Theory

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DC – IX: Complex Analysis

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25

Learning Outcomes:

This course will enable the students to:

- understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
- evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
- expand some simple functions as their Taylor and Laurent series, classify the nature ofsingularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Unit-I

- Complex numbers: Definition, examples and its properties. Representation of complex numbers in the form of ordered pairs. Geometric representation of complex numbers. Stereographic projection.
- Continuity and differentiability of complex functions. Analytic functions. Cauchy-Riemann equations. Harmonic functions.

Unit-II

- Exponential, Logarithmic, Trigonometric functions of complex numbers and their derivatives.
- Definite integrals of functions of complex numbers, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.

Unit-III

- Antiderivatives of complex functions and its properties.
- Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula.
- Liouville's theorem and Fundamental Theorem of Algebra.

Unit-IV

- Convergence of sequences and series of complex numbers, Taylor`s series and Laurent`s series.
- Absolute and uniform convergence of power series, Unique representations of power series.

Unit-V

- Singular points, Residues, Cauchy's residue theorem,residue at infinity.

Suggested Readings:

- Brown, James Ward, & Churchill, Ruel V. (2014). *Complex Variables andApplications* (9th ed.). McGraw-Hill Education. New York.
- Bak, Joseph & Newman, Donald J. (2010). *Complex analysis* (3rd ed.). UndergraduateTexts in Mathematics, Springer. New York.
- Zills, Dennis G., & Shanahan, Patrick D. (2003). *A First Course in Complex Analysiswith Applications*. Jones & Bartlett Publishers, Inc.
- Mathews, John H., & Howell, Rusell W. (2012). *Complex Analysis for Mathematicsand Engineering* (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition.

Practical
DC – IX: Complex Analysis

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEC-III: Mechanics-I

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes: This course will enable the students to:

- understand concept of statics and dynamics of particles.
- Connect the concept of Mechanics with real world.

Unit-I

- Analytical conditions of equilibrium of coplanar forces.

Unit-I

- Virtual work.

Unit-III

- Velocities and accelerations along radial, transverse, tangential and normal directions.

Unit-IV

- Catenary, Uniform or Common Catenary, Intrinsic equation of the Common Catenary

Unit-V

- Simple Harmonic Motion
- Elastic strings.

Suggested Readings:

- S.L. Loney, Statics, Mc Millan & Co
- S.L. Loney, Dynamics, Mc Millan & Co
- Hibbeler, R. C. (2016). *Engineering Mechanics*: *Statics & Dynamics* (14th ed.).Pearson Prentice Hall (Pearson Education), New Jersey.

- Shames, Irving H., & Rao, G. Krishna Mohan (2009). *Engineering Mechanics*: *Staticsand Dynamics* (4th ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi.

SEC-IV: Mechanics-II

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40
Learning Outcomes: This course will enable the students to:

- understand concept of statics and dynamics of particles.
- Connect the concept of Mechanics with real world.

Unit-I

- Stable and unstable equilibrium

Unit-II

- Poinsot's central axis.

Unit-III

- Forces in three dimensions

Unit-IV

- Motion in a resisting medium

Unit-V

- Motion of particles of varying mass.

Suggested Readings:

- S.L. Loney, Statics, Mc Millan & Co
- S.L. Loney, Dynamics, Mc Millan & Co
- Hibbeler, R. C. (2016). *Engineering Mechanics*: *Statics & Dynamics* (14th ed.).Pearson Prentice Hall (Pearson Education), New Jersey.
- Shames, Irving H., & Rao, G. Krishna Mohan (2009). *Engineering Mechanics*: *Staticsand Dynamics* (4th ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi.

CHEMISTRY
DC- VIII: Inorganic Chemistry- III

Credits: 4
Contact Hours: 5 hrs per week (Theory: 3hrs + Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Unit-I: Transition Elements-I

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Different between the first, second and third transition series.

Unit-II: Transition Elements-II

Chemistry of Cr, Mn, Fe and Co in various oxidation states with special reference to the following compounds peroxo compounds of chromium, potassium dichromate, potassium permanganate, potassium ferrocyanide, potassium ferricyanide, sodium nitroprusside and sodium cobaltinitrite.

Unit-III: Coordination Chemistry

Introduction: EAN rule and 18-electron rules, Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit-IV: Inorganic Reaction Mechanism

Thermodynamic and Kinetic stability. Factor affecting the stability of complexes, determination of stability constant (stepwise and overall)-Job's method. Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect.

Unit-V: Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Suggested Readings:

- Purcell, K.F & Kotz, J.C., Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Cotton, F.A. & Wilkinson, G., Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann,1997.
- Miessler, G. L. &. Tarr, Donald A. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009

Practicals (Lab Work)

DC- VIII: Inorganic Chemistry- III

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. Acetylacetonate complexes of Cu_2+/Fe_3+
iii. Tetraamminecarbonatocobalt (III) nitrate
iv. Potassium tri (oxalato)ferrate(III)

Properties of Complexes

i. Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.
iii. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Suggested Readings:

- Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
- G. Marr and B.W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972

DC – IX: Organic Chemistry- III

Credits: 4
Contact Hours: 5 hrs per week (Theory: 3hrs + Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. realize the aromatic behavior of polynuclear hydrocarbons like naphthalene, phenonthrene and anthracene.
2. investigate the aromatic behavior in five membered and six membered heterocyclic compounds.
3. know the importance of keto-enol tantomerism and correlate it with reactivity.
4. get detailed insight of alkaloids like nicotine, quinine, morphine, etc.
5. establish structure of glucose and fructose and investigate the biological importance of polysaccharides like starch, cellulose and glucose.
6. analyze binary mixture of organic compounds employing qualitative organic analysis.

7. learn the technique to separate organic compounds using TLC and paper chromatography.

Unit-I: Polynuclear Hydrocarbons
Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.

Unit-II: Heterocyclic Compounds
Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole(Fischer indole synthesis and Madelung synthesis), Quinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction)

Unit-III: Chemistry of Active Methylene Compounds
Introduction, Active Methylene Compounds, Ethyl Acetoacetate (Ethyl 3-Oxobutanoate) IUPAC Nomenclature Keto-Enol Tautomerism Preparation via Claisen Ester Condensation, Synthetic Applications of Ethyl 3-Oxobutanoate: Preparation of Some Important Compounds, Chemistry of Diethyl malonate, Synthetic importance of active methylene compunds.

Unit-IV: Alkaloids
Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Terpenes Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral.

Unit-V: Carbohydrates
Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

Suggested Readings:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiParakashan (2010).

Practicals
DC – IX: Organic Chemistry -III (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
Practical: 25
External: 25

1. Functional group test for nitro, amine and amide groups.
2. Qualitative analysis of unknown organic compounds and Binary organic mixtures.
3. Thin Layer Chromatography.
4. Paper Chromatography.

Suggested Readings:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

- Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

SEC- III (Choose any one)

Credits: 02
Contact Hours: 2 hrs per week
Total: 50
Internal: 10
External: 40

Learning Outcomes: After completing the course the students will be able to:

1. know the importance of intellectual property right.
2. know the various types of trade marks.
3. know the details of patents and the technique to obtain it.
4. investigate the trade secrets and its legal aspects.
5. get the detailed knowledge of synthesis and technical manufacture of pesticides.
6. know the details of organochlorine, organophosphrus, quinines, pesticide.
7. learn the techniques of calculating acidity and alkalinity in given sample of pesticide formulation.

1. Intellectual Property Rights (IPR)

In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.

Unit-I: Introduction to Intellectual Property, Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights Introduction, How to obtain, Differences from Patents.
Unit-II: Trade Marks Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.
Differences from Designs
Patents
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.
Geographical Indications
Definition, rules for registration, prevention of illegal exploitation, importance to India.
Industrial Designs
Definition, How to obtain, features, International design registration.
Layout design of integrated circuits
Circuit Boards, Integrated Chips, Importance for electronic industry.
Unit-III: Trade Secrets
Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.
Different International agreements
(a) Word Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty
(b) Paris Convention
WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Suggested Readings:

- N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
- Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, TataMcGraw-Hill (2001).

- Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a
- Nutshell, West Group Publishers (2000).
- Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

2. Pesticide Chemistry

Unit-I: General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture.

Unit-II: Uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Unit-III:

1. Calculation of acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

Reference Book:

- R. Cremlyn: Pesticides, John Wiley.

SEC- IV (Choose any one)

Credits: 02

Contact Hours: 2 hrs per week
Total: 50
Internal: 10
External: 40

Learning Outcomes: After completing the course the students will be able to:

1. know twelve basic principles of green chemistry.
2. know the real world cases of green chemistry.
3. learn the technique of preparation and characterization of biodiesel from vegetable oil.
4. know the key business concepts for chemists.
5. get appropriate information about current challenges and opportunity in chemistry industry.
6. obtain the knowledge of financial aspects of business in chemistry field with case studies.

1. Green Methods in Chemistry

Unit-I: Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability.

Unit-II: Real world Cases in Green Chemistry:

1. Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.
2. Designing of Environmentally safe marine antifoulant.
3. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
4. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

Unit-III: Preparation and characterization of biodiesel from vegetable oil, Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice, Mechanochemical solvent free synthesis of azomethine, Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

Suggested Readings:

1. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry- Theory and Practical, University Press, 1998
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
3. Cann, M.C. and Connely, M.E., Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
4. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society, Washington, 2002
5. Sharma, R.K., Sidhwani, I.T. and Chaudhari, M.K. Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7, 2013

6. Lancaster, Mike Green Chemistry: An Introductory Text 2nd Ed., RSC Publishing, ISBN 978-1-84755-873-2, 2010
7. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated — A social Awareness Project‖ Indu Tucker Sidhwani, Geeta Saini, Sushmita Chowdhury, Dimple Garg, Malovika, Nidhi Garg, Delhi University Journal of Undergraduate Research and Innovation, Vol1, Issue 1, Feb 2015. ISSN: 2395-2334.

2. Business Skills for Chemists

Business Basics

Unit-I: Key business concepts: Business plans, market need, project management and routes to market.
Unit-II: Chemistry in Industry Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies. Making money
Unit-III: Financial aspects of business with case studies, Intellectual property, Concept of intellectual property, patents.

References:

- www.rsc.org

BOTANY
DC-VIII: Plant Systematics

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
To provide understanding of origin, evolution and taxonomy of angiosperms and to familiarize the students with different locally available plants of some families

Unit 1: Significance of Plant systematics
Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Taxonomic Keys: Single access and Multi-access.
Unit 2: Taxonomic hierarchy and Botanical nomenclature
Concept of taxa, taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
Principles and rules (ICBN); History and different codes, Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.
Unit 3: Systems of classification
Introductory concepts of Artificial system of classification, Natural system of classification, Phylogenetic system of classification and Molecular system of classification with examples of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Bentham and Hooker, Engler and Prantl, Hutchinson, Takhtajan, Cronquist and APG IV .
Unit 4: Biometrics, numerical taxonomy and cladistics
Characters; Variations; Operational Taxonomic Units (OTUs), character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).
Unit 5: Phylogeny of Angiosperms
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Practicals
DC-VIII: Plant Systematics

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Apocynaceae- Thevetia,Tabernemontana,Vinca/Catharanthus,Rauvolfia serpentine
Leguminosae- Fabaceae
Ranunculaceae - Ranunculus, Delphinium
Brassicaceae - Brassica, Alyssum / Iberis
Myrtaceae - Eucalyptus, Callistemon
Umbelliferae - Coriandrum /Anethum / Foeniculum
Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax
Solanaceae – Solanum nigrum/Withania
Lamiaceae - Salvia/Ocimum/Hyptis
Euphorbiaceae - Euphorbia hirta/E.milii, Jatropha
Liliaceae - Asphodelus/Lilium/Allium
Poaceae - Triticum/Hordeum/Avena
2. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings:

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

DC- IX: Reproductive Biology of Angiosperms

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60
Learning Outcomes
To provide understanding of flower and its reproductive structures in dicots and monocots, both internal and externally.

Unit 1: Introduction to reproductive development of angiosperms
History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.
Introduction of flower; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

Unit 2: Anther and ovule development
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.
Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.
Ovule- Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte–megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.

Unit 3: Pollination, fertilization and self-incompatibility
Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
Basic concepts of incompatibilty (interspecific, intraspecific, homomorphic, heteromorphic, GSI- gametophyticself incompatibility and SSI- sporophyticself incompatibility); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.

Unit 4: Embryo, Endosperm and Seed
Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia/any species.
Seed structure, importance and dispersal mechanisms

Units 5: Polyembryony and apomixis
Introduction to polyembryony and apomixis; Classification; Causes and applications.

Practicals

DC- IX: Reproductive Biology of Angiosperms

Credit: 1
Contact Hours: 2hours per week
Max. Marks: 25
External: 25

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph);
3. Pollen viability: Tetrazoliumtest.germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/ specimens/ photographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

SEC- III

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Choose any one:

1. Mushroom Culture Technology

Learning Outcomes

To provide understanding on culturing techniques on mushroom production and edible mushroom types, their nutritional values etc.

Unit 1:

Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.
Types of edible mushrooms available in India –Agaricus bisporus, Pleurotus citrinopileatus, Volvariella volvacea.

Unit 2:

Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low-cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.
Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves.

Unit 3:

Factors affecting the mushroom bed preparation – Low-cost technology, composting technology in mushroom production.

Unit 4:

Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions.
Nutrition: Proteins - amino acids, mineral elements nutrition with special reference to Selenium, Carbohydrates, Crude fiber content; Vitamins.

Unit 5:

Food Preparation: Types of foods prepared from mushroom.
Research Centres - National level and regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings:

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

2. Intellectual Property Rights (IPR)

Learning Outcomes

To provide understanding on Intellectual Property Rights and national and international agencies enforcing the acts meant for the patent protection, patent filing etc.

Unit 1: Introduction to Intellectual Property Right (IPR) and patents

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents. Infringement.

Unit 2: Copyrights and Trademarks

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement; Plagiarism.

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 3: Geographical Indications and Protection of Traditional Knowledge

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 4: Industrial Designs and Protection of Plant Varieties

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement.

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 5: Information Technology, BiotechnologyRelated Intellectual Property Rights

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection.

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

Suggested Readings

1. N.S. Gopalakrishnan& T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet &Maxweel.
3. AjitParulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

SEC- IV

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Choose any one:

1. Herbal Technology

Learning Outcomes

To provide understanding on medicinally important herbal plants. Pharmaceutical uses and economical importance etc.

Unit 1:

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2:

Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3:

Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster).

Unit 4:

Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

Unit 5:

Medicinal plant banks micro propagation of important species (Withania somnifera, neem and tulsi- Herbal foods-future of pharmacognosy).

Suggested Readings:

1. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
2. Ayurvedic drugs and their plant source. V.V. Sivarajan and BalachandranIndra 1994. Oxford IBH publishing Co.
3. Glossary of Indian medicinal plants, R.N. Chopra, S.L. Nayar and I.C. Chopra, 1956. C.S.I.R, New Delhi.
4. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
5. Pharmacognosy, Dr.C.K. Kokate et al. 1999. NiraliPrakashan.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.

2. Floriculture

Learning Outcomes

To enable the students to have an understanding about gardening and floriculture, successful flower production, ornamental plants and garden designing etc.

Unit 1:

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 2:

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginella; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 3:

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water Garden. Some Famous gardens of India.

Landscaping: Places of Public Importance: Landscaping highways and educational institutions.

Unit 4:

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids).

Unit 5:

Diseases and Pests of Ornamental Plants.

Suggested Readings:

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

ZOOLOGY

DC- VIII: EVOLUTIONARY BIOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25

External: 60

Learning Outcomes

Unit 1:
Origin of Life; Chemogeny, RNA world, Biogenesis, Origin of photosynthesis, Evolution of eukaryotes.
Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism.
Unit 2:
Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c.
Sources of variations: Heritable variations and their role in evolution.
Unit 3:
Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium. Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneckphenomenon; Role of Migration and Mutation in changing allele frequencies.
Unit 4:
Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.
Unit 5:
Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin.
Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.

PRACTICALS
DC- VIII: EVOLUTIONARY BIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of fossils from models/ pictures
2. Study of homology and analogy through specimens / photographs
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of different stages of evolution of man on the basis of their height.
6. Construction of phylogenetic trees.

Suggested Readings:

- Ridley, M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Snustad. S Principles of Genetics.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition WileyBlackwell
- Minkoff, E. (1983). Evolutionary Biology. Addison-Wesley

DC- IX: DEVELOPMENTAL BIOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Introduction
Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division
Unit 2: Early Embryonic Development
Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula;
Fate maps (including Techniques); Early development of frog and chick up
to gastrulation; Embryonic induction and organizers
Unit 3: Late Embryonic Development
Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)
Unit 4: Post Embryonic Development
Metamorphosis: Changes, hormonal regulations in amphibians and insects;
Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories
Unit 5: Implications of Developmental Biology
Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis

PRACTICALS
DC- IX: DEVELOPMENTAL BIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of whole mounts and sections of developmental stages of frog (through permanent slides): Cleavage, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of developmental stages of chick through (permanent slides): Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96
   hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of Drosophila
4. Study of different types of placenta through slides or photomicropgraph
5. Project report on Drosophila culture/chick embryo development
6. Demonstration of chick embryonic development through window experiment

Suggested Readings

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V
- Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

SEC- III
ADVANCED COMPUTATIONAL TOOLS - ML, AI AND BLOCKCHAIN IN BIOLOGICAL SCIENCES
Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes

Unit 1: Human Genetics and Genomics

Organization of genome in viruses, prokaryotes, and eukaryotes.
DNA sequence variation: single nucleotide variants (SNVs), small insertions and deletions (indels), copy number variation (CNVs), rearrangements and tandem repeats.
Mutational mechanism: DNA variants, epigenetics and imprinting. Effects of mutation on gene function or expression that cause disease.

Unit 2: Machine Learning

Classification: Types of machine learning, supervised, unsupervised, reinforcement and transfer learning.
Applications of ML: disease prognosis and management, disease detection, analytics in health care, intelligent healthcare, smart health records, drug discovery, clinical trials and research, and behavioural modifications.
Medical therapies: medical care, pharmaceutical care, hospital care, home health care, concurrent medical conditions (comorbidity), precision medicine, medical/surgical robotics, stem cell and regenerative medicine, and genomics therapies.
Clinical consideration: Coronavirus infection, epidemiology and public health consideration during the pandemic of 2020.

Unit 3: Artificial Intelligence

Fundamentals, use-cases, and application of AI.
Brief history of AI in healthcare and genomics.
Machine learning workflow and terminologies.
Computational models of intelligence.
Challenges in pharmaceutical industries that AI can solve.
Approaches of AI to be used in solving healthcare data and its applications.

Unit 4: Blockchain

Blockchain architecture: block, hash function, encryption, private and public keys, decentralized identifier.
Blockchain ecosystem: nodes, miners, wallets, key characteristics.
Classification of Blockchain on access management: public blockchain, private blockchain, consortium blockchain, working of blockchain.

Unit 5: Blockchain for Real World

Health information and records on blockchain, including data security and privacy, sharing and collaboration.
Clinical trials, intellectual property rights, personalized medicine, data marketplaces, population health vaccinations and clinical trials, informed consent and feedback, drug supplied same management, intellectual property protection, vaccine distribution management, and public health surveillance.

Suggested Readings:

- Agrawal, R., Chatterjee, J., Kumar. A, Rathore, PS. and Le Dac-Huhong (2021)Machine Learning for Healthcare: Handling and Managing Data. First edition CRC press
- Fitzgerald, Pasternak J. (1999). An Introduction to Human Molecular Genetics: Mechanism of Inherited Diseases. Science Press.
- Garg Rishabh (2023). Blockchain for Real World Applications. John Wiley & Sons. New Jersey, US.
- Garg, Rishabh (2023). From Virtual World to Real Lives. Volume 1: Sculpting New Realities with AI, ML and IoT. Taylor & Francis, Oxfordshire, UK
- Garg, Rishabh (2023). From Virtual World to Real Lives. Volume 2: Crafting Dreams with AR, Metaverse and Blockchain. Chapman & Hall CRC London UK
- Harper, P. S. (Ed.). (2004). Landmarks in Medical Genetics. Oxford University Press.
- Machine Learning and Data Mining in Pattern Recognition. (2019). In Lecture Notes in Computer Science (Vol. 11535). Springer.
- Russell, S., & Norvig, P. (2010). Artificial Intelligence: A Modern Approach. Third Edition. Prentice Hall.

SEC- IV
GENETIC ENGINEERING

Credits: 2
Contact Hours: 2 hours per week
Max. Marks: 50
Internal: 10
External: 40

Learning Outcomes

Unit 1: Enzymes and Vectors

Molecular tools and applications restriction enzymes, nucleases, ligases, topoisomerases, polymerases, alkaline phosphatase. Restriction and modification system. Vectors used in recombinant DNA technology: Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes)

Unit 2: Gene cloning

Genomic and cDNA library, Preparation Recombinant and Gene transfer, Physical and Chemical methods of gene transfer, screening of recombinants, reverse transcription, genome mapping.

Unit 3: Techniques in Recombinant DNA Technology

Blotting Techniques - Southern, Northern and Western. DNA sequencing - Maxam Gilbert chemical cleavage method and Sanger Coulson dideoxy method, Principle and applications of Polymerase chain reaction (PCR), brief outline of primer design, RT- (quantitative) PCR and RT(Reverse Transcriptase) PCR

Unit 4: Application of Genetic Engineering

Hybridoma Technology, gene Therapy, DNA fingerprinting, RFLP, and RADP. Production and application of transgenic plants and animals. Role of embryonic stem cells in gene targeting in mice

Unit 5: Therapeutics

Therapeutic products produced by genetic engineering-human hormones, immune modulators and vaccines. Products of pharmaceuticals, production of donor organs, knockout mice.

Suggested Readings:

- Brown T.A. (2006). Gene Cloning and DNA Analysis. 5th Edition. Blackwell Publishing, Oxford, UK
- Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
- Glick, B.R., Pasternak, J.J (2003). Molecular Biotechnology-Principles and Applications of recombinant DNA, ASM Press, Washington
- Primrose SB and Twyman RM (2006). Principles of Gene Manipulation and Genomics. 7th Edition. Blackwell Publishing Oxford, UK
- Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning- A Laboratory Manual. 3rd Edition. Cold Spring Harbor Laboratory, Press.

EDUCATION PART

Semester – IV

FE- III: Philosophical and Sociological Perspectives of Education-1

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

The course aims at enabling student teachers to explore educational philosophy, including the concept, nature and scope; the aims of educational philosophy; relationship between philosophy and education; Indian philosophical traditions and their implications for education; some of the key philosophical schools of thought such as idealism, naturalism, pragmatism, progressivism and existentialism and their implication for educational practices. The course also would provide an analysis of the Western schools of philosophy and their approaches etc. Along with the philosophical perspectives, the course intends to initiate students into sociological bases of education and the role of education in socialization.

Learning Outcomes

After going through the lesson, students will be able to:

- To develop perspective on education
- Develop insights into the nature and purpose of Philosophy of education
- Understand and appreciate the relevance of philosophical thinking Ancient India to modern education
- Understand the different educational philosophies and their implications to educational practices
- To facilitate prospective teachers to engage themselves in peer groups for sharing of their real-life reflective experiences regarding socio-cultural and philosophical living and facilitate them to conceptualize the meaning of terms like philosophical, social and cultural traditions in Indian educational context.
- To orient and engage prospective teachers to read, observe and understand the vision of some great Indian and global educators and categorically reflect on vision/aim, process of education and the contemporary relevance.
- Develop critical understanding of the role of education in socialization

UNIT – I: Education and Philosophy

- Philosophy: Meaning and Nature
- Object of study in Philosophy

- Branches of Philosophy and their educational implications: Metaphysics (तत्त्वमीमांसा), Epistemology (ज्ञानमीमांसा), Axiology (मूल्यमीमांसा)
- Aims of studying philosophical perspective of education.
- Education: Meaning and Nature
- Education as a System, Process and an Opportunity
- Constituents of Education: Aims, Curriculum and Pedagogy (Methods)
- Relationship between Philosophy and Education

UNIT – II: Philosophical Perspectives of Education in India

- Theory of knowledge, or pramana-sashtra: perception (pratyaksha). Anumana, Upamana, Arthapathi, Anupalabdhi, Shabdha (testimony)
- Understanding the terms Darshana, Dharma, Mukti, Nirvana
- Brahmacharya and Vidyarambha- Upanayana, Pabja (Pabbaja), Upasampada and Bismillah
- Vedic and Vedantic, Buddhist, Jain, Sikh and Islamic Perspectives on:
  - Aims of education,
  - Knowledge and Curriculum and
  - Processes of education: Methods of Education and Assessment
  - Teacher-taught (Guru-shishya) roles and relationship

Unit-- III: Philosophical Perspectives of Education: Western

- Perspective of Idealism, Naturalism, Pragmatism and Existentialism on:
- Aims of Education
- Knowledge and Curriculum
- Processes of Education: Methods of education and Assessment
- Teacher- taught roles and relationship

UNIT – IV: Educational Thinkers

- Deliberations on aims, process and educational institutions developed on thoughts of following thinkers and practitioners:
- **Bharatiya:** Swami Vivekananda, Mahatma Gandhi, Sri Aurobindo Ghosh, Gurudev Rabindra Nath Tagore, J. Krishnamurti, Mahamanav Madan Mohan Malaviya.
- **Western:** J. J. Rousseau, Maria Montessori, Friedrich Froebel, John Dewey.

UNIT—V: Education and Sociology

- Sociology and Education: Meaning and relationship; Implications of Sociology for aims, curriculum, and methods of Education
- Conceptual clarity of the terms: Community, Society, Institution, Social Interaction, Social Structure, Conflict, Social Group, Normative framework
- Society as a system; Education as sub-system; Their interrelationships
- Concept of Educational Sociology and Sociology of Education; Historical Development of Sociology of Education in India

UNIT--VI: Schooling, Socialization: and Identity Development

- Socialization: Meaning and purpose
- Agencies of socialization: Family, Community, Peer group, Mass and social media, School: changing roles of agencies in socialization in the context of technological revolution
- Identity: Meaning and development process
- Role socialization by agencies in identity formation
- Ascribed Identities v/s Acquired Identity
- Role of Schooling in Identity transformation: Intended and achieved: Critical Understanding
- Multiple Identities

Suggestive Practicum

1. Individual/group assignments/tasks in various forms like writing small paragraphs/brief notes, conceptualizations on specific terms etc.
2. Institutional visits in small groups in coordination to institutions related to different thinker/s and preparation of a report followed by individual/group presentation.
3. Sharing of student experiences (in groups) related to readings on great thinkers help them to reshape their concept and enable them to develop vision, mission and objectives for a school and their plan to accomplish the objectives in form of a group report.
4. Identification and reporting of Indian perspective related to educational aims, student-teacher characteristics, methods, evaluation procedure, convocation etc. based on critical study of life and thoughts of thinkers.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Organized lectures using variety of media.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, engagement of in reading of primary or secondary sources of literature (Original texts, reference books etc.) related to different aspects of life and education of Great Educators, case studies, short term project work etc.
- Critically examining their experiences to carve out their world and life view and further analyze them from philosophical point of view to reshape their perspective. They will engage prospective teachers in the development of comparative educational charts related to vision, aims, process, institution etc. They will also lead to reading-based interactions and critical reflections related to process and significance of entry/admission rituals, convocation system etc.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

1. Altekar (1948). Education in Ancient India. Nand Kishor & Bros., Educational publishers, Benares
2. Archibald, R. (1974). *Philosophical analysis and education*. Oxford University Press.
3. Brubacher, J. S. (1950). *Modern Philosophies of Education*. McGraw Hill, Book Company, Inc.
4. Butler, T.D. (1968). *Four philosophies and their practice in education*. Harper and Row
5. Chaturvedi Badrinth. (2015). Swami Vivekananda: The Living Vedanta. Penguin Books, New Delhi.
6. Dewey, John. (2009). Democracy and Education. Aakaar Books, New Delhi.
7. Dhokalia, R. P. (2001). Eternal Human Values and World Religions. NCERT, New Delhi.
8. Eknath Easwaran. (1996). The Upanishads. Penguin Books, New Delhi.
9. Kabir, H. (1964). *Indian Philosophy of Education*. Asia Publishing House.
10. Kilpatric, W. H. (1951). *Philosophy of education*. Macmillan.
11. Kneller, G.F. (1967). *Foundations of education*. John Wiley: Sons Inc.
12. Kneller. G.F. (1964). Introduction to Philosophy of Education. John Wiley.
13. Mohanty, J. (1994). *Indian education in the emerging society*. Sterling Publisher Private Limited.
14. Radhakrishnan, S. (2008). *Indian Philosophy*. Oxford.
15. Radha Kumud Mukherjee. (1989). Ancient Indian Education. Motilal Banarasidas, New Delhi
16. Rusk, R. R. (1956). *The philosophical bases of education.* University of London Press
17. Russell, B. (2016). A history of Western Philosophy. Routledge Classics
18. Saxena, N.R.S. & Dutt, N.K. (2008). *Philosophical and sociological foundations of education*. Raj Printers.
19. Sudhakshina Rangaswami (ed.). (2012). The Roots of Vedanta. Penguin Books, New Delhi
20. Taneja, V. R. (1989). *Socio and philosophical approach to education*. Atlantic Publishing House.
21. Weber, C. O. (1960). *Basic Philosophies of Education*. New York.

CP- II: Content-cum-Pedagogy Courses (Secondary): Physical Sciences- I

Credits: 2
Contact Hours: 2 hrs per week
Maxmum Marks: 50
Internal: 20
External: 30

About the Course

The focus of the National Education Policy (NEP) 2020 is on the holistic development of students. To achieve the objectives, interventions from quality teachers are vital. Sound pedagogical content knowledge and teaching methods are the determinants of a teacher's quality and professionalism. Teacher education programme strongly emphasizes pedagogy, its principles, and the practices of teaching and learning. Pedagogical knowledge and approaches refer to the specialized knowledge of the teacher for creating an active, child-centered, and inclusive teaching-learning environment for the students and need to be developed among the student teachers. This pedagogical course in Physical Sciences is intended to enhance the pedagogical content knowledge of student teachers through different learning approaches and methods. This course comprises three units and a practicum. The course is devoted to developing an understanding of the nature and scope of Physical Sciences and the aims and objectives of teaching Physical Sciences and its linkages with other disciplines.

Historical/policy perspectives of Physical Sciences are discussed in unit second. Physical Sciences is conceptualized in very broad terms by relating it to technology, society, humans, and sustainable development. It also focuses on the place of Physical Sciences in school curriculum including an emphasis on how to build inclusive classrooms. It focuses on pedagogical concerns of Physical Sciences. Critical, creative, and analytical pedagogical concerns in teaching Physical Sciences with special reference to higher-order thinking are also placed in unit third.

Learning Outcomes

After completion of this course, student teachers will be able to:

- explain nature, scope and importance of Physical Sciences,
- illustrate aims and objectives of teaching Physical Sciences for sustainable development of society,
- outline linkages between Physical Sciences and other subjects,
- identify the values and importance of Physical Sciences and alternative knowledge systems,
- summarize the historical/policies perspective of Physical Sciences,
- examine pedagogical concerns of Physical Sciences,
- categorize approaches and methods of teaching learning Physical Sciences,
- apply appropriate pedagogy in teaching learning the concepts of Physical Sciences.

UNIT – I: Nature, Scope and Historical Perspective of Physical Sciences

- Nature, scope, and importance of Physical Sciences.
- Historical perspective of Physical Sciences.
- Contributions of Indian (ancient and modern) and other scientists.
- Physical Sciences, society and human and sustainable development.
- Recommendations/suggestions of various committees, commissions, and policies in reference to Physical Sciences.

UNIT – II: Aims and Objectives of Physical Sciences

- Aims and objectives of teaching Physical Sciences.
- Learning outcomes and competencies of teaching Physical Sciences at secondary stage.
- Linkages of Physical Sciences with other school subjects and place of the Physical Sciences in school curriculum.
- Values of Physical Sciences: scientific attitude and appreciating other systems of knowledge / alternative knowledge systems.

UNIT – III: Pedagogical Aspects of Physical Sciences

- Implication of various approaches - inductive deductive, constructivist, experiential learning, art integrated learning, sports integrated learning, blended learning, interdisciplinary and multidisciplinary approaches in Physical Sciences.
- Analytical pedagogical concerns in teaching of Physical Sciences for higher order thinking skills such as critical, creative, communication, decision making, reflective.
- Methods of teaching learning Physical Sciences: learner-centric and group-centric, lecture cum demonstration, activity based, discussion, problem-solving, laboratory, stem and steam, project based, scientific inquiry, hands on activity, discovery, experimentation, concept-mapping, collaborative and cooperative learning.

Suggestive Practicum (Any Three)

1. Explore contributions of Indian scientists in the development of Physical Sciences and make presentations on historical development of Physical Sciences.
2. Analyze recommendations of policies/commissions in context of Physical Sciences.
3. Develop concept maps on different concepts of Physical Sciences.
4. Identify and integrate values in Physical Sciences concepts.
5. Demonstrate different pedagogical approaches and strategies for transacting concepts of Physical Sciences.
6. Prepare write-ups on the teaching of science using interdisciplinary and multidisciplinary approaches as recommended in NEP 2020.
7. Any other project assigned by HEI
8. Prepare at least two lesson plans based on constructivisit approach for teaching at secondary stage.

Suggestive Mode of Transaction

Lecture cum discussion/demonstration, hands-on activities, experiential learning, art and environment integrated learning, sports integrated learning.

Suggestive Mode of Assessment

Written tests, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Material

- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India.

- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
- NCERT, Textbooks of Physical Sciences at Secondary Stage.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- III: Content-cum-Pedagogy Courses (Secondary): Mathematics- I

Credits: 2
Contact Hours: 4 hrs per week
Maxmum Marks: 50
Internal: 20
External: 30

About the Course

Mathematics is an important school subject and students are expected to master computational and problem-solving skills with the help of mathematical concepts and reasoning during study. Teaching of Mathematics is not only concerned with the computational know-how of the subject but is also concerned with pedagogical content knowledge and communication leading to its meaningful learning amongst students. This course enables the student-teachers to understand the nature of mathematical knowledge and the mathematics curriculum at secondary stage. The objectives of teaching Mathematics should not be limited to the development of computational skills but to enable mathematical reasoning to solve problems of life. Student teachers will develop skills to formulate classroom objectives as well as plan for development of the values through Mathematics. Student teachers will have a thorough understanding of Mathematics content and their relevant specific pedagogy for the effective learning of Mathematics. They would be exposed to various pedagogical approaches, methods, and techniques so that they will be able to create a learner friendly classroom environment.

Learning Outcomes

After completion of this course, student teachers will be able to:

- appraise the contribution of Indian Knowledge Systems in development of Mathematics,
- explain the nature of Mathematics as an important subject for human development,
- interpret the recommendation of the various policy documents in reference to Mathematics education,
- classify the aims and objectives of teaching Mathematics,
- formulate objectives based on learning outcomes for Mathematics teaching,
- select and demonstrate various approaches and methods of teaching Mathematics,
- plan strategies to inculcate values through teaching Mathematics.

UNIT – I: Nature, Scope and Historical Perspective of Mathematics

- Development of Mathematics from a historical perspective.
- Nature of Mathematical Knowledge – Axioms and Postulates, Conjectures, Proofs in Mathematics: inductive - deductive reasoning, theorems, mathematical modeling.
- Importance of Mathematics knowledge in everyday life.
- Recommendations of various committees, commissions and policies related to Mathematics education at Secondary stage (especially in National Education Policies and National Curriculum Frameworks).

UNIT – II: Aims and Objectives of Teaching Mathematics

- Aims and objectives of teaching Mathematics at secondary stage.
- Learning outcomes and competencies of teaching Mathematics at secondary stage.
- Linkages of Mathematics with other school subjects and place in school curriculum.
- Inculcation of values through teaching of Mathematics.

UNIT – III: Pedagogical Aspects of Mathematics

- Implication of various approaches of teaching Mathematics; inductive-deductive, analytical-synthetical, constructivist, blended learning, experiential learning, transdisciplinary, interdisciplinary, and multidisciplinary.
- Learner-centric and participative methods of teaching of Mathematics: lecture cum demonstration, problem-solving, laboratory, project-based, problem-based, and inquiry-based.
- Analytical pedagogical concerns in teaching of Mathematics for higher order thinking skills such as critical, creative, decision making, reflective, collaborative, and cooperative.
- Techniques of teaching learning Mathematics: oral, written, drill work, homework, self-study, group study, supervised study, concept-mapping, learning, art and sports integrated learning.

Suggestive Practicum (Any Three)

1. Prepare a collage/ biographic sketch on the contribution of Indian mathematician.
2. Present a paper on comparison of nature of mathematical knowledge with other school subjects.
3. Formulate objectives based on learning outcomes and experiential learning for any one unit of secondary Mathematics.
4. Develop strategy to connect any three topics for value inculcation in teaching of Mathematics.
5. Analyze the content of one chapter of Mathematics textbook and develop concept maps at secondary stage.
6. Select and list approaches and methods for teaching various topics of secondary stage Mathematics.
7. Any other project assigned by HEI.

Suggestive Mode of Transaction

Demonstration, field-based experience, library visits, classroom discussions, self-study, field observations, assignment preparation, classroom presentations, discussion forums, observation, research report, engaging in dialogue, flipped classroom.

Suggestive Mode of Assessment

Written test, classroom presentation, workshop, assignments, practicum, sessional and terminal semester examination (As per UGC norms).

Suggestive Reading Material

- MESE 001(2003) Teaching and Learning Mathematics. IGNOU series
- NCERT Publications: Pedagogy of Mathematics (Code-13074)

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- III: Content-cum-Pedagogy (Secondary): Biological Sciences- I

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course

Biology is an inseparable part of human life and is hence learning biological concepts and principles is given ample importance in school curricula. Knowledge of Biological Sciences enables students to recognize and value the diverse living forms, their structure and method of functioning, co-existence and how they harmoniously blend with other natural/physical factors that constitutes the complex environment. This course aims to educate the student teachers to learn the various methods and strategies in teaching Biological Sciences. The course comprises of three units describing the aims and scope of Biological Sciences in Secondary level. A glimpse of the history of Biological Sciences is dealt with ancient and modern Indian and international contributions in the study of biological methods and practices in building the modern-day Biological Sciences. Salient features of selected earlier curricular exercises with special reference to biology at secondary level are also emphasized.

Learning Outcomes

After completion of this course, Student teachers will be able to:

- explain nature, scope, and importance of Biological Sciences,
- illustrate aims and objectives of teaching Biological Sciences for sustainable development of society,
- outline linkages between Biological Sciences and other subjects,
- identify the values and importance of Biological Sciences and alternative knowledge systems,
- examine pedagogical concerns of Biological Sciences,
- categorize approaches and methods of teaching learning Biological Sciences,
- apply proper pedagogy in teaching learning the concepts of Biological Sciences,
- apply appropriate method/s in teaching concepts of Biological Sciences.

UNIT – I: Nature, Scope and Historical Perspective of Biological Sciences

- Nature, scope, and importance of Biological Sciences.
- Historical perspective of Biological Sciences.
- Contributions of Indian (ancient and modern) and other scientists.
- Biological science for sustaining self, society, environment, and world.

UNIT – II: Aims and Objectives of Biological Sciences

- Aims and objectives of teaching biological science as a component of multidisciplinary science.
- Learning outcomes and competencies of teaching Biological Sciences at secondary stage.
- Linkages of Biological Sciences with other school subjects and place of the Biological Sciences in school curriculum.
- Values of Biological Sciences; ethical, environmental and sustainability concerns.

UNIT – III: Pedagogical Aspects of Biological Sciences

- Implication of various approaches – inductive deductive, constructivist, experiential, art-integrated, blended learning, interdisciplinary and multidisciplinary approaches, stimulating the spirit of investigation and enquiry.
- Analytical pedagogical concerns in teaching of physical sciences for higher order thinking skills such as critical, creative, communication, decision making, reflective.
- Methods of teaching learning Biological Sciences: learner-centric and group-centric, lecture cum demonstration, activity based, discussion, problem-solving, laboratory and hands on activity based, sports- integrated, project based, inquiry, discovery, experimentation, concept-mapping, collaborative and cooperative learning; stem and steam concept.

Suggestive Practicum (Any Three)

1. Plot a timeline of development of Biological Sciences from ancient to modern times mentioning the important developments.
2. Analyze and prepare a report on pedagogy of Biological Sciences with reference to NEP 2020.
3. Prepare a write up on ancient Indian contributions and practices in Ayurveda/Herbal medicines.
4. Develop concept maps on different concepts of Biological Sciences.
5. Demonstrate different pedagogical approaches and strategies for transacting concepts of Biological Sciences.
6. Any other project assigned by HEI.

Suggestive Mode of Transaction

Lecture cum discussion, demonstration, hands-on activities, experiential learning, inquiry, Group work, Presentations, multimedia.

Suggestive Mode of Assessment

Written tests, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Material

- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India.
- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
- NCERT, Textbooks of Biological Sciences at Secondary Stage.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

SEMESTER - V

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per

									Week (Hrs)
1	DC (Major) Any one Group	Physics/ Chemistry/ Mathematics Botany/Zoology	DC-X	3+1	100	15	25	60	5
			DC-XI*	3+1	100	15	25	60	5
			DSE-I*	3+1	100	15	25	60	5
2	CP	Content-cum-Pedagogy Courses (Secondary): Physical Science-II	CP-IV	2	50	20	--	30	2
3	CP	Content-cum-Pedagogy Courses (Secondary): Mathematics- II/ Biological Science-II	CP-V	2	50	20	--	30	2
4	AE&VAC	ICT in Education	AE & VAC-VII	2	50	20	--	30	2
5	SE	Pre-Internship Practice As per CP	SE-I	2	50	50	--	--	4
Total				**20**	**500**	**155**	**75**	**270**	**25**

***The practical of Subject Mathematics is Internal**

SEMESTER - V
PHYSICS
DC- X: QUANTUM MECHANICS AND APPLICATIONS

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

- demonstrate a comprehensive understanding of the time-independent Schrödinger equation, recognizing the role of the Hamiltonian in determining stationary states and energy eigenvalues.
- solve the time-independent Schrödinger equation for a given physical system, identifying stationary states and determining the associated energy eigenvalues.
- articulate and apply the time-dependent Schrödinger equation, understanding its role in describing the dynamical evolution of quantum states over time.
- Understand Properties of Wave Functions and Quantum Operators
- Understand the General Principles of Bound States in Quantum Mechanics
- Apply Quantum Mechanics to Specific Cases - Square Well Potential and Simple Harmonic Oscillator
- Understand Angular Momentum in Quantum Mechanics and Quantum Numbers
- Explore the Interaction of Atoms with Electric and Magnetic Fields

Unit-1

Introduction to quantum mechanics and time independent Schrodinger equation-In adequacy in classical mechanics and need of quantum mechanics (basis of old and new quantum mechanics), postulates of quantum mechanics (Hilbert space, stationary states, energy eigenvalues and operator formalism), expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states;

Unit-2

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators;

Unit 3

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator- Hermite polynomials; ground state, zero-point energy & uncertainty principle.

Unit 4

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Orbital angular momentum quantum numbers l and m; s, p, d shells.

Unit 5

Atoms in Electric and Magnetic Fields: Electron angular momentum. Angular momentum quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Normal Zeeman Effect: Electron Magnetic Moment and Magnetic Energy.

Many electron atoms: Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Spin-orbit coupling in atoms-L-S and J-J couplings

Suggested Readings:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education

Practicals

DC- X: QUANTUM MECHANICS AND APPLICATIONS

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
3. Quantum efficiency of CCDs

DC- XI: Nuclear and Particle Physics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

1. To understand the basic concepts of nuclear physics
2. To explain radioactive decays
3. To explain successive decays
4. To explain the alpha, beta and gamma decay
5. To explain nuclear binding energy and nuclear masses
6. To understand nuclear reactions
7. To explain nuclear fission and fusion

Unit-1

General Properties of Nuclei: Nuclear structure, Proton-electron hypothesis, discovery of neutron, Proton-neutron hypothesis, Yukawa theory, Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density, matter density, packing fraction, binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/Z plot, angular momentum, parity, magnetic moment, electric moments.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, Evidence of nuclear shell structure, nuclear magic number, basic assumptions of shell model.

Unit-2

Radioactivity decay: Radioactivity decay, radioactive displacement, Decay rate and equilibrium (Secular and Transient) (a) Alpha decay: basics of α-decay processes, theory of α-emission, 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's emission from the excited state of the nucleus & kinematics, internal conversion.

Unit-3

Nuclear Reactions: Nuclear fission and fusion, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, resonance reaction, Coulomb scattering (Rutherford scattering), Basics of nuclear reactors, Energy liberated in nuclear fission, energy production in stars.

Unit-4

Particle Accelerators: Cockcroft-Walton voltage multiplier, LINAC, Cyclotron, Betatron.

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). neutron detector.

Unit-5

Particle Physics: particles and anti-particles, Classification of particles, antiparticles and their interactions, Particle interactions (concept of different types of forces), exchange forces, basic features, Cosmic Rays, Conservation Laws (energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness) concept of quark model, color quantum number and gluons, God Particles

Suggested Readings:

- Basic Ideas and concepts in Nuclear Physics : An introductory Approach by K Heyde, Third edition, IOP Publication, 1999.
- Nuclear Physics by S. N. Ghoshal, First edition, S. Chand Publication, 2010.
- Concepts of Nuclear Physics by Bernard L Cohen, Tata McGraw Hill Publication, 1974.
- Introductory Nuclear Physics by Kenneth S, Krane, Wiley-India Publication, 2008
- Nuclear Physics : principles and applications by John Lilley, Wiley Publication, 2006.
- Physics and Engineering of Radiation Detection by Syed Naeem Ahmed, Academic Press Elsevier, 2007.
- Radiation detection and measurement, G.F. Knoll, John Wiley & Sons, 2010.
- Technique for Nuclear and Particle Physics experiments by William R Leo, Springer, 1994.
- Introduction to Modern Physics by Mani & Mehta, Affiliated East-West Press, 1990.
- Introduction to elementary particles by David J Griffiths, Wiley, 2008.
- Modern Physics by Serway, Moses and Moyer, CENGAGE LEARNING, 2012.
- Concepts of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009. For Numericals
- Schaum‟s Outline of Modern Physics, McGraw-Hill Education, 1999
- Modern Physics by R. Murugaeshan. S. Chand Publication, 2010

Practicals

DC- XI: Nuclear and Particle Physics

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

Practical:

Make simple projects by chosing topics from below

1. Visit accelerator facility in India and make detailed report of the observations
2. Case study of nuclear fission
3. Case study of nuclear fusion
4. Scintillation Detetectors
5. Experiments on cosmic rays
6. GM counter characteristics
7. GM counter -Absorption coefficients
8. Simulation experiment on radioactive decay
9. Verification of inverse square law.
10. Randomicity of radioactive decay
11. Cockcroft-Walton voltage multiplier.
12. End point energy of beta rays (Nomogram method and Feather analysis)
13. Energy resolution of NaI (Tl) scintillator spectrometer.

DSE- I

Choose any one:

1. Atmospheric Physics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)

Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
1. To understand the general features of Earth's atmosphere
2. To study atmospheric dynamics
3. To understand the types of atmospheric waves and their generation
4. To understand the use of Atmospheric Radar and Lidar
5. To undertand the concept of Atmospheric Aerosols

Unit-1
General features of Earth's atmosphere: Thermal structure of the Earth‟s Atmosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze.
Unit-2
Atmospheric Dynamics: Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi-annual oscillations.
Unit 3
Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration.
Unit 4
Atmospheric Radar and Lidar: Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Applications of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques.

Unit 5
Atmospheric Aerosols: Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Aerosol studies using Lidars.

Suggested Readings:

- Fundamental of Atmospheric Physics, M.L Salby; Academic Press, Vol 61, 1996
- The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002. • An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
- Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

Practicals
Atmospheric Physics

Credit: 1
Contact Hours: 2 hrs week
Max. Marks: 25
External: 25

Scilab/python-based simulations experiments based on Atmospheric Physics problems like (at least 05 experiments)
1. Numerical Simulation for atmospheric waves using dispersion relations (a) Atmospheric gravity waves (AGW)
(b) Kelvin waves
(c) Rossby waves, and mountain waves
2. Offline and online processing of radar data (a) VHF radar, (b) X-band radar, and (c) UHF radar
3. Offline and online processing of LIDAR data
4. Radiosonde data and its interpretation in terms of atmospheric parameters using vertical profiles in different regions of the globe.
5. Handling of satellite data and plotting of atmospheric parameters using radio occultation technique

6. Time series analysis of temperature using long term data over metropolitan cities in India – an approach to understand the climate change
7. PM 2.5 measurement using compact instruments
8. Field visits to Bhopal center for medium range weather forecasting, India meteorological departments, and to see onsite radiosonde balloon launch, simulation on computers and radar operations on real time basis.

Suggested Readings:

- Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
- The Physics of Atmosphere – J.T. Houghton; Cambridge Univ. Press; 3rd edn. 2002.
- An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
- Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

2. Communication System

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

1. To understand the basics of Electronic communication
2. To understand the concept of modulation.
3. To understand analog and digital modulation and their applications.
4. To understand working of Communication and Navigation systems
5. To understand working of Mobile Telephony System

Unit 1

Electronic communication: Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals.

Unit 2

Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver.

Unit 3

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Digital Pulse Modulation: 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),

Unit 4

Introduction to Communication and Navigation systems: Satellite Communication– Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink

Unit 5

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only), GPS navigation system (qualitative idea only).

Suggested Readings:

- Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- Modern Digital and Analog Communication Systems, B.P. Lathi, 4th Edition, 2011, Oxford University Press.
- Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
- Communication Systems, S. Haykin, 2006, Wiley India

- Electronic Communication system, Blake, Cengage, 5th edition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

Practicals
Communication System

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1. To design an Amplitude Modulator using Transistor
2. To study 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 study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulators

Suggested FReadings:
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Electronic Communication system, Blake, Cengage, 5th edition.

MATHEMATICS
DC – X: Linear Algebra

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25

Learning Outcomes: This course will enable the students to:
- the fundamental concept of Vector Spaces
- the concept of linear independence of vectors over a field, the idea of a finitedimensional vector space, basis of a vector space and the dimension of a vector space.
- basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a lineartransformation, algebra of transformations and the change of basis.

Unit-I
- Vector Spaces: Definition, examples and its properties, Subspaces, Algebra of subspaces.
- Linear sum and Direct sum of subspaces. Linear span. Linear dependence, independence and their properties.
- Basis, Dimension of Vector spaces. Existence and Extension theorem for basis.

Unit-II
- Existence of complementary subspace of a subspace of a finite dimensional Vector space.
- Quotient spaces, Fundamental Theorem of Vector Spaces.

Unit-III
- Linear transformations and their representation as matrices.
- The Algebra of linear transformations. Rank-Nullity theorem.
- Change of basis, Dual space, Bidual spaces.
- Adjoint of a linear transformation.

Unit-IV
- Eigenvalues and eigenvectors of a linear transformation.
- Diagonalization. Annihilator of a subspace. Bilinear, Quadratic and Hermitian forms.
- Inner Product Spaces, Cauchy-Schwarz`s Inequality.
- Orthogonal vectors. Orthogonal complements. Orthonormal sets and basis.

Unit-V

- Bessel's inequality for finite dimensional spaces.
- Gram-Schmidt Orthogonalization – Process.
- Modules and Submodules.
- Quotient modules. Homomorphism and Isomorphism theorems.

Suggested Readings:

- I. N. Heirstein; Topics in Algebra Wiley Eastern.
- Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *LinearAlgebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.

Practical
DC – X: Linear Algebra

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DC – XI: Metric Spaces

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- understand the basic concepts of metric spaces;
- correlate these concepts to their counter parts in real analysis;
- appreciate the abstractness of the concepts such as open balls, closed balls,compactness, connectedness etc. beyond their geometrical imaginations.

Unit-I

- Metric Spaces: Definition, examples and its properties.
- Neighborhood, Limit points, Interior points, exterior points and Boundary points. Open and closed sets.
- Closure, Interior and Exterior of a Set. Dense Set.
- Sub-spaces: Definition, examples and its properties.

Unit-II

- Cauchy sequences, Completeness, Cantor's Intersection Theorem.
- Contraction principle.

Unit-III

- First and second countable spaces. Separable spaces, Baire's Category Theorem.

Unit-IV

- Compactness for metric spaces, continuous function and Compact sets.
- Sequential compactness, Heine Borel Theorem.

Unit-V

- Totally bounded spaces, Finite Intersection Property.

- Connectedness.

Suggested Readings:

- G.F. Simons -Introduction to Topology and Modern Analysis Mc Graw Hill
- Satish Shirali & Harikishan L. Vasudeva, Metric Spaces, Springer Verlag London (2006) (First Indian Reprint 2009)

Practical

DC – XI: Metric Spaces

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DSE – 1(a): Operation Research

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- Analyze and solve linear programming models of real-life situations.
- The graphical solution of LPP with only two variables, and illustrate the concept ofconvex set and extreme points.
- The theory of the simplex method and its development.

Unit- I

- Origin and Development of Operations Research. Development of Operations Research in India. Scope of Operations Research. Phases of Operations Research. Models of Operations Research. Advantages and limitations of Operations Research.

Unit- II

- Linear Programming Problem (LPP): Standard form of LPP, Canonical and Matrix forms of LPP. Network of LPP. Conversion of real-world problems into standard form of LPP.

Unit-III

- Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondencebetween basic feasible solutions and extreme points.

Unit-IV

- Graphical method for the solution of LPP and its limitations.

Unit-V

- Simplex Method: Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness, Simplex algorithm, flow chart and its tableau format.

Suggested Readings:

- Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). *Linear Programmingand Network Flows* (4th ed.). John Wiley and Sons.

- Hadley, G. (1997). *Linear Programming*. Narosa Publishing House. New Delhi.
- Hamdy A. (2010). *Operations Research*: *An Introduction* (9th ed.). Pearson
- Hillier, F. S. & Lieberman, G. J. (2010). *Introduction to Operations Research-Concepts and Cases* (9th ed.). Tata McGraw Hill.
- Thie, Paul R., & Keough, G. E. (2014). *An Introduction to Linear Programming andGame Theory*. (3rd ed.). Wiley India Pvt. Ltd.

DSE – 1(b): Mathematical Statistics

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- connect basic concepts of Mathematical Statistics with new ideas.
- increase their capacity to develop logics of Mathematical Statistics.
- solve problems in the subject of Mathematical Statistics.
- enhance confidence level to teach the same subject.
- visualize the available data in the statistical form.

Unit- I

- Frequency distribution, measures of location, dispersion and skewness.
- Moments and Cumulate, Moment generating function.
- Simple Correlation coefficient, Multiple and Partial Correlation.
- Linear and Multiple Regression and their applications, Intra class correlation, Correlation ratio.

Unit- II

- Testing of hypothesis, Level of significance, degrees of freedom,
- Central and Non-central chi-square, t, z and F- distributions their properties and related tests.

Unit- III

- Definition of probability, Bayes' theorem, Basic distribution function probability mass function.
- Probability density function, Joint, Marginal and Conditional probability mass function.
- Random Variables and its Mathematical Expectations, Conditional Expectation, Expectation of sum and multiplication of random variables.
- Variance of sum and multiplication of random variables.

Unit- IV

- Standard Discrete Distributions- Bernoulli, Binomial, Poisson, Geometric, Hyper geometric and Multinomial distributions.
- Limiting form of Binomial and Poisson distributions.

Unit- V

- Standard continuous distributions-Uniform, Exponential, Normal, Beta, Gamma and Cauchy distributions.
- Order Statistics-Introduction and its distributions and properties. Joint & Marginal distributions of Order-Statistics.

Suggested Readings:

- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Wiley, Int'I Student's Edition.
- Rohatgi, V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
- Rao, C.R. (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
- Weather,Burn,C.E. : A first Course in Mathematical Statistics.
- Keany,J.F. and Keeping,E.S. : Mathematics of Statistics Pt. I and II
- Kendall,M.G. and stuart A : Advanced Theory of Statistics.
- Mood,gybrill and Boes : Introduction to theory of Statistics
- Hogs and Craig: Mathematical Statistics
- Goon,gupta and Dasgupta : Fundamental of Mathematical statistics Vol.I
- D N Elhance, Practical problems in statistics kitab mahal Allahabad 1979

DSE – 1(c): Mathematical Modeling

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)

Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes:
The learner-
- connect basic concepts of Mathematical Modelling with new ideas.
- increase their capacity to develop logics of Mathematical Modelling.
- solve problems in the subject of Mathematical Modelling.
- enhance confidence level to teach the same subject.
- generalize some important theorems of Mathematical Modelling.

Unit- I
- Mathematical Modelling: Need, Techniques, Classifications, Characteristics and Limitations of Mathematical models. Identification of real-world problems.
- Modelling process, Elementary Mathematical models.

Unit- II
- Mathematical Modelling through Ordinary differential equations of first order
- Linear growth and decay models, Nonlinear growth and decay models, Discreate models.

Unit- III
- Mathematical Modelling through systems of ordinary differential equations of first order, Stability using Jacobians.
- Mathematical Modelling in population dynamics, epidemics, economics and finance.

Unit- IV
- Mathematical Modelling through difference equations.

Unit- V
- Single species population model: The exponential model, Logistic model, Harvesting model and their critical values.

Suggested Readings:

- J.N. Kapur, Mathematical Modelling, New Age Intern. Pub.
- J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press.
- Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer.
- Frank R. Giordano, William Price Fox, Maurice D. Weir, A First Course in Mathematical Modelling, 4th Ed., Charlie Van Wagner.
- Walter J. Meyer, Concept of Mathematical Modelling, McGraw-Hill.

DSE – 1(d): Elementary Number Theory

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:
- some of the open problems related to prime numbers, viz., Goldbach conjecture, etc.
- about number theoretic functions and modular arithmetic.

Unit- I
- Division algorithm.
- Linear Congruence and their properties.
- G.C.D. and Euclidean Algorithm.
- Diophantine Equation.
- Chinese remainder theorem.
- Factorization, Prime and Co-prime.
- Fundamental theorem of arithmetic.

Unit- II

- Fermat's theorem.
- Euler theorem and Wilson's theorem.
- Fermat factorization theorem.
- Number theoretic function: Sum of Factors Function σ(n).
- Möbius function, Greatest Integer function.
- Euler φ function and its properties, Euler theorem.
- Multiplicative function. Mobius inversion formula. An Application to Calendar.

Unit- III

- The order of integer modulo n.
- Primitive-roots for primes, Composite number having primitive roots
- Quadratic Residues, Legendre's Symbol.
- Euler Criterion, Gauss's lemma.
- Law of Quadratic reciprocity and its applications.

Unit- IV

- Numbers of special form: Perfect numbers, Mersenne primes, Amicable Numbers and Fermat numbers.
- Primitive Pythagorean Triples and their specials forms (with corresponding theorem).
- Theorem linking in radius of Pythagorean Triangles and their properties.

Unit- V

- Triangular numbers.
- Lucas numbers and their properties.
- Fibonacci numbers and their properties, continued fraction (both finite and infinite),
- Pell`s equation.
- Farey`s sequence and their properties.

Suggested Readings:

- David M. Burton: Elementary Number theory, Wm C.Brown Publishers.
- Hans Rademacher: Lectures on Elementary Number Theory, Blaisdell Publishing Company.

Practical
DSE-I (a/b/c/d)

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

CHEMISTRY

DC- X: Organic Chemistry-IV

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. know the details of amino acids as a building block of proteins.
2. learn the biological importance of Nucleic acids with their synthesis and reactivits.

3. know the chemistry dyes and various colorants.
4. analyze the mechanism of enzyme action and specificity of enzymes.
5. know the involvement of enzymes in biosystems.
6. classify polymers along with method of their synthesis.
7. know the technique of estimation of glycine, proteins along with determination of saponification value and iodine number of oil and fats.

Unit-I: Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation

Unit-II: Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides (DNA and RNA).

Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl orange; Triphenyl methane dyes-Malachite green and Rosaniline; Phthalein Dyes – Phenolphthalein; Natural dyes – structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

Unit-III: Enzymes and Lipids

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance.

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit-IV: Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.

Caloric value of food, standard caloric content of food types.

Pharmaceutical Compounds: Structure and Importance Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Unit-V: Polymers

Introduction and classification including di-block, tri-block and amphiphilic polymers; Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to; Biodegradable and conducting polymers with examples.

Reference Books:

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition.
- W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated
- Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

Practicals

DC- X: Organic Chemistry -IV (Lab Work)

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.

3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.
9. Chromatography.
10. Synthesis of Polymers.

Reference Books:

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. Quantitative Organic Analysis, Pearson.

DC – XI: Physical Chemistry- IV

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. analyze Schrodinger wave equation and apply for rigid rotator, harmonic oscillator and hydrogen atom.
2. apply quantum mechanics to understand minute details of chemical bonding.
3. appreciate the utility of spectroscopic technique in the structural elecudidation of organic compounds.
4. know the importance of NMR in the structure determination of organic compounds.
5. differentiate between thermal and photochemical reactions and will be able to determine quantum efficiency of various photochemical reactions.
6. apply colorimetric and spectrophotometric methods in the determination of structure of organic compounds.

Unit-I: Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Schrödinger equation and its application to free particle and ―particle-in-a-box‖ (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two- and three-dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar (Derivation not required). Separation of variables. Spherical harmonics. Discussion of solution (Qualitative). Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Unit-II: Quantum Mechanical aspects of Chemical bonding

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H^{2+}. Bonding and antibonding orbitals. Qualitative extension to H_2.

Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).

Unit-III: Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Application of UV-visible spectroscopy, calculation of absorption maxima using Woodward Fisher's Rule.

Unit-IV: Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low-resolution spectra, different scales (δ and T), spin-spin coupling and high-resolution spectra, interpretation of PMR spectra of organic molecules.

Application of spectroscopy in the Structural elucidation of Organic Compounds, Conjoint problems.

Unit-V: Photochemistry: Characteristics of electromagnetic radiation, 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, photosensitised reactions, quenching. Role of photochemical 34 reactions in biochemical processes, photostationary states, fluorescence and phosphorescence, chemiluminescence.

Reference Books:

- Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).
- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E.
- Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).
- Y.R. Sharma, Organic absorption spectroscopy

Practicals

DC- XI: Physical Chemistry - IV (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Colorimetry:

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration

II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1, 10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analysis of the given vibration-rotation spectrum of HCl(g) Adsorption

UV/Visible spectroscopy:

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm-1 , eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2- propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

DSE- I

Choose any one:

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. get knowledge of sampling techniques and statistical method of analysis of data.
2. handle the uv-visible spectrophotometer and analyze the data obtained after spectrophotometric determination.
3. analyze the data obtained by flame atomic absorption and emission spectrometry.
4. get the knowledge of thermal methods of analysis and separation techniques.
5. acquire practical knowledge of separation techniques and solvent extraction.
6. get knowledge of synthesis and modification of inorganic solids.
7. classify nanostructure and nanomaterial.
8. acquire detailed knowledge of conducting polymers, ceramics and refractory.
9. synthesize hydrogels and silver and gold metal nanoparticles.
10. acquire details of industrial and inorganic chemicals.
11. segment the environment and major sources of air pollution.
12. know about industrial effluents and extent of pollution caused by it.
13. learn the technique of determining dissolved oxygen, chemical oxygen demand, biological oxygen demand, dissolved CO_2.

1. Analytical Methods in Chemistry

Unit-I: Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
Unit-II: Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers.
Unit-III: Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.
Unit-IV: Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.
Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit-V: Separation techniques:
Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.
Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.
Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.

Suggested Readings:

- Vogel, Arthur I: A Text book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman.
- Willard, Hobart H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A., Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore, 1998.
- Mikes, O. and Chalmers, R.A. Ed. Laboratory Hand Book of Chromatographic and Allied Methods, Elles Horwood Ltd. London.
- Dilts, R.V. Analytical Chemistry – Methods of separation Van Nostrand 1974.

Practicals
DSE- I

Analytical Methods in Chemistry (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

I. Separation Techniques
Chromatography:
(a) Separation of mixtures
(i) Paper chromatographic separation of Co^{2+} and Ni^{2+}.
(ii) Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values.
II. Solvent Extractions:
(i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in chloroform, and determine its concentration by spectrophotometry.
Analysis of soil:
(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium, magnesium
(iv) Qualitative detection of nitrate, phosphate
Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of amino acids from organic acids by ion exchange chromatography.
III Spectrophotometry
Verification of Lambert-Beer's law and determination of concentration of a coloured species ($CuSO_4$, $KMnO_4$)

Suggested Readings:

- Vogel, Arthur I: A Text book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman.
- Willard, Hobart H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore, 1998.
- Mikes, O. & Chalmers, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Horwood Ltd. London.
- Dilts, R.V. Analytical Chemistry – Methods of separation Van Nostrand 1974

2. Novel Inorganic Solids

Unit-I: Synthesis and modification of inorganic solids
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.
Unit-II: Inorganic solids of technological importance:
Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.
One-dimensional metals, molecular magnets, inorganic liquid crystals.
Unit-III: Nanomaterials
Overview of nanostructures and nanomaterials: classification.

Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.

Unit-IV: Introduction to engineering materials for mechanical construction

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

Composite Materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Unit-V: Speciality polymers

Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Reference Books:

- Atkins, Peter, Overton, Tina, Rourke, Jonathan, Weller, Mark and Armstrong, Fraser Shriver & Atkins' Inorganic Chemistry, 5th Edition, Oxford University Press 2011-2012
- Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry, John Wiley and Sons, London, New York, Sydney, Toronto, 1974
- Poole Jr., Charles P., Owens, Frank J., Introduction to Nanotechnology John Wiley and Sons, 2003.

Practicals

Novel Inorganic Solids (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1. Determination of cation exchange method
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticles.

Reference Book:

- Fahlman, B.D., Materials Chemistry, Springer, 2007

3. Industrial Chemicals and Environment

Unit-I: Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Unit-II: Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO_2, CO_2, CO, NOx, H_2S and other foul-smelling gases. Methods of estimation of CO, NOx,
SOx and control procedures. Effects of air pollution on living organisms and vegetation.
Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen,
chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Unit-III Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Unit-IV: Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis: Introduction to biocatalysis: Importance in ―Green Chemistry‖ and Chemical Industry.

Unit-V: Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Suggested Readings:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, Environmental Chemistry, CRC Press (2005).
- G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
- A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

Practicals

Industrial Chemicals and Environment (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

BOTANY

DC- X: Plant Physiology

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
To study the biomolecules and their functions with reference to different physiological processes in various cells and tissues in the plant.

Unit 1: Plant-water relations and mineral nutrition
Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory, Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.
Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
Unit 2: Nutrient Uptake and Translocation
Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.
Unit 3: Plant growth regulators
History of Discovery, chemical nature, bioassay, biosynthesis, mechanism of action and physiological roles of plant growth regulators: Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.
Unit 4: Physiology of flowering
Photoperiodism, flowering stimulus, florigen concept, vernalization, biological clock, fruit ripening, physiology of senescence, seed dormancy, seed germination and regulation.
Unit 5: Phytochrome, crytochromes and phototropins
Discovery, chemical nature, role in photo morphogenesis, low fluence responses (LFR) and high irradiance responses (HIR), mechanism of action.

Practicals
DC- X: Plant Physiology

Credit: 1
Contact Hours: 2hours per week
Max. Marks: 25
External: 25

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of plant growth regulators e.g., auxins/cytokinins/gibberellins/ETH/ABA etc. on Avena coleoptiles bending/root induction in shoots/ internode elongation/callus formation etc.
8. To study the induction of amylase activity in germinating barley grains.

Suggested Readings:
1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates zInc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

DC- XI: Plant Metabolism

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To study the various metabolic pathways associated in the cell functional activities and cell signal propagation and reception mechanisms.

Unit 1: Concept of metabolism and ATP synthesis
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase and role of uncouplers.
Unit 2: Photosynthesis: Carbon assimilation
Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna complex and reaction centres, OEC- Oxygen Evolving Complex, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration.
C_4 pathways; Differences from C_3 pathway, Crassulacean acid metabolism; Factors affecting CO_2 reduction.
Unit 3: Respiration: Carbohydrate metabolism and Carbon Oxidation Synthesis and catabolism of sucrose and starch.
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 4: Lipid metabolism and Nitrogen metabolism
Synthesis of fatty acids and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, α oxidation.
Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes);
Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.
Unit 5: Mechanisms of signal transduction
Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

Practicals
DC- XI: Plant Metabolism

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis using Hydrilla plant.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings
1.Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

DSE- I

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Choose any one:

1. Analytical Techniques in Plant Sciences

Learning Outcomes

To study the various **Analytical Techniques** associated in the cell activity and structure assessment. To study the structure and isolation of various biomolecules through various methods.

Unit 1: Imaging and related techniques
Principles of microscopy; Light microscopy; Fluorescence microscopy; confocal microscopy.
Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning
Electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.
Unit 2: Cell fractionation and Chromatography
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient,
$CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.
Principles of Paper chromatography, Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
Unit 3: Radioisotopes and Spectrophotometry
Radioisotope use in biological research, auto-radiography.
Spectrophotometry: Principle and its application in biological research.
Unit 4: Characterization of proteins and nucleic acids
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.
Unit 5: Biostatistics
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation, standard error; Chi-square test for goodness of fit.

Practicals
Analytical Techniques in Plant Sciences

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Suggested Readings:
1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

2. Bioinformatics

Learning Oiutcomes
To study about the various **bioinformatics methods, biological data bases from national and international origin**. To study the applications of bioinformatics in current research.

Unit 1. Introduction to Bioinformatics and Databases

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.
Introduction of Biological Databases- Primary and Secondary, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 2. Biological Sequence Databases

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
Swiss-Prot: Introduction and Salient Features.

Unit 3.Sequence Alignments

Introduction, Concept of Alignment, Local and Global Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid.
Block Substitution Matrix (BLOSUM).

Unit 4. Molecular Phylogeny

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 5. Applications of Bioinformatics

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practicals
Bioinformatics

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

ZOOLOGY
DC- X: CELL BIOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Overview of Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions
Various models of plasma membrane structure
Transport across membranes: Active and Passive transport, Facilitated transport
Cell junctions: Tight junctions, Desmosomes, Gap junctions

Unit 2: Endomembrane System

Structure and Functions:

- Endoplasmic Reticulum,
- Golgi Apparatus,
- Lysosomes

Unit 4: Mitochondria and Peroxisomes

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis
Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis
Peroxisomes

Unit 5: Cytoskeleton and Nucleus

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments
Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus
Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)

Unit 5: Cell Division and Cell Signaling

Mitosis, Meiosis, Cell cycle and its regulation
GPCR and Role of second messenger (cAMP)

PRACTICALS
DC- X: CELL BIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis in the testis of grasshopper
3. Preparation of temporary slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
   i. DNA by Feulgen reaction
   ii. DNA and RNA by MGP
   iii. Mucopolysaccharides by PAS reaction
   iv. Proteins by Mercurobromophenol blue/Fast Green

Suggested Readings:

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of theCell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London

DC- XI: PRINCIPLES OF GENETICS

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Mendelian Genetics and its Extension

Principles of inheritance, Incomplete dominance and co-dominance,
Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sexinfluenced and sex-limited characters inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping
Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.
Unit 3: Mutations
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.
Unit 4: Extra-chromosomal Inheritance, Sex Determination and Polygenic Inheritance
Criteria for extra-chromosomal inheritance, Antibiotic resistance in
Chlamydomonas, Mitochondrial mutations in Saccharomyces, Infective heredity in Paramecium and Maternal effects
Chromosomal mechanisms of sex determination in Drosophila and Man
Polygenic inheritance with suitable examples; simple numericals based on it.
Unit 5: Recombination in Bacteria and Viruses and Transposable Genetic Elements
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage
Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in humans

PRACTICALS
DC- XI: PRINCIPLES OF GENETICS

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/Drosophila.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from Drosophila crosses.
5. Study of human karyotype and associated abnormalities
6. Pedigree analysis of inherited traits in man

Suggested Readings:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
- Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

DSE- I

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Choose any one:

1. ENTOMOLOGY

Learning Outcomes

Unit I: Introduction and Insect Taxonomy
Distribution and Success of Insects on the Earth
General Features of Insects
Classification of insects up to orders
Unit II: General Morphology of Insects

External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits; Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat; Abdominal appendages and genitalia

Unit III: Physiology of Insects

Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system, Sensory receptors. Growth and metamorphosis

Unit IV: Insect Society and Insect Plant Interaction

Group of social insects and their social life

Social organization and social behaviour (w.r.t. any one example)

Theory of co-evolution, role of allelochemicals in host plant mediation

Unit V: Insects as Vectors

Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors

PRACTICALS
ENTOMOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of insect wings and their venation.
4. Methodology of collection, preservation and identification of insects.
5. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
6. Study of any three insect pests and their damages
7. Study of any three beneficial insects and their products
8. Field study of insects and submission of a project report on the insect diversity

Suggested Readings:

- A general text book of entomology, Imms, A. D., Chapman & Hall, UK
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
- The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
- Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
- Physiological system in Insects, Klowden, M. J., Academic Press, USA
- The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
- Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

2. PARASITOLOGY

Learning Outcomes

Unit I: Introduction to Parasitology

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical andbiological vector) Host parasite relationship.

Unit II: Parasitic Protists

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Entamoeba histolytica, Giardiaintestinalis, Trypanosoma gambiense, Plasmodium vivax.

Unit III: Parasitic Platyhelminthes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Fasciolopsisbuski, Schistosoma haematobium, Taeniasolium and Hymenolepis nana.

Unit IV: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Ascaris lumbricoides, Ancylostomaduodenale, Wuchereriabancrofti and Trichinella spiralis.

Unit IV: Parasitic Arthropoda

Biology, importance and control of ticks, mites, Pediculus humanus (head and body louse), Xenopsyllacheopis and Cimex lectularius.

Unit V: Parasitic Vertebrates

A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbirdand Vampire bat.

PRACTICALS
Parasitology

Credit: 1
Contact Hours: 2 hours per week (Max. Marks: 100
Max. Marks: 25
External: 25

1. Study of life stages of Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani and Plasmodium vivaxthrough permanentslides/micro photographs
2. Study of adult and life stages ofFasciolopsisbuski, Schistosomahaematobium, Taenia solium and Hymenolepis nana through permanentslides/micro photographs
3. Study of adult and life stages of Ascaris lumbricoides, Ancylostomaduodenale, Wuchereriabancrofti and Trichinella spiralis throughpermanentslides/microphotographs
4. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample
5. Study of Pediculus humanus (Head louse and Body louse), Xenopsyllacheopis andCimex lectularius through permanent slides/ photographs

Suggested Readings:

- Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications andDistributors
- E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor andFrancis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text andcolour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee BrothersMedical Publishers (P) Ltd., New Delhi
- Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. BrownPublishers
- Thomas C. Cheng (1986). General Parasitology, II Edition, Academic Press Inc
- K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

3. ANIMAL BIOTECHNOLOGY

Unit 1. Introduction

Concept and scope of biotechnology

Unit 2. Molecular Techniques I

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II.

Transformation techniques: Calcium chloride method and electroporation.

Unit 3. Molecular Techniques II

Construction of genomic and cDNA libraries and screening by colony and plaque

HybridizationSouthern, Northern and Western blotting

DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 4. Genetically Modified Organisms

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: production of donororgans, knock out mice.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 5. Culture Techniques and Applications

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis ofgenetic diseases (Cystic fibrosis, Sickle cell anemia). Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene Therapy.

PRACTICALS
ANIMAL BIOTECHNOLOGY

Credit: 1

Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Genomic DNA isolation from E.coli
2. Plasmid DNA isolation (pUC 18/19) from E.coli
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs and documentation
    a. Southern Blotting
    b. Northern Blotting
    c. Western Blotting
    d. DNA Sequencing (Sanger's Method)
    e. PCR

SUGGESTED READINGS

- Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applicationsof Recombinant DNA. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). AnIntroduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley andSons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genesand Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). Principles of Biomedical Ethics. VI Edition, Oxford University Press.

EDUCATION PART

Semester- V

CP- IV: Content cum Pedagogy Courses (Secondary): Physical Sciences- II

Credit: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course

This course comprises three units and the practicum. The course is devoted to introducing various teaching aids material types and uses for teaching the concepts of physical sciences at secondary stage. Enough space is provided to discuss different types of teaching aids/materials for teaching learning concepts of physical sciences. It focuses on learning resources in physical sciences to enable student teachers to make use of available learning resources and how to generate new resources for teaching learning the concepts of physical sciences. It also focuses on textbook analysis and planning for teaching physical sciences and its pedagogical issues in the light of NEP 2020. Student teachers are expected to identify various concepts and processes, list learning and outcomes, find out about various activities and experiments. Accordingly, they are expected to develop lesson plan based on learning outcomes and experiential learning for classroom and online teaching.

Learning Outcomes

After completion of this course, student teachers will be able to:

- identify teaching learning aids / materials and illustrate their importance in teaching learning the concepts of Physical Sciences,
- categorize teaching aids/materials/learning resources,
- develop teaching learning aids/material/kits/learning resources for teaching learning the concepts of Physical Sciences,
- utilize teaching aids/materials/learning resources for teaching learning the concepts of Physical Sciences,
- analyze the content of physical sciences textbooks at secondary stage,
- develop lesson plan based on learning outcomes and experiential learning using appropriate strategies.

UNIT – I: Teaching Learning Resources

- Teaching learning aids/materials: concept, definition, role and importance in classroom teaching learning the physical sciences.
- Types of teaching learning aids/ materials: print media such as textbook, teachers' manual/ handbook, laboratory manual and other print materials, non-print and digital media such as radio, TV, websites, animations, audios, videos, images, simulations, digital repository, Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI) based digital resources and Open Educational Resources (OERs) for offline/ online classroom teaching learning reflective journals, charts, 2-D and 3-D models, games, cards, worksheets, multimedia.
- Identification and use of learning resources in physical sciences from the local environment.
- Resource room/ laboratory/ library, virtual laboratories, teaching learning kits, physical sciences clubs, fairs, exhibitions, educational parks, excursions, community resources and pooling of resources.

UNIT – II: Content Analysis and Planning for Teaching Physical Sciences

- Pedagogical analysis of content taking examples from topics of physical sciences textbooks at secondary stage, identification of concepts, listing learning outcomes and competencies, planning, and evaluating learning experiences in an inclusive setup.
- Concept, types and importance of unit and lesson planning.
- Developing unit plans and lesson plans based on learning outcomes and experiential learning by selecting topics from textbooks of physical sciences at secondary stage.

UNIT – III: ICT Integration and Applications

- Scope and importance of ICT in physical sciences.
- Use of ICT such as Artificial Intelligence, machine learning, smart boards in the teaching learning, assessment, and resource management.
- Tools, software, and platforms for teaching learning of physical sciences at secondary stage.
- Developing ICT integrated lesson plans by taking topics of physical sciences at secondary stage using Technological Pedagogical Content Knowledge (TPCK) for classroom and online teaching.

Suggestive Practicum (Any Three)

1. Develop e-content for the concepts of Physical Sciences at Secondary Stage.
2. Analyze the content of textbooks of Physical Sciences (Classes 9-12).
3. Identify the learning resources for transiting the concepts of Physical Sciences.
4. Develop teaching aids/teaching materials for teaching concepts of Physical Sciences at secondary stage.
5. Develop learning outcomes for the concepts of Physical sciences at the secondary stage.
6. Prepare learning outcomes and experiential learning-based lesson plan for the concepts of Physical Sciences.
7. Develop a project on the concepts of Physical Sciences using interdisciplinary and multidisciplinary approaches as recommended in NEP 2020.
8. Any other project assigned by HEI.
9. Analyze the need, importance and scope of science kit developed by NCERT in classroom processes for secondary stage.

Suggestive Mode of Transaction

Lecture cum discussion/demonstration, hands-on activities, demonstration, discovery approach, project approach, inquiry approach, experimentation, problem-solving, concept mapping, experiential learning and ICT integrated approach.

Suggestive Mode of Assessment

Written test, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Materials

- Draft National Curriculum Framework for School Education,
- Laboratory Manual of Science (Grade 9 & 10), NCERT.
- National Education Policy 2020, MoE, Government of India.
- National Steering Committee for National Curriculum Frameworks, (2023).
- NCERT Laboratory Manuals.
- NCERT Textbooks, Chemistry for Class XI and XII.
- NCERT Textbooks, Physics for Class XI and XII.
- NCERT Textbooks, Science for Class IX and XI.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- V: Content-cum-Pedagogy Courses (Secondary): Mathematics- II

Credits: 2

Contact Hours: 2 hrs per week
Maxmum Marks: 50
Internal: 20
External: 30

About the Course

The teaching learning of Mathematics is a complex activity, and many factors determine the success of this activity. The nature and quality of instructional material, thepresentation of content, the pedagogic skills of the teacher, the learning environment. Students at this stage are keen in exploring and constructing their own knowledge, so facilitating with resources is important for the schoolteacher. This course will provide illustrative exposure to the resource materials for Mathematics teaching learning. Teaching Mathematics requires a thorough understanding of the pedagogical content knowledge. It is the integration or the synthesis of teachers' pedagogical knowledge and their subject matter knowledge that comprises pedagogical content knowledge. Planning of the learning experiences is a must for the quality learning outcome and the better use of resources. This course provides skills to develop the planning of Mathematics teaching learning for classroom. This course also extends the support of technology integration for enhancement of pedagogical planning. The course will be helpful for Student teachers in knowing how the mathematical content knowledge is organized and used in the teaching learning process with support of technological tools.

Learning Outcomes:

After completion of the course, student teachers will be able to:

- discuss the nature and functions of various instructional resources,
- explore and utilize the teaching learning resources to support pedagogical experiences of Mathematics,
- organize and manage supportive activities for development of mathematical aptitude of secondary school students,
- plan appropriate experiences for teaching Mathematics,
- explore diverse backgrounds and interests' children bring to set up the inclusive classroom for Mathematics learning,
- elaborate technological tools for teaching and learning of Mathematics,
- integrate technology to judiciously facilitate learning for enhancing inclusive environment.

UNIT – I: Teaching Learning Resources

- Teaching learning materials: meaning and importance for secondary school Mathematics.
- Types of teaching learning resources: print media (Mathematics textbook, teachers' manual/ handbook, laboratory manual), non-print and digital media (charts, 2-D and 3-D models, games, web resources, interactive boards, animations, videos, images, simulations) for offline/ online classroom teaching and learning
- Identification and use of learning resources in Mathematics from the local environment, community resources and pooling of resources.
- Mathematics resource room/ laboratory – equipment and management, concept of virtual laboratories.
- Organization of Mathematics club, fairs, exhibitions, learner community.

UNIT – II: Content Analysis and Planning for Teaching Mathematics

- Analysis for identification of axioms, concepts, rules, formulas, theorems, corollaries; pedagogical content knowledge of Arithmetic, Algebra, Geometry, Mensuration, and Trigonometry of secondary stage.
- Planning and evaluating learning experiences in an inclusive setup based on learning outcomes and competencies, building a community of mathematicians in classrooms.
- Developing annual plan, unit plan, lesson plan – need, main consideration, and format.
- Strategies for method-based lesson plan for secondary classes - inductive-deductive, analytical- synthetical, lecture cum demonstration, problem-solving, laboratory, and project based.

UNIT – III: ICT Integration and Applications in Teaching of Mathematics

- Scope and importance of ICT for teaching and learning Mathematics.
- Use of ICT (digital repository, Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI) based digital resources, open education resources, blogs, forums, interactive boards, and devices) in the teaching learning, assessment and resource management of secondary Mathematics.
- Use of tools, software, and platforms such as GeoGebra, Khan Academy along with national teacher's portal, DIKSHA, SWAYAM.
- Developing ICT integrated lesson plans using Technological Pedagogical Content Knowledge (TPCK) for Mathematics classroom and online teaching.

Suggestive Practicum (Any Three)

1. Develop learning resources for Mathematics teaching learning.
2. Prepare annual plan for any secondary class.
3. Prepare a unit plan from the mathematics textbook at secondary stage.
4. Prepare learning outcomes-based lesson plan using experiential learning for any one topic of Mathematics at secondary stage.

5. Develop a lesson plan on a topic of Mathematics at secondary stage by integrating ICT tools.
6. Write script for developing e-content on any one topic of Mathematics for online teaching.
7. Any other Project assigned by HEI.

Suggestive Mode of Transaction
Lecture cum discussion, group work, ICT enabled methods, Activity based and ArtIntegrated Demonstration, Field-based experiences, Library Visits, Self-study, Field observations, Assignment preparation. Classroom presentations, Discussion forums, Observation, Flip classroom, Use of digital platform.

Suggestive Mode of Assessment
Written test, classroom presentation, workshop, assignments, practicum, sessional, and terminal semester examination (As per UGC norms).

Suggestive Reading Materials
- NCERT: A Handbook for Designing Mathematics Laboratory in Schools (Code- 1555)
- NCERT: Manual for Higher Secondary Mathematics Kit (Code- 3165)

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- V: Content-cum-Pedagogy Courses (Secondary): Biological Sciences- II

Credits: 2
Contact Hours: 2 hrs. per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course
A wide array of teaching-learning resources is available to modern day teachers. This course comprises of three units which aims to introduce various resources and discuss their appropriate utilization in teaching. In this course, student teachers are introduced to different units and lesson plan based on learning outcomes and experiential learning. Requisite skills such as the use of print media, non-print media and digital resources are discussed in the course. This course also focuses on familiarizing student teachers in ICT integration in teaching and preparing ICT based lesson plans for online teaching using suitable tools. This course aims to prepare student teachers for teaching Biological Sciences using different dimensions pedagogical and technological aspects.

Learning Outcomes:
After completion of this course, Student teachers will be able to:
- categorize different teaching learning resources and plan their appropriate usage in teaching learning of concepts of Biological Science,
- develop simple teaching learning materials using easily available/local materials,
- analyze the content of Biological Science textbooks at secondary stage,
- review various methods and strategies for teaching Biological Sciences,
- develop learning outcome-based lesson plan to promote experiential learning and higher order thinking skills,
- develop unit plans and lesson plans on different chapters in biology (Grades IX to XII).

UNIT – I: Teaching Learning Resources
- Teaching learning aids/materials: concept, definition, role, and importance in classroom teaching learning the Biological Sciences.
- Types of teaching learning aids/ materials: print media such as textbook, teachers' manual/ handbook, laboratory manual and other print materials, non-print and digital media such as museum, aquarium, terrarium, games, toys, radio, TV, websites, animations, audios, videos, images, simulations; Biological Sciences mobile apps, digital repository, Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI) based digital resources and Open Educational Resources (OERs) for offline/ online classroom teaching learning (reflective journals, charts, 2-d and 3-d models, games, cards, worksheets, multimedia etc.
- Identification and use of learning resources in Biological Sciences from the local environment - using nature as a laboratory; biology laboratory - designing, management and safe practices; virtual laboratories and museums.
- Biological Sciences clubs, fairs, exhibitions, science parks, zoo, botanical gardens, excursions community resources and pooling of resources.

UNIT – II: Content Analysis and Planning for Teaching Biological Sciences

- Pedagogical analysis of content taking examples from topics of Biological Sciences textbooks at secondary stage, identification of concepts, listing learning outcomes and competencies, planning, and evaluating learning experiences in an inclusive setup.
- Concept, types and importance of unit and lesson planning.
- Developing unit plans and lesson plans based on learning outcomes and experiential learning by selecting topics from textbooks of Biological Sciences at secondary stage.

UNIT – III: ICT Integration and Application

- Scope and benefits of using IT in teaching learning process; Artificial Intelligence, machine learning, smart boards.
- Open Educational Resources in Biological Sciences – BIOIDAC, MOOC, National Teachers Portal, DIKSHA, SWAYAM.
- Developing ICT integrated lesson plans by taking topics of physical sciences at secondary stage using Technological Pedagogical Content Knowledge (TPCK) for classroom and online teaching.

Suggestive Practicum (Any Three)

1. Analyze the content of textbooks of Biological Sciences (Classes 9-12).
2. Develop e-content for the concepts of Biological Sciences at Secondary Stage.
3. Develop unit plans of selected chapters of Textbooks of Biological Sciences.
4. Prepare learning outcomes and experiential learning-based lesson plan for the concepts of Biological Sciences.
5. Developing ICT integrated lesson plans for offline and online classes.
6. Explore a course of Biological Sciences of MOOC and prepare a write up.
7. Any other project assigned by HEI.

Suggestive Mode of Transaction

Lecture cum discussion, demonstration, Hands-on activities, experiential learning, inquiry, Group work, Presentations, multimedia.

Suggestive Mode of Assessment

Written tests, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Material

- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India.
- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
- NCERT, Textbooks of Biological Sciences at Secondary Stage.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

AE&VAC- VII: Information and Communication Technology (ICT) in Education

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course

The present course focuses on moving beyond computer literacy and ICT-aided learning, to help student teachers interpret and adapt ICTs in line with educational aims and principles. The paper will orient the learners about the need for and importance of ICT in education. It will describe the importance of opensource software in education. Students will be given exposure to the various approaches and stages towards the use of ICT in education. Students are expected to develop reasonably good ICT skills in terms of the use of various computer software and ICT tools.

Learning Outcomes

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

- explain the concept, nature, and scope of ICT in education,
- describe the importance of open-source software in education,
- list and explain various approaches to the adoption and use of ICT in education,
- describe the importance of various emerging technologies in education,
- See relationship between the social, economic, and ethical issues associated with the use of ICT,
- list out the challenges of educational technology in India,

- use various technological tools for improving teaching-learning- assessment processes.

UNIT – I: Educational Technology

- Concept of Educational Technology
- Relationship between Education and Technology.
- Concept of Technology of Education and Technology in Education.
- Meaning, Nature, and significance of Technology in Education.
- Historical Development of use of Technology in Education.
- Principles of using Technology in Education.

UNIT – II: Instructional Design and Communication

- Meaning and Uses of Systems Approach in instructional design,
- Models of Development of Instructional Design: ADDIE, ASSURE, Dick and Carey Model Mason's,
- Concept and importance of Communication
- Models of communication: Shannon and Weaver, Newcomb, Schramm,
- Flanders' Interaction Analysis Category System (FIACS),

UNIT – III: Introduction to ICT in Education

- Meaning, Nature, importance: Information Technology, Communication Technology, Information and Communication Technology (ICT) and Instructional Technology,
- ICT in Education: Scope of ICT- Teaching, learning, Research and Publication, Educational Administration and Assessment,
- Technology and Engagement: Internet, Collaborative learning through Online Discussion Forums, group assignments and Peer reviews,
- Hardware and Software: meaning, difference and types.
- System software and Application software.

Suggestive Practicum

- Prepare an assessment tool on any one chapter of the textbook.
- Explore any one online platform for MOOCs and prepare a report highlighting its structure and courses.

Suggestive Mode of Transaction

The pedagogy for the course ICT in Education should be designed to ensure that students have a good understanding of how to use technology for improving teaching-learning-assessment processes. It should provide a balance between theoretical knowledge and practical skills. The approaches to curriculum transaction may include the following:

- Active learning encourages student teachers to participate in discussions, brainstorming sessions, and problem-solving activities that help them develop critical thinking and problem-solving skills.
- Collaborative learning involves group projects and tasks that encourage student teachers to work collaboratively and learn from each other.
- Experiential learning involving Hands-on activities, field trips, and real-life scenarios that will give student teachers the opportunity to apply their knowledge and skills in a practical setting.
- Use of multimedia tools such as videos, interactive simulations, and animations that help enhance learning and make it more engaging.
- Self-directed and self-managed learning activities that encourage students to take charge of their learning process through independent research, self-reflection, and self-assessment which can promote lifelong learning.

Suggestive Mode of Assessment

The assessment for the course ICT in Education should evaluate students' knowledge, capacities, and attitudes towards the use of technology in education. The assessment methods will include the following:

- Project-based assessments involving projects that require student teachers to create an instructional/learning resource that incorporates ICT tools and then assess the quality of the resource.
- Peer assessment helps students develop their critical thinking and evaluative capacities through group tasks requiring assessment by a group of the work of another group.
- Reflective journals requiring student teachers to maintain a reflective journal and to reflect on their learning experience involving the use of ICT tools in education.
- Online quizzes and tests involving online quizzes and tests that can assess students' knowledge of the theoretical aspects of ICT in education.
- Observation and feedback involving observation of performance of student teachers during classroom activities and providing feedback that help assess their practical skills in using ICT tools for improving teaching-learning-assessment processes.

Suggested Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

SE- I: Pre-Internship Practice

Credit: 2
Contact Hours: 2 hrs. per week
Maximum Marks: 50
Internal: 50

About the Course
Pre-Internship is a vital component of the Teacher Education Programme. It is a prerequisite for the student teachers to experience a simulated classroom environment to prepare them for real-life situations. Student teachers get exposure in a conducive, guided environment to manage a classroom and learn pedagogic and classroom management skills and get an opportunity to have hands-on experience.

Learning Objectives
After completion of the course, student teachers will be able to:
- Acquainted with various pedagogic practices, classroom management skills, assessment tools and learning standards,
- Get experience of conducting classes by observing lessons transacted by teacher educators (demonstration lessons),
- Develop lesson plans to transactthem using appropriate pedagogies and learning resources,
- Develop and practice teaching skills in a guided environment to be an effective teacher,
- Be prepared for the school internship.

Suggestive Mode of Transaction
- Demonstration lesson (minimum 1 in each pedagogical subject)
- Peer Group teaching and peer observation (minimum 5 in each pedagogical subject)
- Observation of lessons by teacher educators during peer group teaching
- Reflective group discussions/workshops/seminars
- Preparation and presentation of the video content illustrating best classroom practices.

Content
The pre-internship will include activities relating to the stage-specific pedagogy courses, ability enhancement and value-added courses and foundation courses transacted during previous semesters. It will also include knowledge of pedagogy, formats of lesson plans, different ICT tools, schooling systems in India, principles of classroom management, assessment, and other relevant content.

Activities to be conducted
- Observation of lessons transacted by teacher educators to identify pedagogic skills.
- Exposure to various types of lesson plans through workshops.
- Development of relevant Teaching Learning Materials (TLMs).
- Participation in screening and discussion of educational videos on pedagogy and assessment.
- Learning about inclusiveness in school education
- Orientation for Action Research/case study
- Orientation of student teachers to different pedagogic approaches like storytelling, art-integrated, sports-integrated, project-based, and ICT-integrated for developing critical thinking, attention to life aspirations, and greater flexibility and classroom management skills.
- Designing guided activities, including a laboratory for each class/subject based on learning outcomes.
- Study Secondary Stage Learning Standards in the NCF
- Content analysis and development of the unit plan, concept map and lesson plan.
- Discussion on unit plan and lesson plan with teacher educators/experts
- Preparation of a Portfolio (for self-work) that the student-teacher will use to keep all her/his work.
- Participate in discussions/reflective sessions for conceptualizing teaching-learning practices.
- Exploring available learning resources and educational videos
- Developing local, low-cost, and innovative TLMs
- Reading and reflecting on inspiring books on pedagogic practices

Assessment

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
Classroom teaching skills and assessment tools (including learning standards)	Simulated Presentation	Teacher-Educator	1	25
Reflective group discussions/workshop	Observations	Teacher-Educator	0.5	10

Artefacts (Lesson Plans, TLM, Curated Videos) and action research procedures.	Evaluation	Teacher-Educator	0.5	15

Learning Outcomes

After completion of the course, student teachers will be able to:

- Describe the prerequisites of the internship,
- Demonstrate knowledge of pedagogic practices, classroom management skills, assessment tools and learning standards,
- Develop lessons plans and relevant Teaching Learning Materials (TLMs),
- Develop readiness to take up an internship programme.

SEMESTER – VI

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	FE	Assessment & Evaluation	FE-IV	2	50	20	--	30	2
2	FE	Inclusive Education	FE-V	2	50	20	--	30	2
3	DC (Major) Any one Group	Physics/ Chemistry/ Mathematics Botany/Zoology	DC-XII	3+1	100	15	25	60	5
			DSE-II*	3+1	100	15	25	60	5
4	DCM (Minor) Other than Major	Physics/Mathematics/Chemistry/Botany/Zoology	DCM-IV*	3+1	100	15	25	60	5
5	CP	Content-cum-Pedagogy Courses (Secondary): Physical Science - III	CP-VI	2	50	20	--	30	2
		Content-cum-Pedagogy Courses (Secondary): Mathematics- III/Biological Science- III	CP-VII	2	50	20	---	30	2
6	AE&VAC	Mathematical & Quantitative Reasoning	AE & VAC-VIII	2	50	20	--	30	2
7	SE	School Observation (Field Practice)	SE-II	2	50	50	--	--	2
Total				**24**	**600**	**195**	**75**	**330**	**27**

***The practical of Subject mathematics is Internal**

SEMESTER – VI

PHYSICS

DC- XII: Atomic and Molecular Physics

Credits: 4 (3+1)

Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
1. To describe the atomic spectra of one and two valance electron atoms.
2. To explain the change in behavior of atoms in external applied electric and magnetic field.
3. To explain rotational, vibrational, electronic and Raman spectra of molecules.
4. To describe electron spin and nuclear magnetic resonance spectroscopy and their applications.

Unit I
Atomic Structure: Brief review of Bohr and Sommerfeld model of atom; Electron orbits; Energy levels and spectra; Vector atom model; Concepts of space quantization; Electron spin; Stern-Gerlach experiment; One and two valence electron systems; Pauli's exclusion principle and electron configuration; Spectroscopic notations of energy states, Multiplicity of energy level state.
Unit II
Spin orbit interaction; Selection rules; Spectra of alkaline atom; Fine structure of sodium D line; Spectral terms of two electron atoms; L-S and j-j coupling; Spectra of Helium atom; Frank-Hertz experiment.
Unit III
Zeeman effect: Early discoveries and developments; Experimental arrangement; Normal and anomalous Zeeman effect; Zeeman shift, Stark effect. Nature and production of X-rays; Discrete and continuous X-ray spectra; Characteristics X-ray spectrum; Duane and Hunts rule; X-ray emission spectra; Moseley's law and its application; Auger effect; Doublet structure of X-ray spectra; X-ray absorption spectra.
Unit IV
Molecular spectroscopy: Various types of spectra; Quantization of vibrational and Rotational energies; Pure Rotational Spectra; Determination of intermolecular distance of diatomic molecules; Pure Vibrational Spectra of Diatomic molecules; Electronic Spectra of Diatomic molecules.
Unit V
Raman Spectroscopy: Raman effect; Stokes and Anti Stokes lines; Experimental setup of Raman effect; Classical theory of Raman effect; Quantum theory of Raman effect; Applications of Raman effect; Electronic spectrum; Born-Oppenheimer approximation; Frank Condon principle; Fluorescence and Phosphorescence.

Suggested Readings:
Robert L. Brooks, The Fundamentals of Atomic and Molecular Physics, Springer
B.H. Bransden & C.L. Joachain, Physics of Atoms and Molecules, Pearson

Practicals
DC- XII: Atomic and Molecular Physics

Credits: 2
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1.) Study of Hydrogen Spectrum.
2.) Study of $KMnO_4$ Spectrum.
3.) Study of Iodine Spectrum.
4.) Study of Zeeman Effect.
5.) Perform UV-Visible absorption spectroscopy to investigate the absorption of light by a chemical compound.
6.) Determine absorption maxima and concentrations using UV visible absorption spectroscopy.

DSE – II

Choose any one:

1. RENEWABLE ENERGY AND ENERGY HARVESTING

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100

Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
1. To understand the fossil fuels and alternate sources of energy
2. To understand the concept of renewable energies in terms of solar energy and wind energy
3. To understand Wind Energy harvesting
4. To understand Piezoelectric Energy harvesting
5. To understand Electromagnetic Energy Harvesting

Unit I
Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.
Unit II
Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
Unit III
Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.
Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.
Geothermal Energy: Geothermal Resources, Geothermal Technologies
Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.
Unit 4
Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications,
Unit 5
Human power Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability

Suggested Readings:

- Non-conventional energy sources, B.H. Khan, McGraw Hill
- Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
- Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.
- Renewable Energy, 3rd Edition,
- Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

Practicum
RENEWABLE ENERGY AND ENERGY HARVESTING

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25
Demonstrations and Experiments
1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules

4. Laser Physics and Fiber Optics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:
1. To develop basic understanding of physics of lasers and laser operation.
2. To understand the basic elements and working of fiber Optic Communication Systems
2. To understand the basic elements of fiber optics
3. To understand the working of single mode fibres
4. To understand basic wave guide theory and concept of modes

Unit 1: Lasers: An Introduction
The Fiber Laser, The Ruby Laser, The He-Ne Laser, Optical Resonators, Einstein Coefficients and Optical Amplification, The Line-Shape Function, Typical Parameters of Ruby Laser
Monochromaticity of the Laser Beam
Unit 2: Fiber Optic Communication Systems
Overview of optical fiber communication: Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber single mode fiber, cutoff wave length, mode filed diameter. Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers.

Unit 3: Fiber Optics-1
Basics using Ray Optics, Total Internal Reflection, Critical angle, The Optical Fiber, Why Glass Fibers, The Coherent Bundle, The Numerical Aperture, Attenuation in Optical Fibers, Multimode Fibers, Pulse Dispersion in Multimode Optical Fibers, Dispersion and Maximum Bit Rates, General Expression for Ray Dispersion Corresponding to a Power Law Profile, Plastic Optical Fibers, Fiber Optic Sensors
Unit 4: Fiber Optics II:
Single Mode Fibers, Basic Equations, Guides Modes of a Step Index Fiber
Single-Mode Step Index Fiber, Pulse Dispersion in Single-Mode Fibers, Dispersion Compensating Fibers
Unit 5: Fiber Optics III:
Basic Waveguide Theory and Concepts of Modes, Waveguide Theory and Quantum Mechanics, TE and TM Modes in Rectangular Waveguides
TE Modes of a Symmetric Step Index Planar Waveguide, Physical Understanding of Modes
TM Modes of a Symmetric Step Index Planar Waveguide, TE Modes of a Parabolic Index Planar Waveguide

Suggested Readings:
1. An Introduction to LASERS-N. Avadhanulu, S. Chand & company(2001)
2. Engineering Physics by G.Vijyakumari Vikas publication New Delhi.
3. Ajoy K. Ghatak, K. Thyagarajan, An Introduction to Fiber Optics, Cambridge
University Press
4. Leonid G. Kazovsky, Sergio Benedetto, Alan E. Willner, Optical Fiber
Communication Systems, Artech House, 1996

Practicals
Laser Physics and Fiber Optics

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

Learning Outcomes:
1. Determination of NA by using optical fibre cable.
2. Setting up fiber optic analog link.
3. Setting up fiber optic digital link.
4. Intensity modulation system using analog input signal.
5. Intensity modulation system using digital input signal.
6. Frequency modulation system.

7. Pulse width modulation system.
8. Study of propagation loss in optical fiber.
9. Study of bending loss
10. Measurement of optical power using optical power meter.
11. Measurement of propagation loss using OPM.

MATHEMATICS
DC – XII: Numerical Analysis

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (External): 25

Learning Outcomes:

The learner-

- connect basic concepts of Advance Numerical Analysis with new ideas.
- increase their capacity to develop logics of Advance Numerical Analysis.
- solve problems in the subject of Advance Numerical Analysis.
- enhance confidence level to teach the same subject.
- generalize some important theorems of Advance Numerical Analysis.

Unit- I

- Errors & Approximations
- Different Operators E, Δ and ∇; Relations between the operators E, Δ and ∇; algebraic properties of operators E, Δ and ∇
- Fundamental Theorem of difference calculus
- Determination of Missing Terms
- Differences of zero
- Factorial Function (or Polynomial)
- Expression of a given Polynomial in Terms of Factorials

Unit- II

- Interpolation, Newton-Gregory's Forward and Backward interpolation with equal and unequal interval, Lagrange's and divided difference formulae
- Central Difference Interpolation Formula (Gauss, Stirling, Bessel's
- Solution of Algebraic & Trancedental Equations (Regula Falsi, Newton-Raphson, Iterative, Secant Method)
- Solution of simultaneous linear equations by Gauss Elimination, Gauss Jordan, Crout's methods, Jacobi's and GaussSiedel Iterative methods.

Unit- III

- Numerical Integration: General Quadrature formula for equidistance Ordinates
- Trapezoidal rule, Simpson's $\frac{1}{3}$ rule, Simpson's $\frac{2}{3}$ rules, Weddle's rule, Cote's Formula,
- Legendre-Gauss Quadrature Formula , Chebyshev's Polynomials.

Unit- IV

- Difference Equations of the First Order: Definition of a Difference Equation, Definition and Order of a Linear Difference Equation, Solution of the Difference Equation, Linear Difference Equations of First Order with Constant Coefficients, Properties of Linear Difference Equations, General Solution of the Homogeneous Difference Equations of First Order, Particular Solution of Difference Equation, Generating Functions, Generating Functions Techniques a Linear Difference Equations.

Unit- V

- Numerical Solution of ordinary differential Equation: Introduction, Taylor's Series, Euler's Method, Modified Euler's Method, Picard Method of Successive approximation, Milne's Method, Runge-Kutta Method.

Suggested Readings:

- Numerical methods for scientific and engineering computation. M.K. Jain, S.R.K. Iyengar, R.K. Jain.
- S.S. Sastry: Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi

Practical
DC – XII: Numerical Analysis

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
External: 25

Learning Outcomes:
The learner will be able to:

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

DSE – II (a): Laplace and Fourier Transformation

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- List the Laplace transforms of some standard functions, understand conditions for its existence.
- Find the Inverse Laplace Transforms of functions and implement it in Convolution theorem and Heaviside theorem.
- Apply Laplace and Inverse Laplace Transforms to evaluate Integrals and to solve Ordinary and Partial Differential Equations.
- Understand the basic concepts of Fourier Transforms, Fourier Sine and Cosine Transforms.

Unit- I

- Laplace Transform: Definition, examples and its properties. Existence of Laplace Transforms, Functions of exponential order, Laplace of some elementary functions.
- Null function, Lerch's Theorem (statement only), First and second translation theorems, Use of partial fractions, shifting theorems, change of scale property, linearity property of Laplace transform. Initial and final value theorems, Laplace Transform of the derivatives.
- Laplace transform of integrals of Multiplication by powers of t & division by t, Periodic function, Error function, Beta and Gamma function.

Unit-II

- Inverse Laplace transforms: Definition, examples and its properties. Inverse Laplace transforms of derivatives, integrals, division by powers of p, Heavisides expansion theorem, Beta function, Convolution theorem.

Unit- III

- Applications of Laplace Transform for solutions of ordinary Differential Equations with constant and variable coefficients.
- Applications of Laplace Transform for solutions of Simultaneous Ordinary Differential Equations.
- Applications of Laplace Transform for solutions of Partial Differential Equations.

Unit- IV

- Fourier Transforms: Definition, examples and its properties. Inversion theorem, Fourier sine and cosine transform, Inversion formula for sine and cosine transform.
- Linear property of Fourier Transforms.
- Shifting property of Fourier Transforms.
- Modulation theorem.

Unit- V

- Relationship between Fourier and Laplace transform. Fourier transform of the derivative of a function. Convolution, Convolution theorem.

Suggested Readings:

- Baidyanath Patra, An Introduction to Integral Transforms, CPC Press, Taylor & Francis Group.
- J.K. Goyal, K.P.Gupta, Integral Transforms, published by K.K. Mittal for Prakashan, 16th edition, 2013.
- Erwin Kreyszig, Advanced Engineering Mathematics, 8th edition, Authorized reprint by Wiley Dreamtech India

DSE – II (b): Advance Discrete Mathematics

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- connect basic concepts of Advanced Discrete Mathematics with new ideas.
- increase their capacity to develop logics of Advanced Discrete Mathematics.
- solve problems in the subject of Advanced Discrete Mathematics.
- enhance confidence level to teach the same subject.
- generalize some important theorems of Advanced Discrete Mathematics.

Unit- I

- Computability and Formal languages- Languages, Phrase structure grammars,
- Derivation, Sentential forms, Language generated by grammar. Regular grammar,
- Context-free and context sensitive grammars.

Unit- II

- Lattices- Lattices as partially ordered sets and their properties,
- Lattices as Algebraic systems, sub-lattices, Bounded lattices, Distributive Lattices, Complemented lattices.
- Boolean Algebra- Boolean Algebras as lattices, various Boolean identities. Joint irreducible elements, min-terms, max-terms, min-term Boolean forms,
- Canonical forms, minimization of Boolean functions.
- Applications of Boolean Algebra to switching theory (Using AND, OR, & NOT gates) the Karnaugh method.

Unit- III

- Discrete Numeric functions, Asymptotic Behavior of Numeric functions,
- Generating functions. Recurrence Relations- Linear Recurrence Relations with constant coefficients,
- Homogeneous solutions, particulars solutions, Total Solutions.

Unit IV

- Finite State Automata, Diagram & Language determined by an Automaton,
- Finite State Acceptors, Deterministic and Non-deterministic Finite Automata. Finite State Machines and their transition tables & diagrams. Equivalent machines.

Unit- V

- Reduced Machines, Kleen's theorem (Statement only) Pumping lemma,
- Moore and Mealy Machines, Turning Machines, Regular Expressions and corresponding regular languages (Def. only)

Suggested Readings:

- J.P. Tremblay & R. Manohar, Discrete Mathematical structures, McGraw Hill.
- N. Deo. : Graph theory with applications prentice hall.
- C.L. Liu: Elements of Discrete Mathematics McGraw Hill.

- Semyour Lipschutz/More lipson: Discrete Mathematics, McGraw Hill.

DSE – II (c): Probability Theory

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- Distributions to study the joint behavior of two random variables.
- To establish a formulation helping to predict one variable in terms of the other, i.e.,correlation and linear regression.
- Central limit theorem, which helps to understand the remarkable fact that**:** the empiricalfrequencies of so many natural populations, exhibit a bell shaped curve.

Unit- I

- Probability: Definition, Notation, Examples and Properties.
- Random experiment, Sample space, axioms of probability, equally likely outcomes, independent events, conditional probability.
- Bayes theorem, Geometric Probability.

Unit- II

- Random variables: Concept, Cumulative distribution function, discrete and continuous random variables,
- Expectations, mean, variance and moment generating function.

Unit- III

- Discrete random variable,
- Bernoulli random variable,
- Binomial random variable,
- Geometric random variable,
- Poisson random variable

Unit- IV

- Continuous random variable, Uniform random variable
- Exponential random variable, Gamma random variable,
- Normal random variable,
- Bivariate random variable, Joint distribution,
- Joint and conditional distribution.

Unit- V

- Probability inequalities.
- Characteristic functions. Modes of convergence,
- Weak and strong laws of large numbers.

Suggested Readings:

- R.V. Hogg and A.T. Craig: Introduction to Mathematical Statistics.
- S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics.

DSE – II (d): Biomathematics

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning outcomes: This course will enable the students to:

- Learn the development, analysis and interpretation of bio mathematical models.
- Reinforce the skills in mathematical modeling.
- Appreciate the theory of bifurcation and chaos.
- Learn to apply the basic concepts of probability to molecular evolution and genetics.

Unit- I

- Population growth, Administration of drugs, Cell division,
- Systems of linear ordinary differential equations,
- Predator- prey models, Epidemic models, Continuous and discreate models.

Unit- II

- Stability and oscillations: Epidemics, Stability using Eigen values
- The phase plane and the Jacobian matrix, Local stability,Stability,
- Limit cycles, Forced oscillations;

Unit-III

- Mathematics of Heart Physiology: The local model,
- The Threshold effect, The phase plane analysis and the heartbeat model, A model of the cardiacpacemaker;
- Mathematics of Nerve Impulse Transmission: Excitability and repetitive firing, Travelling waves.

Unit- IV

- Bifurcation, Bifurcation of a limit cycle.
- Saddle node bifurcation, Transcritical bifurcation, Pitchfork bifurcation.
- Stability of limit cycles, The Poincare plane.

Unit- V

- Modelling Molecular Evolution: Matrix models of base substitutions for DNA sequences,
- TheJukes-Cantor model, The Kimura models, Phylogenetic distances; Constructing Phylogenetic
- Trees: Phylogenetic trees, Unweighted pair-group method with arithmetic means (UPGMA),
- Neighbor joining method; Genetics: Mendelian genetics, Probability distributions in genetics.

Suggested Readings:

- Allman, Elizabeth S., & Rhodes, John A. (2004). *Mathematical Models in Biology*:*An Introduction*. Cambridge University Press.
- Jones, D. S., Plank, M. J., & Sleeman, B. D. (2009). *Differential Equations andMathematical Biology* (2nd ed.). CRC Press, Taylor & Francis Group, LLC.
- Murray, J. D. (2002). *An Introduction to Mathematical Biology* (3rd ed.). Springer.
- Myint-U, Tyn (1977). *Ordinary Differential Equation*. Elsevier North-Holland, Inc.
- Simmons, George F., & Krantz, Steven G. (2015). *Differential Equations*. McGraw-Hill Education. Indian Reprint.
- Strogatz, Steven H. (2009). *Nonlinear Dynamics and Chaos* (2nd ed.). Perseus BookPublishing. LLC. Sarat Publication, Kolkata, India.

Practical
DSE – II (a/b/c/d)

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

CHEMISTRY
DC- XII: Inorganic Chemistry- IV

Credits: 4 (3+1)

Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. understand basic principles involved in the analysis of cations and anions during inorganic qualitative analysis.
2. classify organometallic compounds and acquire detailed knowledge of metal carbonyls.
3. know the bonding pattern in metal alkyls.
4. know the biological importance of metals in the formation of bioinorganic compounds.
5. acquire the knowledge of some common applications of organometallic compounds.
6. employ semi-micro qualitative inorganic analysis to analyze the inorganic mixture containing six radicals.

Unit-I: Theoretical Principles in Qualitative Analysis (H_2S Scheme)

Basic principles involved in analysis of cations and anions. Solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

Unit-II: Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Unit-III: Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Unit-IV: Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug.

Iron and its application in bio-systems, Haemoglobin, Myoglobin; Storage and transfer of iron.

Unit-V: Application of Organometallic Compounds

Some common applications of Organometallic Compounds. Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst

Reference Books:

- Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972
- Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-.
- Lippard, S.J. & Berg, J.M., Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A., Wilkinson, G., & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
- Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements 2nd Ed, Elsevier, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
- Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D.D., Atkins, P. and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977

- Miessler, G. L. & Tarr, Donald A., Inorganic Chemistry 4th Ed., Pearson, 2010.
- Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. John Wiley New York, NY, 2000.
- Spessard, Gary O., & Miessler, Gary L., Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

Practicals

Dc- XII: Inorganic Chemistry-IV (Lab Work)

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:
CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}
Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot tests should be done whenever possible. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
i. Ni (II) and Co (II)
ii. Cu (II) and Cd (II)
iii. Pb (II) and Ag (I)
iv. Cr (III) and Cu (II)

Reference Books:

- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
- Vogel, A.I. A Textbook of Quantitative Analysis, ELBS. 1986

DSE- II

Choose any one:

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing the course the students will be able to:

1. know the importance and basic principles of green chemistry.
2. learn the technique of green synthesis and some real world cases.
3. acquire the knowledge of future trends in green chemistry.
4. learn the technique of green synthesis of propene, pthalocyamine complex of copper (II)
5. acquire the detailed knowledge of research methodology and writing of scientific papers.
6. learn the technique of handling the data obtained after chemistry research.
7. complete a project following basic principles of research methodology.

1. Green Chemistry

Unit-I: Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry
Unit-II: Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and special emphasis on the following with examples:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity risk = (function) hazard x exposure ; waste or pollution prevention hierarchy
- Green solvents– super critical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents

- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy
- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups;
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, bio catalysis, asymmetric catalysis and photo catalysis.
- 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 carbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit-III: Examples of Green Synthesis/ Reactions and some real world cases-I

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
4. Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
5. Designing of Environmentally safe marine antifoulant.

Unit-IV: Examples of Green Synthesis/ Reactions and some real world cases-II

6. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
8. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils
9. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Unit-V: Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainable development.

Reference Books:

- Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005
- Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998
- Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
- Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
- Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002
- Lancaster, Mike, Green Chemistry an Introductory Text 2nd Ed., RSC Publishing,. ISBN: 978-1-84755-873-2

Practicals

Green Chemistry (Lab Work)

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Safer starting materials

Preparation and characterization of nano particles of gold using tea leaves.

1. Using renewable resources

Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH- → propene + trimethylpropene + water H2SO4/H2O

(II) 1-propanol propene + water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide Alternative Green solvents

6. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.
7. Mechanochemical solvent free synthesis of azomethines Alternative sources of energy
8. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
9. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

- Anastas, P.T and Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press, 1998
- Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC, 2002
- Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC, 2002
- Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7, 2013
- Cann, M.C. and Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society, 2008
- Cann, M. C. and Thomas, P. Real world cases in Green Chemistry, American Chemical Society, 2008
- Lancaster, Mike Green Chemistry: An introductory text: 2nd Ed. RSC publishing, ISBN 978-1-84755-873-2
- Pavia, D.L., Kriz, G.S., Lampman, G.M. and Engels, R.G. Introduction to Organic Laboratory Techniques – a Microscale Approach 4th Ed., Brooks-Cole Laboratory Series for Organic Chemistry, 2006

2. Research Methodology for Chemistry

Unit-I: Literature Survey

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Unit-II: Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

Unit-III: Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

Unit-IV: Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit-V: Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments. Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.

Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.

Electronics: Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books:

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
- Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
- Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
- OSU safety manual 1.01.

Practicals

RESEARCH METHODOLOGY FOR CHEMISTRY

Dissertation / Research Project in Chemistry

BOTANY

DC- XII: Plant Biotechnology

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To study the various plant tissue culture techniques and their uses in plant mass production and genetically modified plants.

Unit 1: Plant Tissue Culture

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 2: Recombinant DNA technology

Restriction enzymes-Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit 3: Gene Cloning

Recombinant DNA technology, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Basic concept of genomic and cDNA libraries, screening of DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

Unit 4: Methods of gene transfer

Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP), Agrobacterium-mediated gene transfer.

Unit 5: Applications of Biotechnology

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Practicals

DC- XII: Plant Biotechnology

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

A. Preparation of MS medium.
B. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.

2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

DSE- II

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Choose any one:

1. Industrial and Environmental Microbiology

Learning Outcomes
To study the various microbes involved in the industrial productions and their uses in treating polluted environments. To study the agriculturally friendly microbes.

Unit 1: Bioreactors/Fermenters and fermentation processes
Scope of microbes in industry and environment
Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations.
Components of a typical bioreactor, Types of bioreactors-laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.
A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.
Unit 2: Microbial production of industrial products
Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic(Penicillin).
Unit 3: Microbial enzymes of industrial interest and enzyme immobilization
Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).
Unit 4: Microbes and quality of environment and water microflora
Distribution of microbes in air; Isolation of microorganisms from soil, air and water.
Water pollution, role of microbes in sewage and domestic waste water treatment systems.
Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.
Unit 5: Microbes in agriculture and remediation of contaminated soils.
Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscularmycorrhizal colonization in plant roots.

Practicals
Industrial and Environmental Microbiology

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1.Principles and functioning of instruments in microbiology laboratory
2.Hands on sterilization techniques and preparation of culture media.

Suggested Readings
1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

2. Biostatistics

Learning Outcomes

To study the various statistical methods and their use in data set processing to bring statistical inference and relations among the objective of the data's collected in the field.

Unit 1: Biostatistics

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

Unit 2: Collection of data primary and secondary

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

Unit 3: Measures of central tendency

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, standard error, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

Unit 4: Correlation

Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression

Unit 5: Statistical inference

Hypothesis - simple hypothesis, Null hypothesis and Experimental hypothesis,test of significance- student 't' test - chi square test.

Practicals
Biostatistics

Credit: 1
Contact Hours: 2hours per week
Max. Marks: 25
External: 25

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefficient values and finding out the probability
3) Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings:

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

3. Research Methodology

Learning Outcomes

To study the methods involved in plant research, scientific report writing and presentation.

Unit 1: Basic concepts of research

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vsemperical).Research methods vs methodology.

Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: General laboratory practices

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases.Preparation of solutions, Dilutions, Percentage solutions. Molar, molal and normal solutions.Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data collection and documentation of observations and overview of Biological Problems Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics Transcriptional regulatory network.

Unit 4: Methods to study plant cell/tissue structure and Plant micro-techniques

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration;
Preparation of thin and ultrathin sections.
Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags).
Cytogenetic techniques with squashed plant materials.

Unit 5: The art of scientific writing and its presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references.
Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practicals
Research Methodology

Credit: 1
Contact Hours: 2hours per week
Max. Marks: 25
External: 25

Experiments based on chemical calculations.

1. Plant micro-technique experiments.
2. The art of imaging of samples through micro-photography and field photography.
3. Poster presentation on defined topics.
4. Technical writing on topics assigned.
5. Dissertation

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant micro-technique and microscopy. Oxford University Press, New York, U.S.A.

ZOOLOGY
DC- XII: MOLECULAR BIOLOGY

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1: Nucleic Acids and DNA Replication

Salient features of DNA and RNA
Watson and Crick model of DNA
DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming.

Unit 2: Transcription

Mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

Unit 3: Translation

Genetic code and its characteristics, Mechanism of translation in prokaryotes and eukaryotes; Difference between prokaryotic and eukaryotic translation

Unit 4: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 5: Gene Regulation, DNA Repair Mechanisms and Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting.
DNA Repair Mechanisms: Pyrimidine dimerization and mismatch repair

PRACTICALS
DC- XII: MOLECULAR BIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Preparation of liquid culture medium (LB) and raise culture of E. coli
2. Estimation of the growth kinetics of E. coli by turbidity method
3. Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking
4. Demonstration of antibiotic sensitivity/resistance of E. coli to antibiotic pressure and interpretation of results
5. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement)
6. Quantitative estimation of RNA using Orcinol reaction
7. Demonstration of DNA gel electrophoresis and its visualization
8. Study and interpretation of electron micrographs/ photograph showing
   (a) DNA replication
   (b) Transcription
   (c) Split genes

SUGGESTED READINGS

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular
- Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). Gene XI, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

DSE- II

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Choose any One

1. ENDOCRINOLOGY

Learning Outcomes
Unit 1: Introduction to Endocrinology
History of endocrinology, Classification, Characteristic and Transport of Hormones,Neurosecretions and Neurohormones.
Unit 2: Epiphysis
Structure of pineal gland,
Secretions and their functions inbiological rhythms andreproduction.
Unit 3: Hypothalamo-hypophysial Axis
Structure of hypothalamus, Regulationofneuroendocrine glands, Feedback mechanisms
Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysialportal system, Disorders of pituitary gland.
Unit 4: Peripheral Endocrine Glands

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal,Pancreas, Ovary and Testis Hormones in homeostasis, Disorders of endocrine glands.

Unit 5: Regulation of Hormone Action

Hormone action at Cellular level: Hormone receptors, transduction and regulation
Hormone action at Molecular level: Molecular mediators, Genetic control of hormoneaction.

PRACTICALS
ENDOCRINOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of the permanent slides of the following endocrine glands:
   i. Pituitary
   ii. Pineal
   iii. Thyroid
   iv. Parathyroid
   v. Adrenal
   vi. Pancreas
   vii. Ovary
   viii. Testis
2. Estimation of plasma level of any hormone using ELISA
3. Designing of primers of any hormone

SUGGESTED READINGS

- General Endocrinology C. Donnell Turner Pub- SaundersToppan
- Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead.
- Oxford: BIOS Scientific Publishers; 2001.
- Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson PrenticeHall, Pearson Education Inc., New Jersey.
- A textbook of comparative endocrinology, Aubrey Gorbman, Howard Alan Bern,1962, Medical.
- Vertebrate Endocrinology by David O. Norris

2. IMMUNOLOGY

Learning Outcomes

Unit 1: Overview of Immune System

Historical perspective of Immunology, Early theories of Immunology, Cells and organs ofthe Immune system

Unit 2: Innate and Adaptive Immunity

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity,Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity,Active: Artificial and natural Immunity, Immune dysfunctions (brief account ofautoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit 3: Antigens and Immunoglobulins

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors
influencing immunogenicity, B and T-Cell epitopes.
Structure and functions of different classes of immunoglobulins, Antigen-ntibodyinteractions, Immunoassays (ELISA and RIA), Polyclonal sera,Hybridoma technology:Monoclonal antibodies in therapeutics and diagnosis.

Unit 4: Major Histocompatibility Complex, Cytokines, Complement System

Structure and functions of MHC molecules. Endogenous and exogenous pathways ofantigen processing and presentation
Properties and functions of cytokines, Therapeutics Cytokines
Components and pathways of complement activation.

Unit 5: Hypersensitivity and Vaccines

Gell and Coombs' classification and brief description of various types of hypersensitivities. Various types of vaccines.

PRACTICALS
IMMUNOLOGY

Credit: 1
Contact Hours: 2 hours per week

Max. Marks: 25
External: 25

1. Histological study of spleen, thymus and lymph nodes through slides/ photographs
2. Preparation of stained blood film to study various types of blood cells.
3. Ouchterlony's double immuno-diffusion method.
4. ABO blood group determination.
5. Demonstration of ELISA and Immuno-electrophoresis

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H.Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). Immunology, VII Edition, Mosby,Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. VEdition. Saunders Publication

3. RESEARCH METHODOLOGY

Unit 1: The Nature of Research, Literature Survey

Definition of Research, Significance of research, Objectives of research, Components of researchproblem, Steps in scientific research.

Sources of scientific literature: Print and Digital

Unit 2: Types of Research, Tools and Techniques in Research

Descriptive vs Analytical; Applied vs Basic; Qualitative vs Quantitative; Conceptual vsEmpirical; Survey vs Experimental. Model organisms; Principles and applications of Microscopy, Histochemical and Cytochemicaltechniques, Chromatography, Electrophoresis, Spectroscopy, ELISA, PCR and Animal TissueCulture

Unit 3: Research Process

Formulation of research problem; Inductive reasoning; Hypothesis; Preparing the researchdesign; Sample design – deliberate, random, systematic, stratified, quota, cluster, area, multistage, sequential; Data collection – observation, interview, questionnaires, schedules;

Categorization and tabulation of data, graphicalpresentation – Bar, Line, Pie, Histogram, Chart; Analysis of data – central tendencies, standard deviation, variance, coefficient of correlation, Chi-square test,

Use of Software

Unit 4: Preparation of Report, Publication of Report

Scientific presentation, abbreviations, nomenclature used and reference writing

Finding a suitable journal – Open access, Publication charges; Writing scientific research papers

Unit 5: Bio-safety and Ethical Aspects of Biological Research

Awareness about handling of toxic laboratory chemicals, Use of pathogenic micro-organisms,Radioactive hazards, Safe disposal of animals and chemicals.

Ethical principles and government regulations governing use of live animals as objects ofresearch; Copyright and plagiarism; Patents; Peer review; Conflict of interest; IPR issues.

PRACTICALS
RESEARCH METHODOLOGY

Credit:1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Project work based on research problem indicating research design, methodology, use of statistical tools, interpretation of data, results and references.
2. Dissertation

SUGGESTED READINGS

1. Walliman, N. (2011). Research Methods-The Basics. Taylor and Francis, London andNew York.
2. Kothari, C. R. Research Methodologies-Methods and Techniques. New Age Publishers.
3. Dawson, C. (2002). Practical Research Methods. UBS Publishers, New Delhi
4. Booth, W.C., Colomb, G.G. and Williams, J.M. (2003). The Craft of Research, IIEdition, University of Chicago Press.
5. Monamy, V. (2009). Animal Experimentation-A Guide to the Issues, II edition.Cambridge University Press.

EDUCATION PART

Semester- VI

FE- IV: Assessment and Evaluation

Credits: 2
Contact Hours: 2 hrs per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

The main thrust of this course on assessment and evaluation is to equip student teachers with the knowledge and capacities required to develop and implement approaches to assessment that is more regular and formative, more competency-based, is appropriate for assessing learning outcomes relating to all domains of learning, is appropriate for testing not only subject-related learning but also generic learning outcomes such as problem-solving, critical thinking, creative thinking, communication skills, judgements and decision making, ethical and moral reasoning etc.

Learning Outcomes

After completion of this course, student teachers will be able to:

- use different approaches to assess and evaluate student performance, such as time-constrained examinations; closed/open-book tests; problem-based assignments; practical assignments reports; observation of practical skills; individual and group project reports; oral presentations; viva voce interviews; computerized adaptive testing; peer and self-evaluation etc.,
- develop and use informal and formal diagnostic, formative, and summative evaluation strategies to monitor student learning levels and help the teacher continuously revise teaching-learning processes to optimize learning and development for all students,
- develop an understanding among student teachers of the approaches to provide timely, effective, and appropriate feedback to students about their performance relative to the expected learning outcomes and organizing learning enhancement initiatives that are required to bridge the gap in student learning levels,
- present report on student achievement, making use of accurate and reliable records etc.
- develop assessment "as", "of", and "for" learning that are aligned to the expected learning outcomes,
- develop model rubrics for self-assessment, peer-assessment, and teacher-assessment.
- design the progress card of students based on school-based assessment to make it a holistic, 360-degree, multidimensional report that reflects the progress as well as the performance of learners assessed through self-assessment and peer assessment, project-based and inquiry-based learning, quizzes, role plays, group work, portfolios, etc., along with teacher assessment that would provide students with valuable information on their strengths, areas of interest, and needed areas of improvement.

UNIT – I: Assessment in Education

- Assessment and Evaluation
  - Meaning and significance of assessment and evaluation in the educational field.
  - Conceptual Clarity and purpose of Measurement, Assessment, Examination, Appraisal and Evaluation in Education.
  - Learning outcomes across the stages and assessment.
  - Taxonomy of Objectives (Revised in 2001) and Implications.

- Forms of Assessment
  - Formative, Summative, diagnostic, prognostic.
  - Internal and External assessment.
  - Quantitative and Qualitative Assessment.
  - Assessment for learning, of learning and as learning.
  - Authentic Assessment; Online Assessment.
- Improving Assessment and Evaluation in Schools: Brief Historical Review of NCFs(1975, 1988, 2000, 2005, 2020)

UNIT – II: Process of Assessment and Evaluation

- Formative and Summative Assessment: Concept and Characteristics.
- Approaches to assess and evaluate student performance such as time-constrained examinations; closed/open-book tests; problem-based assignments; practical assignment reports; observation of practical skills; individual and group project reports; oral presentations; viva-voce interviews; computerized adaptive testing; peer and self-assessment etc.
- Assessing Higher Order Thinking Abilities: Problem-solving, critical thinking, creative thinking, communication skills, judgement and decision making, ethical and moral reasoning.
- Tools and Techniques
  - Observation, rating scale, checklist, anecdotal record, interviews, Socio-metric techniques.

- Assessment of attitudes and interests.
- Criteria for assessment of social and personal behaviour.
- Portfolio.
- Journal writing.
- Rubrics: Holistic Rubric, Analytic Rubric, Self-Assessment, Peer-Assessment, and Teacher-Assessment.

UNIT –III: Analysis, Interpretation and Reporting

- Analysis of students' performance and scores: credit and grading
- Graphical representation (Histogram, Frequency Curves)
- Interpretation of student's performance based on the analysis and their further uses in improving learner's performance: credit and grading, constructive feedback.
- Reporting student's performance: 360-degree progress reports, cumulative records and their uses, portfolios, PTA meetings, qualitative reporting based on observations, and descriptive indicators in report cards.

Suggestive Practicum

- Review of various education commissions, Policies and reports and NCF 2005 to get a brief view of the recommendations on Assessment and Evaluation.
- Constructing a unit test using the table of specifications.
- Construction of any one of the tools (rating scale, checklist, observation schedule, etc.) and administering it to the group of students or using it to observe the school and classroom environment and interpret it.
- Analysis of question papers of various Boards.
- Analysis of report cards - State and Central (CBSE)
- Develop a Rubric for Self-Assessment.
- Develop a Rubric for Peer-Assessment.
- Develop a Rubric for Teacher-Assessment.
- Preparing format of 360-degree Report Card.
- Review of learning outcomes by NCERT in different subject areas.
- Interviews with teachers and students to study the assessment practices, issues and problems related to it, followed by the presentation.
- Reviewing Assessment Discussions in NPE (2020).

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands-on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

Teachers may suggest books/readings as per the needs of the learners and learning content.

References:

- Bradfield, J. M., & Moredock, H.S (1957). *Measurement and evaluation in education*. New York: The MacMillan Company.
- Central Board of Secondary Education (2019). *Secondary school curriculum.* New Delhi: CBSE.
- Freeman, R. & Lewis, R. (1998). *Planning and implementing assessment.* London: Kogan page.
- Harlen, W. (2006). On the Relationship between assessment for formative and summative purposes. In J. Gardner (Ed), *Assessment and Learning*. *Sage Publications Ltd.*
- Harlen, W., & Crick, R. D. (2003). Testing and motivation for learning. *Assessment in Education,10*(2), 169–207.
- Ministry of Human Resource Development. (2020). *National Education Policy 2020.* New Delhi: Government of India.
- McMillan, J. H. (2004). *Classroom assessment: Principles and practice for effective instruction*. New York, NY: Pearson Education.
- National Council for Education Research & Training. (2019). *Continuous and comprehensive evaluation*. New Delhi: NCERT.

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- Policy, N. E. (2020). Ministry of human resource development, government of India. *English version*.
- Sarkar, T.K. (2012). Assessment in education in India. *Sage Educational Journal, 9(2*).
- Smith, W., & Cumming, J. (2009). *Educational Assessment in the 21st Century: Connecting theory and practice.* Netherlands: Springer.

FE- V: Inclusive Education

Credits: 2
Contact Hours: 2 hrs per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

This course seeks to orient student teachers to the approaches to bridging gender and social category gaps in terms of participation rates and student learning levels at all levels of school education. The course will provide orientation to the strategies pursued and required to improve participation and learning levels of children from Socio-Economically Disadvantaged Groups (SEDGs) that can be broadly categorized based on gender identities, particularly female and transgender individuals, socio-cultural identities (such as Scheduled Castes, Scheduled Tribes, OBCs, and minorities), geographical identities (such as students from remote locations, villages, small towns, and aspirational districts), disabilities (including learning disabilities), linguistic identities, and socio- economic conditions (such as migrant communities, low income households, children in vulnerable situations, including orphans and the urban poor).

Learning Outcomes

After completion of this course, student teachers will be able to:

- ensure inclusion and equal participation in education of children with disabilities in the regular schooling process that allows students with and without disabilities learn together, ensuring their retention in the school system, and enabling them to achieve the defined learning outcomes,
- adapt teaching and learning process to meet the learning needs of different students with disabilities, including providing education and opportunities for participating in arts, sports, and vocation-related activities, making school buildings and compounds as well as other facilities barrier free and accessible for children with disabilities, supporting activities that help the provision of individualized learning environment and learning activities/resources, making available assistive devices and appropriate technology-based tools, as well as adequate and language-appropriate teaching-learning materials (e.g., textbooks in accessible formats such as large print and Braille) to help children with disabilities integrate more easily into classrooms and engage with teachers and their peers, using appropriate modes and means of communication, detecting specific learning disabilities in children at the earliest and taking appropriate measures to overcome them, monitoring completion of education and learning levels of students with disabilities etc.

UNIT – I: Inclusion and Education

- Conceptual Evolution, relation, and significance with special reference to Indian Context:
  United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), 2006,
  The Right of Person with Disabilities (RPWD) Act, 2016,
- Clarity of various terms and phrases associated with Inclusive Education: Special Education, Integrated Education, Impairment and Disability (Divyangta), Assessment and Evaluation, Curriculum (adaptation, modification and differentiation), Universal Design of Learning (UDL)
- Shifting from Special Education to the Inclusive Education view.
- Introductory reference of Policies, Acts and Schemes with reference to educational implications for Children with Disabilities: National Trust Act, 1999, Right to Education Act, 2009, 2012, RPWD Act, 2016, Samagra Siksha Abhiyan and Inclusive Education (2018), National Educational Policy, 2020.

UNIT – II: Children with Disabilities and Marginalized Groups

- Nature and Diverse needs of Children with Disability: as per RPWD Act 2016.
- Specific educational needs of Children with Learning Disabilities and Disability caused due to chronic neurological conditions and Blood Disorders as per RPWD Act 2016.
- SEDG: As per NEP 2020.
- Educational needs of children belonging to SEDG.

UNIT – III: Pedagogical Concerns and Issues in Inclusive Setting

- Conceptual clarity and significance of Pedagogy in Today's Inclusive Classroom.
- Meeting the specific needs of Children with Disabilities with special reference to:

- Education and opportunities for participating in arts, sports, and vocation-related activities
- Making school buildings and compounds as well as another facilities barrier free and accessible
- Supporting the learning activities and resources for individualized learning environment
- Assistive Devices and Strategies,
- language-appropriate teaching-learning materials (e.g., textbooks in accessible formats such as large print, Braille and Audio book)

- Designing strategies of assessment and Evaluation in inclusive Setting.

Suggestive Practicum

- Developing a checklist for identifying the various needs of children with disabilities.
- Visiting schools of different categories and talking to parents, teachers, and Children with and without disabilities and listing the problems faced by these children and the families at the local level in gaining access to education.
- Analyzing RPWD Act 2016 and list its implications for CWD in inclusive settings.
- Outlining the problems faced by children with Visual Disabilities while learning mathematics and EVS.
- Giving a few exemplary adaptations based on the Preparatory Level textbooks.
- Outlining the problems faced by children with hearing impairments while learning language. Give a few exemplar adaptations based on the primary level textbooks.
- Students work in small groups of 10 or so to prepare a street play highlighting the meaning and provisions of inclusive education.
- Analyzing the Context of NPE 2020 in the light of Inclusive Education.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

2.5.6 Suggestive Reading Materials

- Booth, T. and Ainscow, M. (2002). Index of Inclusion: Developing Learning and Participation in Schools. Bistol: CSIE.
- Education Values and Practice. London: Routledge Falmer.
- Hegarty, S. and Mithu Alur (2002). Education and Children with Special Educational Needs-Segregation to Inclusion, New Delhi: Sage Publication India Pvt. Ltd.
- National Education Policy 2020 , Ministry of Human Resource Development, Govt. of India.
- NCERT (2021). Educational Rights of Children with Special needs: Frequently Asked Questions. New Delhi: Office of the Publication Division NCERT.
- Nielsen, L.B. (1998) The Exceptional Child in a regular Classroom-an Educator' Guide. Corwin Press Inc. A Sage Publication Company, California.
- Nind, M., Rix, J., Sheehy, K., and Simmons, K. (2005) Curriculum and Pedagogy in Inclusive
- Orlich, D.C, Harder, R.J. Callahan, R.C., Trevisan, M.S., and Brown, A.H. (2004) Teaching
- Position Paper National Focus Group Education of children with Special Needs, New Delhi NCERT (2006)
- Press Inc. A Sage Publication Company California.
- Right to Education Act 2009,2012. The Gazette of India Part II, New Delhi.
- Ray, R. (2007). Gearing Up for Inclusive Education. New Delhi: SCERT.
- Strategies- A guide to Effective Instruction (Seventh edition) New York: Houghton Mifflin Compnay.
- The Right of Persons with Disabilities Act 2006, The Gazette of India Part II, New Delhi December 2016 No. 59
- The Salmanca Statement and Framework for Action on Special Need Education. Salmanca, spian 7, 10 June 1994
- York-Brar, J., Sommers, W.A. et al. (2001) Reflecting Practice to improve school, Corwin

CP- VI: Content-cum-Pedagogy (Secondary): Physical Sciences- III

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50

Internal: 20
External: 30

About the Course

This course comprises three units and a practicum. It focuses on assessment and evaluation. It also focuses on assessment based on learning outcomes, strategies for continuous assessment, school-based assessment, formative and summative assessment including 360◦ assessment. Student teachers are expected to identify various concepts and processes, list learning and behavioral outcomes, find out about various activities and experiments, and identify relevant evaluation techniques and strategies. It focuses on Psychological, Sociological and Philosophical Perspective of Activity Oriented Classrooms in Physical Sciences. The importance of planning science learning and teaching in secondary schools. In this course student teachers will learn how to plan different types of activities in online and offline mode. It emphasizes how to integrate and use ICT in the classroom of Physical Sciences. Assessment serves the dual purpose of tracking the performance of the learners as well as feedback mechanism for effectiveness of teaching. Today's scenario emphasizes competency-based assessment practices and tests higher order thinking skills and conceptual clarity. Major reforms in assessment are need of the hour to stay vibrant and effective in the process of teaching learning of Physical Sciences.

Learning Outcomes

After completion of this course, student teachers will be able to:

- explain the significance of acquiring 21st-century skills for Physical Sciences teaching,
- outline the need for and importance of assessment and evaluation in the teaching of Physical Sciences,
- appraise with various assessment strategies for continuous assessment in reference to teaching of Physical Sciences,
- utilize appropriate tools and techniques for assessment and evaluation in teaching learning of Physical Sciences,
- identify recent trends in research related to the teaching and learning and its implications in teaching learning of Physical Sciences,
- prepare unit test item based on TOSS and develop different types of test items,
- construct and administer different type of tests,
- plan offline and online activities for testing higher order thinking skills in teaching learning of Physical Sciences,
- relate ICT integration and elaborate its use in classroom situations,
- identify a problem in the context of Physical Sciences teaching learning and plan action research.

UNIT – I: 21st Century Skills for Learning

- Need for and importance of how to learn 21st century skills for learners and teachers of Physical Sciences.
- Psychological, sociological, and philosophical perspective of teaching and learning Physical Sciences.
- Qualities of a Physical Sciences teacher as professional for enhancing teaching learning skills.
- Role of a teacher in facilitating learning and creating dynamic learning environment of Physical Sciences.

UNIT – II: Assessment and Evaluation

- Assessment and evaluation: need for and importance of Physical Sciences.
- Assessment based on learning outcomes, strategies for continuous assessment, school-based assessment, qualitative assessment; formative and summative assessment, formal, informal and 360◦ assessment.
- Performance assessment: assessment of group activities, field observations, recording and reporting, creating platform and portfolio management, assessment of laboratory skills, assignments, projects, and presentations.
- Tools and techniques of assessment and evaluation - unit test based on Table of Specification (TOS) and its importance, basic steps of question paper setting, types of test items and preparing answer key and criteria for school, assessment, and feedback mechanism in teaching learning the content of Physical Sciences.
- Rubrics: Need, importance and characteristics.

UNIT – III: Research and Innovative Practices in Physical Sciences

- Divergent thinking and innovation in psychological, sociological, and philosophical perspectives for quality learning experiences.
- Recent trends in research related to teaching learning of Physical Sciences.
- Action research: meaning, significance, steps and planning.
- Evidence-based practices and reflection, school-based research in Physical Sciences.

Suggestive Practicum (Any Three)

1. Prepare, administer, and analyze scores of an achievement test.
2. Explore AI based assessment tools and prepare an E-Portfolio for a student of Secondary Stage.
3. Conduct Simulated Teaching session for the concepts of Physical Sciences and observation by self, peer, and teacher.
4. Explore development of multidisciplinary projects and present using PowerPoint.

5. Interpret the concept of Physical Sciences with Psychological, Sociological and Philosophical Perspective.
6. Apply innovative practices in classroom teaching learning of Physical Sciences.
7. Make a presentation on the role of Physical Sciences in sustainable development of society.
8. Plan action research for Continuous Professional Development (CPD) of Physical Sciences teacher.
9. Any other project assigned by HEI.
10. Prepare a blue print for an achievement of class VIII science subject.

Suggestive Mode of Transaction
Lecture cum discussion/demonstration, demonstration, discovery approach, project approach, inquiry approach, problem-solving, experiential learning.

Suggestive Mode of Assessment
Written test, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Material
- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India
- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- VII: Content-cum-Pedagogy (Secondary): Mathematics- III

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course:
Development of 21st century skills are important for Mathematics teaching learning. Learning the imagination, spatial visualization, mathematical reasoning is important for novice learners. The course comprises three units describing 21st century skills for learning, assessment and evaluation and research and innovative practices in teaching learning Mathematics. This course also aims to improve skills and competencies required for Mathematics teachers to conduct effective learner assessments. The course describes various evaluation strategies and devices which can be efficiently used in the teaching learning of Mathematics and in the development of skills among the student teachers for improving student outcomes, conduct action research and school-based research in the teaching of Mathematics.

Learning Outcomes
After completion of the course, student teachers will be able to:

- analyze the sources of the development of 21st century skills through Mathematics teaching and learning,
- determine role of teacher in facilitating learning and creating dynamic learning environment of Mathematics,
- describe need for and importance of assessment in the learning process of Mathematics,
- develop various types of tests for assessing students learning in Mathematics,
- design and develop innovative strategies and techniques for successful inteaching and learning Mathematics,
- conduct school- based research in Mathematics teaching,
- explain the various methods of exploring knowledge,
- explore innovative ideas for teaching and learning of Mathematics,
- assess the steps of action research.

UNIT – I: 21st Century Skills for Learning Mathematics
- Need and importance of 21st century skills such as practicing imagination, spatial visualization, mathematical reasoning, problem-solving for learners and teachers of Mathematics.
- Psychological, sociological, and philosophical perspective of teaching learning and development of Mathematics.
- Qualities of a Mathematics teacher as professional.
- Role of a teacher in facilitating learning and creating dynamic learning environment of Mathematics.

UNIT – II: Assessment for Learning in Mathematics

- Meaning, need and organization of oral, written, and practical assessment in Mathematics.
- Construction of types of questions in Mathematics: objective, short answer, long answer, considerations for the marking different types of questions in Mathematics.
- Planning and developing teachers made tests in Mathematics - Table of Specification (TOS), question paper setting and preparing answer key.
- Tools to identify learning difficulties and provide corrective measures in Mathematics, concept of 360° assessment, holistic progress card and assessment of mathematical aspects of students.

UNIT – III: Research and Innovative Practices in Teaching of Mathematics

- Divergent thinking for innovation in psychological, sociological, and philosophical perspectives of Mathematics for quality learning experiences.
- Innovative practices in Mathematics for diversified learnes in the classroom.
- Research on issues of gender, class and culture in Mathematics learning and achievement - expectations, attitudes and stereotypes; access to higher Mathematics; interrogating the notion of 'Achievement Gap'; construction of learners' identity in a Mathematics classroom.
- Recent trends and research related to teaching learning of Mathematics – digital gaming, digital storytelling, using Artificial Intelligence for Mathematics teaching and learning.
- Action research for solving problems of teaching and learning of Mathematics: meaning, significance, steps, and planning.

Suggestive Practicum (Any Three)

1. List 21st century skills with reference to various topics of school Mathematics.
2. Writing a paper on recent trends and research related to teaching learning of Mathematics.
3. Prepare a scrap book for 'Mathematics in Print Media'.
4. Prepare a small video for recent trends of Mathematics in social media.
5. Plan a teacher made test for a unit of secondary Mathematics.
6. Prepare a report after using an innovative idea to teach a difficult topic of secondary Mathematics.
7. Plan for action research on any one problem of teaching learning Mathematics.
8. Any other project assigned by HEI.

Suggestive Mode of Transaction

Lecture cum discussion, group work, ICT enabled methods, activity based and art integrated demonstration, field-based experiences, library visits, self-study, field observations, assignment preparation, classroom presentations, discussion forums, observation, flip classroom, use of digital platform.

Suggestive Mode of Assessment

Written test, classroom presentation, workshop, assignments, practicum, sessional and terminal semester examination (As per UGC norms).

Suggestive Reading Material

- NCERT (2012). Pedagogy of Mathematics
- NCERT: Manual for Higher Secondary Mathematics Kit (Code- 3165)

*Teachers may also suggest books/readings as per the need of the learners and learning content.

CP- VII: Content-cum-Pedagogy (Secondary): Biological Sciences- III

Credits: 2
Maximum Marks: 50
Contact Hours: 2 hrs. per week
Internal: 20
External: 30

About the Course

Assessment and Evaluation are an inseparable component of teaching learning of Biological Sciences. In this course, student teachers will be exposed to various assessment practices that can be followed in assessment of Biological Sciences. The course also deals with planning action research in classroom situations. It focuses on Psychological, Sociological and Philosophical Perspective of Learning of Biological Sciences. The importance of planning science learning and teaching in secondary schools. In this course student teachers will learn how to plan different types of activities in online and offline mode. It emphasizes how to integrate and use ICT in the classroom of Biological Sciences.

Learning Outcomes

After completion of this course, Student teachers will be able to:

- appraise different types of assessment and strategies for continuous assessment,
- distinguish between assessment and evaluation,
- compare merits and demerits of different types of assessment,
- develop unit test item based on TOS and develop different type of test items,
- construct and administer the achievement test,
- familiarize with basic statistical methods for analyzing performance in tests,
- recognize challenges in modern day classrooms and plan appropriate strategies,
- relate ICT integration and elaborate its use in classroom situations.

UNIT – I: 21st Century Skills for Learning

- Need for and importance of how to learn 21st century skills for learners and teachers of Biological Sciences.
- Psychological, sociological, and philosophical perspective of teaching and learning Biological Sciences.
- Role of a teacher in facilitating learning and creating dynamic learning environment of Biological Sciences.

UNIT – II: Assessment and Evaluation

- Assessment and evaluation: concept, need for and importance of teaching learning the Biological Sciences.
- Assessment based on learning outcomes, strategies for continuous assessment, school-based assessment, qualitative assessment; formative and summative assessment, formal, informal, and 360-degree assessment.
- Performance assessment: assessment of group activities, field observations, recording and reporting, creating platform and portfolio management, assessment of lab skills, assignments, projects, and presentations based on the concepts of Biological Sciences.
- Unit test based on Table of Specification (TOS) and its importance; basic steps of question paper setting of Biological Sciences, types of test items and preparing answer key and criteria for school, assessment, and feedback mechanism in teaching learning the concepts of physical science at secondary stage.

UNIT – III: Research and Innovative Practices in Biological Sciences

- Recent trends in research related to teaching learning of Biological Sciences.
- Action research: meaning, significance, steps, and planning.
- Evidence-based practices and reflection, school-based research in Biological Sciences.

Suggestive Practicum (Any Three)

1. Prepare, administer, and analyze scores of an achievement test.
2. Explore AI based assessment tools and prepare an E-Portfolio for a student of Secondary Stage.
3. Identify a topic and Plan action research at secondary stage.
4. Conduct Simulated Teaching session for the concepts of Biological Sciences and observation by self, peer, and teacher.
5. Apply innovative practices in classroom teaching learning of Biological Sciences.
6. Any other project assigned by HEI.

Suggestive Mode of Transaction

Lecture cum discussion, demonstration, Hands-on activities, experiential learning, inquiry, Group work, Presentations, multimedia.

Suggestive Mode of Assessment

Written tests, classroom presentations, workshops, seminars, assignments, practicums, sessional and terminal semester examinations (as per UGC norms).

Suggestive Reading Material

- National Council of Educational Research and Training. (April 2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
- National Education Policy 2020, MoE, Government of India.
- National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
- NCERT, Textbooks of Biological Sciences at Secondary Stage.

*Teachers may also suggest books/readings as per the need of the learners and learning content.

AE&VAC- VIII: Mathematical and Quantitative Reasoning

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the course

The course introduces the student teachers to study the basic mathematical and quantitative reasoning for their practice usage. This course is designed to provide student teachers with the knowledge and capacities required to analyse, interpret, and communicate data. Student teachers will learn to think critically about data and use quantitative reasoning to solve real-life problems.

Learning Outcomes

After completion of this, student teachers will be able to:

- Adapt mathematical reasoning to solve problems in the real world and explain some fundamental ideas and tenets in the field,
- analyse and interpret quantitative data,
- interpret and deduce the right conclusions from numerical representations like formulas, graphs, or tables,
- demonstrate critical thinking and problem-solving skills using mathematical and quantitative reasoning methods,
- evaluate operational matrix,
- analyse educational data and create the educational model and use them in decision-making,
- analyse and evaluate mathematical and quantitative reasoning problems and solutions.

UNIT- I: Introduction to Mathematical and Quantitative Reasoning

A. Meaning, nature, and scope of Mathematical and quantitative reasoning.
B. Difference between Mathematics and Quantitative reasoning.
C. Importance of Mathematical and quantitative reasoning in various fields.
D. Types of quantitative reasoning.
E. Use of Mathematical and quantitative reasoning.
F. Concept of Mathematization.

UNIT- II: Introduction to data in Equation

A. Data requirement, different sources of data
B. School enrolment: gross enrolment ratios, net enrolment ratios, educational progression; dropout rate, literacy: measure of literacy
C. Indian censuses, details of different items on which Indian censuses collect data.
D. Indian censuses, details of different items on which Indian censuses collect data.
E. Nationwide sample surveys, National family health survey, District level household survey, and UDISE.

UNIT- III: Data Analysis and Interpretation

A. Concept of data interpretation (equation, diagram, graph, tables)
B. Statistical analysis of data in the educational context and its applications
    - Measures of central tendency (Mean, Median, Mode)
    - Measures of variability (Range, Inter Quartile Range (IQR), Variance and Standard Deviation)
    - Percentile
C. Visual and numerical representation of data and its applications (Bar diagram, Histogram, Frequency polygon, Pie charts)
D. Learning analytics: concept, significance, types, levels and its applications in the educational context.

Suggestive Practicum

- Take the last 5 years of UDISE data and analyse various indicators related to schools and students.

Suggestive Mode of Transaction

The approaches to curriculum transaction will focus on developing the analytical and critical thinking skills of students, as well as their ability to apply Mathematical and quantitative reasoning in real-life situations. Some of the approaches to curriculum transaction will include the following:

- Active learning, which involves the active participation of student teachers in problem-solving situations, group discussions, and hands-on activities that help student teachers engage with the material and apply Mathematical thinking and reasoning to solve problems.
- Real-world applications involving the use of real-world examples to demonstrate the practical applications of Mathematical concepts that help student teachers see the relevance of what they are learning and how it can be applied in various fields.
- Collaborative learning encourages student teachers to work together in small groups, where they can share ideas and help each other and learn. This fosters a sense of community in the classroom and helps students develop teamwork and communication skills.

- Technology integration involves the incorporation of technology tools such as calculations, spreadsheets, and interactive software to help student teachers visualize and solve Mathematical problems easily.
- Overall, a pedagogy that combines active learning, real-world applications, collaborative learning, technology integration, and effective assessment strategies that help student teachers develop a strong foundation in Mathematical and quantitative reasoning.

Suggestive Mode of Assessment

Use of a variety of assessment methods such as quizzes, exams, group projects, and presentations to evaluate student learning. Providing timely feedback and offering opportunities for students to revise their work and improve their understanding.

Suggestive Reading Materials

- Creswell, J. W. (2013). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications.
- Ellenberg, J. (2015). How Not to Be Wrong: The Power of Mathematical Thinking. Penguin Books.
- Few, S. (2012). Show Me the Numbers: Designing Tables and Graphs to Enlighten. Analytics Press.
- Gaze, E. (2018). Quantitative Reasoning: Tools for Today's Informed Citizen. Cengage Learning.
- Gravetter, F. J., & Wallnau, L. B. (2016). Essentials of Statistics for the Behavioral Sciences. Cengage Learning.
- General, R. (2011). Provisional Population Totals. Census Commissioner, India.
- Howison, S. (2005). Practical Applied Mathematics: Modelling, Analysis, Approximation. Cambridge University Press.
- Johnson, R. B., & Christensen, L. (2019). Educational Research: Quantitative, Qualitative, and Mixed Approaches. Sage Publications.
- Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Age International.
- Ministry of Human Resource Development, Government of India (2018). Educational Statistics at a Glance.
- Mason, J., & Burton, L. (2010). Thinking Mathematically. Pearson
- National Institute of Educational Planning and Administration (2018-19): A Annual Report.
- Siemens, G. (2013). Learning Analytics: The Emergence of a Discipline. American Behavioral Scientist, 57(10), 1380-1400.
- Solow, D. (2002). How to Read and Do Proofs: An Introduction to Mathematical Thought Processes. Pearson.
- Tufte, E. R. (2001). The Visual Display of Quantitative Information. Graphics Press.

SE- II: School Observation

Credit: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 50

About the Course

As school is the heart of the teacher education programme, the student teachers need to gain hands-on experiences from various activities organized by the school. School observation offers an opportunity to learn the processes and practices in a school setup. To expose the student teachers to various schooling systems (urban, rural, tribal, residential, non-residential, government, private, affiliated to different school boards like Central Board, State Board, International Board) prevailing in the country. School observation will also prepare the student teachers to build relationships with various stakeholders. The school observation by the student teachersis aimed at helping them build perspective in the schooling system, student needs, pedagogies, and assessment.

Learning Objectives

After completion of school observation program, student teachers will be able to:

- Get acquainted with various schooling systems.
- Experience the processes, practices, and overall environment of the school.
- Establish a rapport with all the stakeholders of the school system.
- Observe the process of conducting different activities in the school.
- Study availability and the work of human resources, including members of school management (SMC), school head, teachers, administrative and support staff)
- Observe the existing infrastructure available in the schools (classrooms, libraries, laboratories, playground, sanitation, drinking water facility, mid-day meal facility, inclusive facilities, safety and security, rainwater harvesting).
- Observe and document the availability and usage of TLM, including ICT.

- Study the available physical and digital documents, including UDISE data.
- Study interpersonal relationships among the stakeholders.
- Study various assessment processes adopted in different types of schools for holistic development of children.
- Prepare and present a comprehensive profile of the schools observed (including classroom processes)
- Study the engagement of parents and other community members in school activities.

Suggestive Mode of Transaction
- Observation
- Interaction
- Discussion
- Reviewing the available literature on the different schooling system
- Collection of relevant documents and data

Preparation for school observation
- Orientation on the school observation process
- Development of the observation formats/tools

School Observation (minimum three types of schools)
- Student teachers will go for school observation in small groups to observe and collect data by using the developed formats/tools.
- Analysis of the collected data
- Preparing a comprehensive profile of the schools observed

Post-school observation session
- Group-wise presentation of the school profile
- Discussion and Feedback
- Reflection on the understanding of various types of schooling systems.

Content

The school observation as a field-based activity will cover observation of school and classroom processes. The student teachers under the mentorship of teacher educators will visit schools, interact with teachers, students, and other stakeholders, and relate the observation with the courses studied during the previous semesters, i.e. Foundations of Education, Disciplinary Courses, Pedagogy courses and Ability Enhancement and Value-Added Courses.
- Meaning and Nature of school observation process
- Difference between monitoring and observation
- Theory and practices of school observation components such as:
    - Schooling system
    - Rapport with all the stakeholders
    - Office management procedures of different types of schools
    - School environment in all perspectives
    - Process of conducting curricular activities in the schooling process
    - Existing infrastructure available in the school
    - Utility of ICT and TLM facilities
    - Interpersonal relationships among the stakeholders
    - Various assessment processes adopted in different types of schools.
    - Engagement of parents and other community members in school activities.

Activities to be conducted at Secondary Stage
- Visit three types of secondary schools with observation formats developed in the institute and get acquainted with various schooling systems. Establish rapport with all stakeholders.
- Collect information about the demography of students in classes IX to XII and understand the linkage of the secondary stage with the middle stage and higher education through interaction with teachers, students and staff.
- Observe school processes and transactions of the curriculum through experiential learning and prepare a report.
- Interact with teachers and students and report on implementing ten bag-less days and internship opportunities to learn vocational subjects.
- Study the available opportunities for learning interdisciplinary subjects.
- Observe the availability and usage of library resources, laboratories (Atal Tinkering Lab, Physics, Chemistry, Biology, Mathematics, Languages, Social Science, Computer), sports facilities, and art and music learning facilities.

- Study the provision of other student support services- guidance and counselling, NCC, NSS, health and wellness programme.
- Observe the organization of various activities like classroom teaching-learning processes, laboratory activities, library activities, sports and games, debate/elocution/essay writing and other competitions.
- Interact with School heads and subject teachers to understand how students are evaluated by following different tools and techniques of evaluation, how examinations are conducted, how answers are assessed, and how the result is communicated to parents in at least two different types of schools.

Assessment

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
Involvement and active participation during the school visit	Observations	Teacher Educator	0.5	15
Comprehensive school profile	Presentation & reflection	Teacher-Educator	1.5	35

Outcomes

Student teachers will be able to:

- describe various schooling systems,
- describe the processes, practices, and overall environment of the school,
- establish rapport with the stakeholders of the school system state the process of conducting different activities in the school,
- describe the available school infrastructure (classrooms, libraries, laboratories, playground, sanitation, drinking water facility, mid-day meal facility, inclusive facilities, safety and security, rainwater harvesting),
- describe the availability and usage of ICT and TLMs,
- summarize the available documents in both physical and digital modes, including UDISE data,
- reflect upon relationships among the stakeholders,
- analyze various assessment processes adopted in different types of schools,
- prepare and present a comprehensive profile of the schools observed (including classroom processes).

Suggested Components for school observation report

- School information (Context, Vision and Mission, Association with the Board)
- School Infrastructure
- Provision for CWSN/Divyang Children
- Inclusiveness at all levels
- Teacher-Student Ratio
- Teaching-Learning process
  - Academic plan
  - Classroom activities
  - Assessment
- School Development Plan (SDP)
- Academic Calendar
- Administrative processes
  - Maintenance of students' records
  - Maintenance of teachers' records
- Cultural activities
- Sports activities and Annual Day
- National and Social functions
- School Management
- School Discipline
- Interpersonal Relationships
- Understanding different types (socio-economic status, ability) of students and their needs
- Development of ICT and TLMs
- Engagement of parents and community members in the school activity
- Office Management
- The assessment process includes provision and practices for 360-degree holistic assessment.
- The overall progress of the school (planning, organizing, staffing, directing, motivating and controlling)
- Challenges faced and overcoming them.

SEMESTER - VII

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	FE	Perspectives on School Leadership and Management	FE-VI	2	50	20	--	30	2
2	FE	Curriculum Planning & Development Textbooks, Material Development, etc. (Secondary)	FE-VII	2	50	20	--	30	2
3	AE&VAC	Art Education (Performing and Visual) and Creative Expressions	AE & VAC-IX	2	50	20	--	30	2

4	AE&VAC	Sports, Nutrition and Fitness	AE & VAC-X	2	50	20	--	30	2
5	SE	School-based Research project	SE-III	2	50	50	--	--	2
6	SE	Internship in Teaching (as per CP)	SE-IV	10	250	250	--	--	20
Total				**20**	**500**	**380**	--	**120**	**10+20**

Semester VII
FE- VI: Perspectives on School Leadership and Management

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course
Amidst the changing policy landscape, the new curriculum framework, the challenge of accommodating and adapting to the changing demands and the increasing expectations that come with the culture of performativity. The role of the school leader has never been more complex. School leaders are key change agents and as instructional leaders are responsible for improving practice while navigating an increasingly challenging school environment. Understanding the school system, its nuances, the social, cultural, and political contexts and leading schools requires a strong foundation of knowledge and skills to effectively manage improvement and lead successful schools. The course on 'Perspectives on School Leadership and Management' is designed to equip student teachers with the competencies they need to drive school transformation and help diverse stakeholders establish priorities and improve practice.

Learning Outcomes
After completion of the course, student teachers will be able to:
- describe the diversity of schools in India, its structure, its governance, issues, challenges and school leadership needs,
- critically examine the different leadership theories and practices and its relationship with the governance structures, the autonomy and accountability mechanisms and the larger educational policy context,
- critically think in relation to education leadership and its potential application to different contexts,
- reflect critically on school-based data for reflection and improvement,
- develop a culture of cooperation collaboration and teamwork,
- synthesise effectively to develop coherent and compelling arguments in the area of study,
- develop school vision, mission, goals, and School Development Plans.

UNIT – I: Understanding Indian School System
- School as a normative organization vis-a-vis school as a socio-emotional-cultural space for learning.
- Studying the diversity of schools in India; their structure, governance, socio-political and cultural context, funding, management, autonomy and accountability mechanisms, support systems.
- Relationship between school leadership and school diversity issues, challenges, and needs.
- Engagement with diversity discourses, educational policies, reforms and practices and role in developing inclusive schools.

UNIT – II: Understanding School Leadership
- School Leadership: concept as defined, and concept as practiced.
- Being a School Leader: exploring the multiple roles and responsibilities, issues and challenges of school leadership in the Indian context.
- What works in schools: sharing National and International best practices on School Leadership.

UNIT – III: Schools as Learning Organizations: Role of School Leadership
- Schools as motivating learning spaces: Developing inspiring school ethos.
- Schools as learning organization: promoting personal mastery, examining mental models, and developing a shared vision, team learning and a system's thinking perspective.
- Development of a shared vision and shaping of the school culture.
- Use of data for school improvement focused on students' learning, addressing equity challenges, and building an equitable school culture that promotes excellence for all.

- Nurturing school belongingness: engaging students, teachers, staff, parents, SMC, and community in the formulation of a whole school development plan.
- Designing professional and collaborative learning opportunities for self and others (teachers, parents, and SMC members) and improving teaching and learning.

Suggestive Mode of Transaction

Perspectives on school leadership and management is a practitioner-centric course and aims to enable future teachers to be efficient school leaders. The approach to curriculum transaction therefore would include a blend of lectures, tutorials, group-work, case-based approaches, and enquiry-based learning.

- Student teachers would engage in case-based learning on topics like improving student learning, classroom observation and feedback, planning and budgeting for school improvement, leadership in diversified school contexts and such others.
- Exposure of student teachers to virtual case studies featuring leaders from a representative cross-section of Schools in India and analyze their experiences, insights, and best practices.
- Learning activities that help student teachers to understand the entire structure and functioning of school organization through interactive lectures and panel discussion with education officers who hold leadership positions at different levels from schools to cluster, block, and district and state levels and understand their leadership issues, challenges and needs and thus get a perspective of the school ecosystem.
- Learners would reflect on their practice as pre-service interns, knowledge, skills, and understandings—and identify opportunities to apply course learnings to their school context.

Suggestive Mode of Assessment

Being a practitioner centric course, the assessment would largely include application-based tasks. This includes exploring the work and life of a school principal and writing a detailed report on the observations and the learning. The following are some exemplars. The institutes may choose either of these or think of other innovative assignment that would enhance the leadership learning experience:

- Preparing school vision, mission, goals, and school development plan.
- Shadowing school principals: a critical observation of the principal's daily work life.
- A critical examination of the diversity of schools; their governance structure, leadership, autonomy and accountability mechanisms, issues and challenges and work life of the school principal

Suggestive Reading Materials

- Aggarwal, J.C. (2007). School management. Shipra publication, Daryagunj, New Delhi.
- Bhatnagar, R. P. and Agarwal, V. (2006). Educational Administration Supervision, Planning and Financing. R. Lall Book Depot, Meerut.
- Bush, Tony (2003). Theories of educational leadership and management. New Delhi: Sage.
- Carlson, R. V. (1996). Reframing and reform: Perspectives on organization, leadership, and school change. White Plains, NY: Longman Publishers.
- Davies, B. and Ellison, L. (2001). School leadership for the 21st century. Routledge Falmer, London.
- Desai, D and Other (1970) School management and change, Baroda: M.S University.
- Drucnker, F.B (1985).Management - Tasks, Responsibilities and Practices, New Delhi: Allied Publishers Pvt. Ltd.
- Eric, H. and McMohan, A. (eds) (1986).The management of schools, London: Kogan Page.
- Hersey, P. and Blanchard, K.E (1978) Management of organizational behavior, New Delhi: Prentice Hall of India.
- Kast and Rosenweig (1974).Organizational and management systems approach, Tokyo McGraw Hill.
- Khanna, S.S (2000).Organizaiional behavior, New Deihi: Chand and Company
- Kochhar, S.K. (2011). School Administration and Management. Sterling Publisher Pvt.Ltd.,NewDelhi
- Krishnamacharyulu V. (2011). School management and systems of education. Neelkamal Publications Private limited, Hyderabad.
- Mohanty, J. (2007). Educational management supervision school organization. Neelkamal Publications Private Limited, Hyderabad.
- National curriculum Frame work for teachers, (2009), NCTE. National curriculum frame work, (2005), NCERT, New Delhi. NCFFS-2022, NCFSE-2023, NCFTE-2023.
- NIEPA. (1986). Educational management in India. New Delhi: NIEPA,.
- Padmanabham, C.B.(1998). Educational financing and structural adjustment policies in India. Delhi: Common Wealth.
- Pareek, H., Rao, T.V and Pestonjee, D.M (1981).Behavioral process in organization, New Delhi: Oxford and B.M Publishing Co.
- Prasad, L.M. (2001).Principles and practice of management, New Delhi: Sultan Chand andSons.

- Rao V.K.R.V. (1961). Education and human resource development. New Delhi: Applied Publishers.
- Scalan, B. and Keys, D. (l 983).Management and organizational behavior, New York: John Wiley and Son.
- Sri Prakash, (1994). Expenditures on education. New Delhi: NIEPA.
- Stoner, J.A.F. and Wankel, S. (1987).Management. New Delhi: Prentice Hall of India.
- Strauss, G. and Sayles, L.R. (1985).Personnel: The human problems of management. New· Delhi: Prentice Hall of India.
- Tilak, J.B.G. (1992). Educational planning at Grass roots. Ashish Publishing House, New Delhi.
- Tripathi, P.C., and Sayles, L.R. (1991).Principles of management, New Delhi: Tata McGraw Hill.

FE- VII: Curriculum Planning and Development

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course

The course on curriculum planning and development will introduce to student teachers to the process of designing and organizing the curriculum i.e., the totality of learning experience provided to learners through a deliberate and organized set of arrangements (the selection of subjects that are to be taught, the pedagogical approaches and practices to be pursued, books and other teaching-learning-material to be used, examinations and other forms of learning assessment, school culture and processes etc.) that contribute to the development of the knowledge, capacities, and values and dispositions that help fulfill the aims of school education derived from the purposes and goals articulated in NEP 2020.

Learning Outcomes

After completion of this course, student teachers will be able to:

- discuss aims of education,
- identify and formulate of desirable values and dispositions,
- explain capacities and knowledge,
- outline curricular areas,
- demonstrate teaching-learning assessment processes and
- practice the relevance in terms of achieving the aims of school education.

UNIT – I: Education and Curriculum

- Meaning, need, relationship and significance.
- Types of Curriculums: subject-centered, activity-centered, environmental centered, community-centered and facets of curriculum.
- Relationship and difference between curriculum, curriculum framework, syllabus and textbooks.
- Curriculum visualized at different levels: National level; State level, school level, class level and related issues.

UNIT – II: Developing the Curriculum

- Concept, Need and Scope, Strategies of curriculum development.
- Basic principles, Determinants and considerations of curriculum development.
- Concerns for developing the Curriculum - aims to be achieved, structure and nature of discipline, different perspectives on learning and their implications to curriculum development, socio–cultural aspects and aspirations of society, value transitions, social efficiency and needs, environmental concerns, gender concerns, inclusiveness, technological advancement.
- Impact of Globalization.

UNIT – III: Approaches, Planning, and Implementation

- Approaches to Curriculum Development: Learner and activity centered, Constructivist, Knowledge Construction
- Curriculum planning as a cyclic process.
- Curriculum Implementation: Operationalizing curriculum into learning situations, Converting curriculum into syllabus, Curriculum engagement activities, Role of school at Regional, State and National level for implementation.
- Role of teachers in operationalizing and evaluating the curriculum with special reference to: textbooks and teachers handbooks, source books, workbooks and manuals, other learning material such as kits, AV and software materials, library, laboratory, playground, neighborhood etc.

Suggestive Practicum

- Arranging discussion on:
  - Basis of National curriculum frame works (1975, 1988, 2000, and 2005).

- Document: Learning without burden" by Prof. Yashpal
- Preparing of Report based on observation of:
- Facilities and infrastructure to implement the present curriculum.
- Interviewing teachers to understand their role in:
- Implementing and assessment of the curriculum.
- Analysis of the following in the context of principles of developing the Curriculum:
- Guidelines of NEP, 2020.
- Curriculum of 4 Years B.Ed. Integrated Programme
- Learning without Burden, MHRD, and India.
- Position paper (2006). National Focus Group on 'Curriculum, Syllabus, Textbooks', NCERT.
- NCERT (1988) National Curriculum for Elementary and Secondary Education: A framework.
- NCERT (2000) National Curriculum Framework for school Education.
- NCERT (2005) National Curriculum Framework. NCERT publications.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

- Aggarwal, Deepak (2007): Curriculum development: Concept, Methods and Techniques. New Delhi. Book Enclave.
- Arora, G.L. (1984): Reflections on Curriculum. NCERT.
- Bob Moon and Patricia Murphy (Ed) (1999). Curriculum in Context. Paul Chapman Publishing, London.
- Butchvarov, P.(1970), The Concept of Knowledge, Evanston, Illinois: North Western University Press.
- Chomsky, N (1986). Knowledge of Language, Prager, New York.
- Datta, D.M. (1972). Six ways of Knowing. Calcultta University Press, Calcultta.
- G.W. Ford and Lawrence Pungo, (1964). The structure of Knowledge and the curriculum. Rand McNally & Company, Chicago.
- Joseph Schwab, (1969). The Practical: A language for curriculum. School Review, November.
- Kelley, A.B. (1996). The Curricular Theory and Practice. Harper and Row, US.
- Kumar Krishna (1997). What is Worth Teaching, Orient Longman, New Delhi.
- Margaret, K.T. The open Classroom, Orient Longman: New Delhi, 1999.
- NCERT (1984). Curriculum and Evaluation, NCERT, New Delhi.
- NCERT (2006): Systematic reforms for Curriculum change. New Delhi.
- Dewey, John (1966). The Child and the Curriculum. The University of Chicago Press.
- NCTE (2009) National Curriculum Framework for Teacher Education.
- NCERT (2000). National Curriculum Framework for School Education, NCERT, New Delhi.
- NCERT (2005). National Curriculum Framework, NCERT, Sri Aurobindo Marg, New Delhi.
- NCERT (2014). Basics in Education, NCERT, Sri Aurobindo Marg, New Delhi.
- Nirantar (1997). Developing a Curriculum for Rural Women, Nirantar, New Delhi.
- Padma M. Sarangapani (2003). Constructing School Knowledge, An Ethnography of learning in anIndian Village, Sage Publication Inc., New Delhi.
- Prema Clarke (2001). Teaching & Learning: The Culture of pedagogy, Sage Publication, New Delhi.
- Steven H. Cahn (1970). The Philosophical Foundation of Education, Harper & Row Publishers, New York.
- Taba, Hilda (1962).Curriculum Development. Theory and Practice, Har Court, Brace and Wald. New York.
- Wiles, J.W. & Joseph Bondi (2006): Curriculum Development: A Guide to Practice. Pearson Publication.
- Whecker, D.K. (1967) Curriculum Process, University of London Press.

AE&VAC- IX: Arts (Performing and Visual) and Creative Expressions

Credits: 2

Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

Exemplar- Theatre

About the Course

The engagement with various forms of art as self-expression and the need to develop a sensibility to appreciate them has been an important concern in educational theory and practice. This concern is premised on the claim that forms of self-expression contribute immensely to the development of cognitive, affective, and psycho-motor dimensions among children, as well as that through one or another art form that children come to explore ways of expressing themselves. Further, it is also the case that critical appreciation of art enables children to form judgments of a very special kind, namely, an aesthetic judgment. This enables students as they grow into adults to have focused attention on making meaning of what surrounds them and in appreciating cultural productions.

Children are naturally tuned to appreciate art, as it activates their senses. Further, their psycho-motor skills get developed through art. It gives them space to think independently, create and reflect, while working with others. It is a unique space where all the three are involved- hand, head and heart.

Therefore, students who aim to be educational practitioners, will need to bring an element of art in educational practices that they engage in. To be able to do this, they need an appreciation of art in general, familiarity with one art form, and basic skills and capabilities to be creative and artful.

To this end in the first semester students will attend one course that aims to help them recognize and appreciate the importance of aesthetic judgment, develop familiarity with an art form and basic skills to be creative in their expressions. Skills develop from practice, therefore hands on training in doing art will be emphasised in this course. This course aims to help students develop a habit of improvising on theatrical performances that include following aesthetic judgement at all stages, which will contribute to other educational practices that they develop in the larger programme. Therefore, this course will explicitly relate this skill to activities that practitioners of education engage in, like teaching, development of teaching-learning material, and also producing content of other subject areas wherever possible.

Theatre

Theatre is a collaborative art form, and it is inherently interdisciplinary in its nature. It comprises many facets and skills like acting, directing, writing, designing the sets and costumes, make-up, production, lights, sounds and music. All these elements and skill sets come together and are stitched in the form of a 'play' which is performed live, in front of an audience. In the Indian context, theatre has a deep-rooted history with its classical, folk, and other cultural forms until other contemporary forms of theatre evolved in recent times.

Theatre education for children can play a vital role in their individual, social, and emotional development. It teaches them the values of trust and interdependence, makes them confident to express themselves and helps them learn to work in a collaborative environment. It develops their ability to contextualise, critique and discuss certain questions and thoughts they encounter in everyday life. It further helps them imagine, explore, and create their own narratives.

In this course, we will briefly talk about the aesthetics of theatre and how theatre exists in different forms. The students will learn some basic theatre tools that will help them create and perform a narrative they collaboratively arrive at.

In simple terms one can say theatre has two major aspects i.e., creating the script and then performing it. Body is the primary instrument in any theatrical performance accompanied by text, material, visual and sound. This course will introduce students to these aspects of any theatre performance, in the form of direct experience by doing this themselves.

Learning Outcomes

After completion of this course, students will be able to:

- articulate the importance of aesthetics and art in elementary education,
- demonstrate their familiarity with and appreciation of theatre,
- learn basic theatre tools of improvisation, ideation, and creation of a script,
- create a short performance with educational possibilities.

UNIT – I: Importance of Aesthetics and Art education (2 Sessions)

In this unit the basic idea of aesthetics and art, and ways in which the aesthetic dimension manifests itself in human life will be discussed. Using various examples of art, students will engage in identifying aesthetic aspects of daily life, develop aesthetic judgment, and gain familiarity with the role of art in education. Students will also be introduced to three aspects of art in education: The value of art itself and its use as an instrument in education; moral dimensions of works of art and the controversial distinction between the value of Popular art and High art.

UNIT – II: Introduction to Theatre, and Beginning with the body (3 Sessions)

We will discuss some core essentials in the aesthetics of theatre like the performance, the makers, the audience, and the context and how we relate this to the world around us, in everyday lives. In this unit, we will discuss examples of how

theatre was used in social movements that have contributed to educating the larger population about important social issues. Additionally, we will also learn from practices and approaches of theatre groups like Budhan Theatre who work with denotified tribes, and Manalmagudi who work closely with physical nonverbal theatre. Exposing students to these approaches will lead to rich discussions on the role of theatre in pedagogy and practice.
In this unit, students will learn certain principles and awareness on how to use their body and voice in a given space and time, with respect to other bodies. There will be several games, exercises that will familiarise them with certain basics of movement, voice, acting and thereby create improvisations and images in a given context. The activities and tasks will be both in individuals and groups.

AE&VAC- X: Sports, Nutrition and Fitness

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course
This course aims at enabling student teachers to recognize the importance of good health, fitness, and the right nutrition to live a healthy life. It also provides students with the experience of organizing and participating in sports and games.
Learning Outcomes
After completion of the course, student teachers will be able to:
- explain the importance of sports, and the need and impact of sport for maintaining,
- discuss physical fitness, and the methods of teaching and organization of different types of sports,
- explain the importance of physical fitness, describe different components of physical fitness, and identify activities that help maintain physical fitness,
- Recognize the importance of basic health and nutrition and healthy lifestyles and identify food items that help maintain basic health and nutrition among children of different age groups.

UNIT – I: Sports
- Meaning of sports, importance of sports, types of sports.
- Different stages of sports (primary and secondary).
- Psychology of sports, methods of teaching different sports (indoor, outdoor, team and individual), different sports activities (individual and team games).
- Sports for children with disabilities and inclusion.

UNIT – II: Nutrition
- Meaning of nutrition, types of nutrition, importance of nutrition, need of nutrition, methods for teaching nutrition,
- Nutrition for different age group, nutritious food for sports personalities and common individuals, nutrition and health, nutrition and fitness, nutritious food in schools (midday meals), hostels.

UNIT – III: Physical Fitness
- Meaning and importance of Physical fitness, components of physical fitness, Muscular Strength, Endurance, Flexibility, Body Composition, Cardiovascular Endurance, importance of healthy lifestyle.
- Coordination of Health and Fitness.

Suggestive Practicum
Reflective Reading of different Sports Personalities. Collections of different types of games (Indoor, Outdoor, Individual, Team); Organizing different games (Play) for different age-groups, Organizing Group Games for cooperation, Organizing fitness programmes, Exercises at various levels. Collection of different nutritious items food. (Charts, Things, Objects, Models). Programmes organized to promote the use of nutritious food.

Suggestive Mode of Transaction
The mode of transaction should be designed to ensure that should provide a balance between theoretical knowledge and practical skills. The approaches to curriculum transaction may include the following:
- Active learning encourages student teachers to participate in discussions, brainstorming sessions, and problem-solving activities that help them develop critical thinking and problem-solving skills.
- Collaborative learning involves group projects and tasks that encourage student teachers to work collaboratively and learn from each other.

Suggestive Mode of Assessment
Assessment of theoretical aspects and Practicum.

Suggestive Reading Materials

- Teachers may suggest books/readings as per the need of the learners and learning content.
- Rhonda L Clements_ Amy Meltzer Rady - Urban physical education _ instructional practices and cultural activities-Human Kinetics (2012)
- John Byl_ Bettie Van Gils Kloet - Physical education for homeschool, classroom, and recreation settings-Human Kinetics (2014)
- Teresa Sullivan - Build it so they can play _ affordable equipment for adapted physical education-Human Kinetics (2012)
- (International studies in physical education and youth sport) Hayley Fitzgerald - Disability and Youth Sport (Routledge Studies in Physical Education and Youth Sport) -Routledge (2009)
- Harvey Grout, Gareth Long - Improving Teaching and Learning in Physical Education-Open University Press (2009)
- Tim Chandler - Sport and Physical Education_ The Key Concepts (2002)
- SHAPE_America_Appropriate_Instructional_Practice_Guidelines_Higher_Ed_Physical_Activity
- Martin E. Block - A Teacher's Guide to Including Students with Disabilities in General Physical Education-Brookes Publishing (2015)

E. References

Physical Education and Health Education-Shape America
APENS welcome (ncpeid.org)
Physical Education for Students with Disabilities - Wrightslaw
Olympic Games - Wikipedia
Special Olympics - Wikipedia
Paralympic Games - Wikipedia
Deaflympics - Wikipedia

SE- III: School-Based Research Projects

Credits: 2
Contact Hours: 2hrs per week
Maximum Marks: 50
Internal: 50

About the Course

Action research enables teachers to reflect on their wisdom to bring the desired changeover and explore the system when necessary. They may experiment with practices in a controlled environment to improve the transactional processes. Learning about classroom research in action research and case studies practices promotes opportunities to improve the student-teacher learning environment in teacher education institutions. Their involvement in the learning processes during their stay in teacher education institutions becomes more fruitful. It could be individual or collaborative research among the student teachers. Action research and case studies are school-based research, which is acted upon as collective, self-reflective inquiry undertaken in social situations to improve the rationality and justice of their own contextual and educational practices. These two processes explore the answers to the problem and contribute towards theory development. These two methodologies foster critical thinking, problem-solving, collaboration and ethical decision-making skills. The student teachers are placed in schools for internships. School Internship provides the student teachers with a platform to apply theoretical knowledge understanding, techniques, methods, and approaches in an actual classroom situation. It enables them to gain intensive experience in teaching, planning, preparing support materials, and performing other school activities that a regular teacher is expected to do. The student teachers will systematically undertake school-based research to find solutions to contextual problems/challenges. During the school internship, the student teachers will identify school practices and challenges through involvement in different activities, design relevant interventions, analyze data and prepare reports.

Learning Objectives

The student teachers will:

- Identify contextual problems and formulate appropriate research design,
- Prepare the plan of action for undertaking school-based research,
- Develop and use tools and techniques for the collection of relevant data,
- Collect and analyze the data to identify the causes,
- Develop and implement need-based interventions for addressing the problems,

- Study the effectiveness of the intervention(s),
- Reflect and share school-based research experiences through reports and presentations.

Suggestive Mode of Transaction

The following strategies will be used during the school-based research project:

- Discussions with teacher educator, school head, mentors, and peers for identification of problem and development of intervention(s).
- Finalize the school-based research project proposal outline through discussion with mentor teachers/teacher educators.
- Document analysis, interaction with all stakeholders, and field visits.
- Sharing and presentation of the outcomes of school-based research.

Content

The student teachers during previous semesters have studied different courses in Foundations of Education, Disciplinary Courses, Stage-specific pedagogy courses, Ability Enhancement and Value-Added Courses. The required knowledge of action research and case study includes- the concept and importance of action research/case study, the steps of conducting action research/case study (objectives, methods, research design, design tools, data collection, and data analysis) and report writing.

The research problem will be taken from the day-to-day teaching-learning process of the school. Some of the significant areas may cover:

- Learning progress and outcomes in different subjects
- School-based assessment
- Learners' diversity and inclusion
- Participation in arts, games, sports

Suggestive Mode of Assessment

The assessment of the school-based research project will be continuous. The teacher educators, as well as mentors, will be involved in the assessment of the activities. The following rating scale may be used to assess the student teachers:

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
Observation during the execution of action research	Observation	Teacher-Educator	0.5	15
Research Report	Presentation of Report	Teacher-Educators (panel of three experts)	1.5	35

Learning Outcomes

The student teachers will:

- Present contextual problems, an appropriate research design and the plan of action for undertaking school-based research,
- Demonstrate the tools and techniques used for the collection of relevant data,
- Summarize the analyzed data used to identify the causes,
- Demonstrate the interventions used for addressing the problems,
- Present the effectiveness of the intervention(s),
- Share the school-based research experiences through reports and presentation.

SE- IV: Internship in Teaching

Credit: 10
Contact Hours: 50 hours
Maximum Marks: 250
Internal: 250

About the Course

Teacher preparation is a reflective and experiential process, and internship is vital to connecting student teachers with school, teachers, students and other stakeholders in various ways. It provides a platform and actual field experience for the student teachers to apply theoretical knowledge and teaching methods. During the internship, student teachers are placed in schools in groups as an integral part of all school activities. This provides them with the opportunity to observe classes taken by school teachers, take independent classes, develop a relationship with students, contribute to everyday school activities (e.g., conducting the assembly, assisting in the mid-day meal scheme, organizing school events) and get exposure to all school administrative practices (e.g., maintaining administration records, creating an annual calendar). This enables them to get intensive experience in all aspects of teaching- preparation, planning, developing/

collecting/localizing Teaching Learning Materials, classroom transactions, assessment, reflection, and review of their experience. The student teachers are exposed to situations where they can observe different roles played by the teacher in the field, which they will also have to undergo. After completing the internship, student teachers will be ready to take up a teacher's responsibility independently.

Structure

Student teachers are expected to go to the participating schools.

- Seven weeks in one school and seven weeks in another school (preferably in two different types of schools)

Learning Objectives:

On completion of the school internship, student teachers will be able to:

- Explain the overall functioning of the school.
- Describe and appreciate the different roles played by a teacher in the school.
- Experience the importance of teacher-student relationships for effective teaching.
- Develop age-appropriate pedagogic skills.
- Use different pedagogies learnt in real-life classrooms.
- Create appropriate teaching-learning materials.
- Develop necessary planning and execution skills to conduct school activities (assembly, celebrations, and cultural programmes).
- Express the school, teacher, parents, and community relationships.
- Create rapport with the stakeholders and understand their roles in the school system.
- Create student portfolios and comprehensive 360-degree (holistic) progress reports.
- Discuss the importance of maintaining different types of records in the school system.
- Develop research aptitude and ability to conduct action research for the situations/problems faced during their school internship experience.

Suggestive Mode of Transaction

- Observation
- Interaction
- Discussion
- Teaching in the classroom
- Analysis and reporting
- Collection of relevant documents and data

Content

- Pedagogies' different methods and strategies
- Scheme of lessons
- Peer lesson observation
- Management of substitute classes
- Various TLMs (including ICT tools) and their uses in teaching-learning.
- Achievement test
- Diagnostic tests
- Analysis of the result of the achievement test
- Assembly activities
- Action research and case studies.

Activities

Student teachers are required to undertake the following stage specific activities:

- Meet the subject-based mentors, collect timetables of classes IX to XII and develop a scheme of lessons from the syllabus to be covered during the internship.
- Get acquainted with the school within 2-3 days. Observe classroom teaching of school teachers.
- Plan and transact minimum 80 lessons (40+40), including 4 stray lessons (2+2). Stray lessons are class appropriate lessons on any topic(s) to be transacted by student teachers as per their convenience to build up confidence gradually. The last 5 lessons in each pedagogy course may be transacted using lesson notes.
    - Lesson plans should include the components to develop critical and reflective thinking, problem-solving, differential learning, synthesis, and application of knowledge in real-life situations.
    - Lesson plans must promote education for sustainability, including equity, environment, global citizenship, pride and rootedness in Indian knowledge systems and character building.
- Participate in post-lesson discussions with peers, mentor(s) and teacher educators.

- Observe peer lessons and discuss with the group.
- Conduct laboratory activities (Atal Tinkering Lab, Physics, Chemistry, Biology, Mathematics, Languages, Social Science, Computer), sports, and arts and crafts activities.
- Participate in student support services- guidance and counselling, NCC, NSS, health and wellness programme.
- Create teaching-learning materials, including ICT tools for opted pedagogic courses.
- Plan assessment, prepare material, formative and summative assessment tools, and analyze the results.
- Prepare and conduct diagnostic tests to identify learning difficulties, analyze data and prepare learning enhancement plan.
- Experience classes as a substitute teacher.
- Participate in library functioning and literary activities.
- Participate in teacher development and training activities.
- Organize school assemblies and other events (cultural, sports, yoga, and other development activities).
- Attend Parents-Teachers Association (PTA) meetings if held during the internship.
- Attend School Management Committee (SMC) meeting if held during the internship.
- Study the process of parent and community engagement for the school development programme.
- Conduct action research /case study.
- Prepare a sample student portfolio,
- Write a reflective diary daily and prepare a report of each activity.

6.4.7 Suggestive Mode of Assessment:

The activities conducted / skills acquired during the internship by the student teachers will be assessed as per the following scheme:

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
Observation of classroom practices	• Observation of a Minimum of 6 lessons of School Teachers (3+3) • Observation of a Minimum of 10 lessons of Peers (5+5)	Teacher-Educator	Non-evaluative	00
Unit planning, Lesson Planning & Transaction	40 lessons transaction for each pedagogical subject * Unit plans and lesson plans * Minimum 2 Innovative lesson plans in each pedagogy subject (Eg: Storytelling, Drama based, Arts and crafts, Use of Technology)	Teacher-Educator, School Mentor	6.0	150
Assessment Planning and execution	Preparation of report on assessment plan in each lesson transacted i.e., within lesson transaction and lesson end activities. Preparation of a Blue Print (For one/two Pedagogical course/s) and preparation of Assessment tools Conduct of Unit Test & analysis of results (for both Pedagogical course/s) Development of plan for learning enhancement of students related to subjects (for both Pedagogical course/s)	Teacher-Educator, School-Mentor	1.5	35
Participation/Organization of assembly and other school-level activities, PTM & SMC Meetings	Observation & Interaction	School Mentor	0.5	15
Preparation of Logbook /Teachers diary Minimum 5 lessons for each pedagogical method	Review	Teacher-Educator, School Mentor	0.5	15

Overall feedback on student-teacher performance by School Head	Observation and Interaction	School Head	0.5	10
Test lesson (one in each pedagogical method)	Presentation	Teacher-Educator	1.0	25

Stakeholders Responsibilities

Role of Head of ITEP Institution

- Identification of the adequate number of internship schools
- Signing the MoU with the schools
- Sharing of mutual expectations of ITEP institutions and the participating schools
- Identification of the internship programme coordinator
- Monitor the progress of the entire School Experience Programme

Role of Teacher-Educators of the ITEP Institution

- Guide the student teachers in preparing lessons and activities, assessment, observation of lessons on peer teaching, action research, and case studies conducting school activities preparation and report writing on Teaching Learning Materials.
- Conduct pre- and post-lesson discussions regularly.
- Assess the transaction of lessons for the complete duration of the lesson in the rating proforma developed by the teacher education institute and give feedback/remarks to the student teachers for lesson improvement.
- Submission of monitoring and supervision reports to the institute in time.
- Discuss with the student teachers frequently and organize a phase-end meeting of the student teachers and mentors to assess the progress and performance of the student teachers.

Role of School Head

- To introduce the student teachers to the students and staff of the school in the assembly on the first day.
- To facilitate student teachers to take classes as per stage requirements- Foundational, Preparatory, Middle, and Secondary.
- Ensure the alignment of the timetable, scheme of lessons and plan of activities/ assignments of the student teachers to be carried out during the programme in the school.
- Countersign on the attendance register maintained by the group leader/ mentor of the school.
- Ensure that all facilities and provisions are available to the student teachers to teach their lessons and carry out their assignments smoothly.
- Grant of leave applications of the student teachers in exceptional circumstances.
- Involve student teachers in different activities of the school.
- Facilitate phase-end meetings of the student teachers and the mentors to assess the progress and removal of difficulties.
- Countersign/ certify the report/ documents of the activities/ assignments conducted by the student teachers towards the end of the internship programme.
- Provide input about student-teacher performance.
- Provide suggestions for improvement of the programme to the ITEP institution.

Role of Mentors

- Guide student teachers to prepare detailed lesson plans, brief lesson notes and plans of activities/ assignments to be conducted by them in school.
- Review the lesson plan before a student-teacher transacts the lesson in the class.
- Observe the classes of student teachers.
- Assess each lesson on the prescribed proforma and write remarks in the lesson plan book provided by the student teachers.
- Give feedback continuously to the student teachers for their improvement in their teaching and other curricular activities.
- Conduct post-lesson discussions regularly.
- Countersign in the peer-teaching observation schedules after their observations in the classroom.
- Organize frequent meetings with the student teachers and supervisors to discuss the progress, difficulties faced, and experience gained by student teachers.

Role of Student-Teacher

- Report to the school head of the participating school at least one day before the start of the internship placement.
- Seek information about the classes, timetable, and topics to teach in stage-specific pedagogic courses from the mentors on the first day of the internship programme.
- Mark your attendance as per the school practice.

- Plan all the assignments/ activities with the help of the mentor/ supervisors.
- Seek cooperation from mentors and supervisors in case of difficulty.
- Prepare the lesson plan and get approval from the mentor/ supervisor before transacting every lesson.
- Take classes according to the timetable of the participating school.
- Take substitute classes and participate in other school duties assigned by the school.
- Follow the conduct and dress code of the participating school.
- Get prior leave approval from the head of the participating school in case of emergency.
- Maintain a diary and regularly list all the innovations, challenges faced and reflections for improvement.
- Check with your mentor before attempting learning activities that depart from routine classroom procedures.
- Carry out the activities you plan for school students according to your approved plans.
- Maintain cordial relationships with the students and staff of the school.
- Refrain from making negative comments about the school or the school's personnel, especially when talking with fellow student teachers.
- Submit student teaching profiles, one each, to the supervisor and mentor who supervises your teaching.
- Before the completion of the internship programme, make sure to return all textbooks and materials to the school.

SEMESTER - VIII

Sl. No.	Subject Code	Subject Name	Paper Code	Credits	Max. Marks	Internal Marks	Pract. (Ext.)	Theory (Ext.)	Periods Per Week (Hrs)
1	FE	Philosophical & Sociological Perspectives of Education – II	FE-VIII	4	100	40	--	60	4
2	FE	Education Policy Analysis	FE-IX	2	50	20	--	30	2
3	FE (One Elective)	Adolescence Education/Education For Mental Health/Education for Sustainable Development/Emerging Technologies in Education/Gender Education/Human Rights Education/Peace Education/Sports and Fitness Education/Tribal Education/Economics of Education	FE-X (One Elective)	4	100	40	--	60	4
4	AE & VAC	Yoga and Understanding Self	AE & VAC-XI	2	50	20	--	30	2
5	AE & VAC	Citizenship Education, Sustainability and Environment Education	AE & VAC-XII	2	50	20	--	30	2
6	SE	Post Internship (Review and Analysis)	SE-V	2	50	50	--	---	2
7	SE	Creating Teaching Learning material/Work Experience	SE-VI	2	50	50	--	---	2
8	CES	Community Engagement and Service	CES-I	2	50	50	--	---	2
Total				**20**	**500**	**290**	**---**	**210**	**18+4**

Semester - VIII
FE- VIII: Philosophical and Sociological Perspectives of Education-II

Credits: 4
Contact Hours: 4 hrs per week
Maximum marks: 100
Internal: 40
External: 60

About the Course
Sociological Perspectives of Education seek to encourage students to explore the relationship between social structures and educational provision. The course focuses on the study of the social behavior of individuals, groups, and societies. It

provides opportunities for student teachers to examine relationships among individuals, as well as relationships between people and their societies.

Learning Outcomes

After completion of this course, student teachers will be able to:

- Appreciate the normative nature of education and Constitutional value frame to modern Indian education
- Identify the evolutionary character of values
- Recognize the social context of education
- analyze the impact of culture on education through a study of dimensions of culture and their importance to education practices
- recognize the different aspects of social stratification
- Identify the close relationship between education and modernization, the role of education in Modernization, and factors and constraints to social change
- describe the issues of access, enrolment, retention, quality, equality and equity in education
- explain the intervening strategies or measures for achieving access, enrolment, retention, quality, equality and equity in education;
- familiarize with selected programs and schemes that are in operation for addressing the needs of weaker sections of society in education

UNIT – I: Education and Values

- Education as Normative Act: How and why?
- Values: Meaning and the role in Human Society
- Indian Traditional Values.
- Understanding Value Prescription in relation to their historical and social contexts of the following systems in India:
  - Vedic and Vedantic
  - Buddhist
  - Jain
  - Islam and
  - Sikhism

UNIT—II: Value Frame to Education in Contemporary India

- Values Enshrined in Indian Constitution:
  - The Preamble
  - Fundamental Rights and Duties
  - Directive Principles of State Policy
  - Educational Provisions on Education: Federal Arrangements
- Value Education: Continuity and Change in the Following Educational Policies
  - 1968, 1986 and 2020
  - NEP- 2020 and Values with special reference to 21st Century.
- Value Crisis and Crisis in Values
- Basic Human Values: Role of Education in Value inculcation

A. Pedagogical Issues.

UNIT--III: Education and Culture

- Education and Culture: Meaning and elements of culture;
- Role of education for preservation, transmission, and enrichment of culture;
- the influence of culture on education, in general, and promotion of meaningful learning, in particular
- Pluralism, Multiculturalism and Multicultural Education; Adaptation, Acculturation and Enculturation, Cultural Mosaic and Cultural lag
- Education and Cultural Capital: Impact of cultural capital in the classroom

UNIT--IV: Education and Social Change

- Social Change and its Concept: Definition, Nature, and Factors Affecting Social Change; Education and Social Change; Role of Teacher in Social Change
- Education: Social Stratification and Social Mobility: Definition, Types and Dimensions; Role of Education in Social Mobility
- Education and Modernization: Meaning of modernization; Characteristics of modernized society; Adaptive demands of modernization and role of education

- Globalization and Education, Expansion, and Privatization of Education

UNIT--V: Education and National Development

- National development - Dimensions and Indicators
- Education for sustainable development; Sustainable Development Goal 4
- Education to meet the situations arising out of conflicts, insurgencies, national calamities, and disasters
- Education and Politics: Power and Dominance, Policies of education, Political Ideologies and goals of education

UNIT--VI: Interface between School and Community: Critical Pedagogy

- School as Miniature society: Present and Future
- School and Identity formation and transformation: Ascribed and Acquired
- School and Community: Role of Parents and community in school development
- School and Community Interactions: interface for Political and Civic Education
- Right to Education Act 2009, in the context of bringing school and community together

UNIT--VII: Education, Inequalities and Social Justice

- Equality and Equity in Education: Dimensions and Causes of Inequality; Measures for Achieving Equality and Equity
- Education and Inequality with reference to: Caste, Class, Tribe, Gender, Region, Rural-Urban
- Role of Education for Empowerment of Marginalized Section: SC, ST, Minorities, and Women; the Policy of Positive Discrimination; Inclusion in Education
- Concept of Equality of Educational Opportunity: Right to Education Act 2009

Suggestive Practicum

1. Critical/Reflective study of contemporary aims of education and their social determinants.
2. Observation and critical study on how textbooks determine every activity of teacher and learner in the school.
3. A critique of textbook culture in school.
4. Observing the process of knowledge construction by children in structured and unstructured environments to appreciate their learning processes and nature.
5. A critical analysis of Constitution of India in the context of process of Education in India / Educational Policies / Educational Commissions)
6. Critically observing nearby society/ locality in groups of 4-5 students and sharing observations related to cultural/ social influences on educational practice.
7. Analyzing social purpose of NEP, 2020.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on group presentations, seminar presentations, assignments and tests.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

1 Badrinath, C. (2019). Dharma: Hinduism and Religious in India. Penguin Random House, India.

2 Berger, P. & Luckman, T. (1971). The social Construction of Reality: A Treatise in the sociology of knowledge. Clays Ltd, St lvesplc, England.

3 Marrish, I. (1978). *The sociology of education: An introduction*. Gorge Allen and Unwin.

4 Mercer & Carr (1958). *Education and Social Order*. Rinehart and Company; Inc.

5 Mohanty, J. (1994). *Indian Education in the Emerging Society*. Sterling Publisher Private Limited.

6 Ottaway, A.K.C. (1962). *Education and Society*. Routledge: Kegan Paul.

7 Ottaway, A.K.C. (1960). Education and Society: An introduction to sociology of education. Routledge: Kegan Paul.

8 Pathak, A. (2002). *Social implication of schooling: Knowledge pedagogy and consciousness*. Rainbow Publishers Ltd.
9 Reid, I. (1978). *Sociological perspectives on school and education*. Open Books, Publishing Ltd.
10 Saxena, N.R.S. &Dutt, N.K. (2008). *Philosophical and sociological foundations of education*. Raj Printers.
11 Saxena, S. (1975). *Sociological perspective in Indian education*. Ashajanake Publications.
12 Shankar, C. N. (2006). *Sociology of Indian society*. S Chand.
13 Shankar, C. N. (2019). *Principles of sociology with an introduction to social thoughts*. S Chand.
14 Taneja, V. R. (1989). *Socio and philosophical approach to education*. Atlantic Publishing House.
15 Thapar, R. (2018). *Indian cultures as heritage: Contemporary parts*. Aleph Book Company.
16 Archibaalt, R. (1974).*Philosophical analysis and education*. Oxford University Press.
17 Brubacher, J.S. (1950).*Modern Philosophies of Education*. McGraw Hill, Book Company, Inc.
18 Butler, T.D. (1968). *Four philosophies and their practice in education*. Harper and Row
19 Kabir, H. (1964). *Indian Philosophy of Education*. Asia Publishing House.
20 Kilpatric, W.H. (1951). *Philosophy of education*. Macmillan.
21 Kneller, G.F. (1967). *Foundations of education*. John Wiley: Sons Inc.
22 Kneller. G.F. (1964). Introduction to Philosophy of Education. John Wiley.
23 Mohanty, J. (1994). *Indian education in the emerging society*. Sterling Publisher Private Limited.
24 Radhakrishnan, S. (2008). *Indain Philosophy*. Oxford.
25 Rusk, R.R. (1956).*The philosophical bases of education.* University of London Press
26 Russell, B. (2016). A history of Western Philosophy. Routledge Classics
27 Saxena, N.R.S. &Dutt, N.K. (2008). *Philosophical and sociological foundations of education*. Raj Printers.
28 Taneja,V.R. (1989). *Socio and philosophical approach to education*. Atlantic Publishing House.
29 Weber, C. O. (1960). *Basic Philosophies of Education*. New York.

FE- IX: Education Policy Analysis

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50
Internal: 20
External: 30

About the Course
This course on Education Policy Analysis aims at orienting student teachers to the theoretical frameworks and methodology that will help assess and evaluate the effectiveness of policies at the national, state and programme levels.

Learning Outcomes
After completion of this course, student-teachers will:
- discuss knowledge and capacity to engage in education policy analysis and evaluate their effectiveness
- explain the importance of developing a policy in education
- relate the policy with the existing education scenario
- appreciate the roles of various bodies in structuring educational policy
- critically look into the educational policies in India
- address positively the policy challenges in Education. Detailed Course
- explain processes involved in policy analysis including undertaking situation analysis and research
- identify possible policy options
- describing these possible options
- comparing the potential policy options
- ranking the possible policy options and
- choosing/selecting the most effective option that could address issues and problems confronting school education

UNIT – I: Planning and Educational Policy
- Meaning and significance of `Policy on Education'.
- Purpose and Dimensions of an Educational Policy at local and Global level.
- Philosophical, Sociological, Cultural, Political and Economic Perspective of planning an Educational Policy.
- Historical development of Educational Policies in India.
- Basic steps involved in planning
- Methods and approaches in developing policy

- Constitutional provision for Policy on Education.
- Fundamental principles for analyzing an Educational Policy.
- Analysis, interpreting and evaluating policy issues in terms of their relevance for the continued improvement and development

UNIT – II: Educational Policies in India

- Critical analysis of Policies on Education since Independence: 1968, 1986 (Modified in 1992), 2020 in the context of: need and significance, goals and frameworks of educational policies, content of policies, issues raised in policies, constitutional provisions, special stress, modification of policies, implementation strategies.
- Management of various aspects and factors deciding education policies in pre and post independent India
- Issue in modifying an Educational Policy.
- Critical analysis of NCF-2005 and NCFSE-2023 in the light of

UNIT – III: Implementation of and Educational Policy

- Education policies and System of School:
  - Public, Private, Government, Aided and local body schools.
  - Role of various national and state level bodies in implementing school and education policies like CABE, NCERT, SCERT, DIETs, BRC etc.
  - Role of centre, state and other bodies in formulation of education policies.
  - Role of UGC & NAAC in implementation of education policies
- Mechanism of Policy Implementation.
- Strategies to Implement an Educational Policy.
- Programme of action and implementation: conceptual clarification and significance.
- Role of different Organization / Groups: Legislature/ Judiciary/ Political Will and Parties/ Voluntary Organizations/ Non-governmental organizations (NGOs)/ Pressure Groups/ Public.
- Challenges for Implementation.

Suggestive Practicum

- Reviewing and presenting report on NEP, 2020 in reference to Policy Implementation.
- Review of NCF-2005 and NCFSE-2023 with reference to implementation
- To present a critical review of the Programme of Action (1992).
- Review of SSA/RMSA/SamagraShiksha with reference to implementation
- Preparing a list of challenges to implement the present new National Education Policy, 2020 in our States.
- Preparing a list of Measures to be taken or taken to implement National Education Policy, 2020 in our State.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, Focus Group Discussions, panel interactions, small theme-based seminars, group discussions, co-operative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands-on experience of engaging with diverse communities, children and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments/projects and field-based engagements.

Suggestive Reading Materials

- **Batra, S. (2003).** School inspection to school support. In Sood, N. (ed.) Management of school Education in India, Delhi: NUEPA.
- **Jha, P., Das, S., Mohanty, S. S., Jha, N. K. (2008).** Public provisioning for Elementary Education in India. New Delhi: Sage.
- **NCERT (2006).** Educational Statistics of India, New Delhi.
- **NUEPA (2008).**Elementary Education in India: Progress towards UEE, DISE data 2006-07.
- **Patnaik, P. (2007).** Alternative Perspectives on Higher Education in Context of Globalization, at http://www.nuepa.org/ Download/ First Foundation DaySpeech.pdf
- **Pratichi (India) Trust (2009).** The Pratichi Education Report –II, Primary Education in West Bengal: Changes and Challenges, Section 6: Learning Inside and Outside Classroom, Section 7: Governance and Participation.
- **PROBE Team (1999).** Public Report on Basic Education in India, and PROBE Revisited (2011). New Delhi: Oxford University Press.

- **Raina, V. (2007).** Integrating Work and Education; Contemporary Education Dialogue Vol. 4:1, pp.72-87.
- **Rampal, A. (2015).** Reaffirming the Vision for Quality and Equality in Education. In Govinda, R. (Ed.) India Education Report. New Delhi: Oxford University Press (section-2 and 3 on the vision of education in our national policies, and how policy is translated into curricular frameworks).The Framework of Implementation of SSA under the RTE Act; MHRD (2011) available at http:/www.ssa.tn.nic.in/Docu/contents.pdf
- **Samson, M., De, Anuradha and Noronha, C.:** Building Unequal Capabilities: Schooling of Delhi's Adolescents, at www.cordindia.com/images/delhi-adolescents.pdf
- **Tilak, J. B. (2004).** Higher Education between State and the Market presented in UNESCO Forum on Higher Education available at portal.unesco.org/education/tilak/colloquium
- Vaidyanatta Ayyar. R.V. (2017) History of Education Policy Making in India, 1947-2016 oxford New Delhi.
- Citizens for Democracy (1978) Education for Our People: A policy Frame for the Development of Education (1978-1984) Allied Publisher, New Delhi.

FE- X: Electives

Choose any one:

FE- X.1: Adolescence Education

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

The course is designed to develop a comprehensive understanding and knowledge about Adolescence and Adolescence education with special references of Adolescence Education programmes in India at School level. There is an attempt to develop understanding about intellectual, emotional, physiological, socio-cultural, and interpersonal issues related to the processes of growing up and to inculcate healthy attitude towards sex and sexuality, respect for the opposite gender and understanding of responsible social behaviour. The courses highlight core life skills and their significance in adolescence life period and try to know about the various Adolescence Education programmes undergoing for Adolescence in India.

Learning Outcomes

After the completion of this course students will be able to:

- develop sensitivity, understanding and knowledge about Adolescence and Adolescence Education,
- know the historical development of Adolescent Educational Programme in India,
- know the role of local as well as international agencies towards Adolescent Educational Programme,
- develop a positive attitude towards the importance of Adolescence Education Programmes at the school level,
- develop knowledge and sensitivity on matters related to reproductive health, sex and sexuality and communicate effectively on these issues,
- develop understanding about intellectual, emotional, physiological, socio-cultural, and interpersonal issues related to the processes of growing-up,
- inculcate a healthy attitude towards sex and sexuality, respect for the opposite gender and an understanding of responsible sexual behavior,
- develop an understanding about the desired life skills,
- acquire pedagogical related skills for Adolescence Education Programmes.

UNIT –I: Adolescence and Adolescence Education

- Understanding Adolescence: intellectual, emotional, social, and physiological aspects of Adolescence, issues and challenges during Adolescence, myths and realities.
- Adolescence Education: concept, nature, aims, objectives and significance of Adolescence Education in Indian context.
- Role of school, family, media, and community as social agencies in Adolescence Education.
- Challenges of Adolescence Education.

UNIT –II: Life Skills and Adolescence Education

- Concept, nature, and significance of life skills for Adolescence Education.
- Relationship between Life Skills and Adolescence Education.
- Core Life Skills: Decision making, Problem solving, Creative thinking, Critical thinking, Effective communication, Interpersonal relationship skills, Self –awareness, Empathy, coping with emotions, Coping with stress.
- Techniques of developing Life Skills.

UNIT –III: Adolescence Issues

- Understanding sexual and reproductive health.
- STIs and HIV/AIDS: causes, prevention, cure, and skills of coping.
- Prevention of Substance Misuse/ Drug Misuse.
- Understanding and reporting abuse and violence.
- Accessing support for prevention and treatment.

UNIT IV: Health and Well being in school

- Health: Physical Health, Social Health, Mental Health and Emotional Health.
- Nutrition Health and sanitation.
- Gender Equality
- Promotion of Healthy lifestyle.
- Promotion of safe use of Internet and social media.

UNIT V: Pedagogical Issues

- Meaning, goals and significance.
- Challenges of teaching adolescence education: understanding student's behavior, dealing with personal self-constraints, socio- cultural issues, class-room issues and challenges, material production, methodology
- Adolescence education and teachers' preparation.
- Approaches to adolescence education: case studies and critical incidents, brainstorming, role-playing, gaming, value clarifications, question box, discussions and debates, puppet shows, role reversal, video shows.

UNIT –VI: Adolescence Education Programme in India (AEP)

- Historical Development of Adolescence Education Programme in India.
- Goals and Significance of Adolescence Education Programme in India.
- Role of Teachers in Adolescence Education in India (AEP).
- Challenges to Educational Programmes in India.

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- Adolescence Education Programme. Department of School of Education and Literacy. MHRD. Government of India. (2011, December 27). Retrieved March 5, 2014 from http://mhrd.gov.in/adolesence_education
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- Durlak J(2011). The impact of enhacing students' social and emotional learning: A meta- analysis of school-based universal interventions'. *Child development*, 82(1), 405-432.
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- Larson R (2006). Positive youth development, wilful adolescents and mentoring. *Journal of Community Psychology* 3(4) 677-689.
- Mofanato, S.K.K & Jurist Lional, K.V.(2013). Health Status among Tenth standard students. Edutrack.
- Olweus, D. (1990). A National Campaign in Norway to reduce the prevalence of bullying behavior. Paper presented to the society for research on Adolscence Biennial Meeting, Atlanta, December 10-12.
- Training and Resource Materials Adolescence Education Programme,
- National Population Education Project Report,
- Department of education in Social Sciences,
- National Council of Educational Research and Training,
- Sri Aurobindo Marg, New Delhi 110016,
- July, 2013.

FE- X.2: Education for Mental Health

Credits: 4

Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

This course on Education for Mental Health will give a comprehensive understanding on the concept of meaning and determinants of Mental Health. The course will further enhance the student teacher's ability to know different stress management and adjustment techniques. The course aims to introduce historical and contemporary developments of Mental Health Education programs in Indian and Global perspectives.

Learning Outcome

After studying this course, student teachers will be able to:

- express the meaning and significance of mental health,
- describe social and psychological determinants of mental health,
- analyze the causes of stress and process of stress management,
- analyze the significance of adjustment in life,
- analyze the needs and importance of global mental health education programme,
- explain the special role of teachers and parents to maintain the good mental health of children,
- suggest prevention and promotional measures to maintain good mental health of society,
- express the need for health policies globally.

Unit – I: Mental Health

- Meaning and determinants of Mental Health.
- Difference between Mental Health and Mental Hygiene.
- Mental disorders: Characteristics and Types.
- Causes of poor Mental Health.
- Myths and Facts about Mental Health.
- Legal perspectives of Mental Health in India.

Unit-II: Adjustment

- Meaning and Definations
- Areas of adjustment
- Charactristics of a well-adjusted adolescent
- Theories of adjustment
- Methods of adjustment

Unit-III: Emotions and Adolescents Adjustment

- Nature and Functions of the Emotions
- Factors that affect emotions
- Effect of the emotions on adolescents
- Education of the emotions
- Specific procedure in emotional direction

Unit-IV: Stress, Stress Management

- Stress: meaning, nature and symptoms, types of stress, social and psychological perspectives, remedial measures.
- Stress management**:** meaning and significance of stress management, stratagies for prevention of stress; role of parents, peer group and teachers.

Unit – V: Mental Health Education Programme

- Meaning and significance of Mental Health Education Programme.
- Dimensions of Mental Health Education Programme in India.
- Historical development of Mental Health Education Programmes in India.
- Local and Global Perspective of Mental Health Education Programme.
- Organizations at local and international level.
- Characteristics of a good Mental Health Education Programme.
- Role of Educational Institutions for awareness about mental health educational programmes.

Unit – VI: Challenges to Pedagogical Issues

- Home and school
    - Diverse school and home contexts

    - Lifestyles of teachers and parents
    - Stereo-type roles
    - Mental health concerns of teachers and parents
    - Material availability and production
- Guidance and Counselling Programme:
    - Concept, need and techniques.
    - Teacher as a counselor
- Designing and evaluating Mental Health Programmes

Suggestive Practicum

1. Visiting of Mental hospital and preparing list of four cases admitted in Hospital.
2. Preparation of two case histories on causes of abnormal behavior.
3. Critical analysis of laws and Public Health Policies.
4. Critical analysis of National Educational Policy, 2020 in the context of Health of children at school.
5. Critical analysis of Legal perspectives Mental Health Education in India.
6. Preparing comprehensive report on Mental Health Education Programme in India.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

FE- X.3: Education for Sustainable Development

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

This course is designed to highlight the meaning, nature and significance of Education and Sustainable Development in the light of 17 sustainable development goals envisaged in United Nations agenda. The course is designed to make student teachers aware and understand SDG 4 goal of Inclusive and Quality Education in the light of NEP 2020. The course also highlights the politics and policies involved in Sustainable Development.

Learning Outcome

After studying this course, student teachers will be able to:

- Clarify the meaning and significance of sustainable development and its different parameters.
- Explore the relationship among education, development and environment, appreciatethe relation between education and sustainable development,
- describe the characteristics of ESD,
- explain the role of education in sustainable development,
- critically analyze the meaning and importance of education in the context of sustainable development.,
- explain the role of education to achieve sustainable development,
- analyze the pedagogical issues related to ESD.

UNIT – I: **Introduction to Sustainability from different Parameters**

- Sustainable Development- The 5P formula (People, Prosperity, Peace, Partnership, and Planet)

- Environmental Sustainability- Meaning, Natural Resource Management, Food & Farming, Waste Water Management and Climate Change
- Economic Sustainability- Alternative Futures, Leadership & change, Globalisation of Economy
- Social Sustainability- Sustainable communication, Cultural diversity, Intercultural understanding, Health & Well being
- The 17 Sustainable Development Goals stipulated by UNESCO

UNIT- II: **Education and Sustainable Development**

- Meaning, relationship, goals, and significance.
- Characteristics of ESD
- Education for Sustainable Development: Historical Perspective
- Philosophical, Sociological and Psychological Perspective.
- Role of Education for Sustainable Development.
- Decolonizing Knowledge for Sustainable Development.

UNIT – III: **Sustainable Development Goals (SDGs)**

- Meaning, nature and significance of SDGs.
- 17 Sustainable Development Goals (SDGs): UNESCO agenda.
- SDGs and Social Transformation as Universal Commitment.
- Education as a Human Right to achieve Sustainable Development.
- Sustainable Development and Peace.

UNIT – IV: **SDG-4: Quality Education for All**

- Meaning, Nature, and Significance.
- NEP, 2020 on SDG-4: Sustainable lifestyle, Gender equality, Promotion of peace & non-violence, Global citizenship, Good mental health & wellbeing, Justice in society.
- Pedagogical issues for SDG-4.
- Initiatives taken by Indian Government to achieve SDG4- SSA, RMSA, NSDC, MDMS, DIGITAL INDIA and others.

UNIT – V: **Sustainable Development: Politics and Policies**

- Understanding the Policy-Making Process and Analysis.
- Democratizing Science and Technology.
- Globalization and the Environment: Capitalism, Ecology and Power.
- Perspectives, Methods, and Skills.
- Innovation for Sustainability.
- Key Issues from an International perspective.
- Critical issues involved in sustainability.

UNIT- VI: **SDG4- Issues and Challenges**

- Critical issues in achievement of SDG4
- Challenges in achieving Quality Education from Indian Context- Low enrollment rate, Quality of Education, Gender Disparity, Digital Divide, Gap prevailing in the society
- Role of Educational Institutions in achieving of SDG4

Suggestive Practicum

- To present critical review on NEP, 2020 in the context of SDGs.
- Critical study of Delors Commission Report, 1996: **Learning: The Treasure within**with reference to SDGs.
- To review and present a critical report on legal perspective on SDGs.
- To prepare Toolkit for Educations for Sustainable Development.
- To organize discussions/ seminars of Teachers of all streams to present their views on SDGs and to present Action Plan for this.
- To prepare and present a short Video/film to promote SDGs.
- To study different Indian commissions and acts in regard to Education.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments. Assessment to be based on report presentation on different Indian policies and acts in regard to Education.

Suggestive Reading Materials

- Ahlawat, A. (2019). SDG: Directive principles for Sustainable India by 2030. New Delhi. Notion Press.
- Ahuja, R. (2021). Social problems in India. Jaipur. Rawat Publications.
- Brinia, V. (2020). Designing an Innovative Pedagogy for Sustainable Development in Higher Education. Florida.
- Chitturu, S. (2021). Youth & India's Sustainable Development Goals. New Delhi. Vitasta Publishing Pvt. Ltd.
- Dhingara, Ishwar C. (2017). Sustainable development in India & South-East Asia. New Delhi. Manakin Press.
- IGNOU BDAG- 174 Sustainable Development. (2022). New Delhi. Neeraj Publications.
- Nikolopoulou, A. (2010). Education for Sustainable development: challenges, strategies and practices in globalising world. New Delhi. Sage Publications.
- Nulkar, G. (2022). Ecology Equity and the Economy. New Delhi. Notion Press.
- Padnabhan, J. (2016). Education for Sustainable Development to integrate in School Education. Chennai. Atlantic Publishers.
- Packiam, S. (2018). Education for Sustainable development. New Delhi. Neelkamal Publications.
- Ranade, J. (2022). Strategic Challenges India in 2030. Gurugram. HarperCollins India.
- Rogers, Peter O. (2008). Introduction to Sustainable Development. New Delhi. Prentice Hall.
- The Sustainable development Goals, A guide for teachers. (2019). OXFAM.
- Uppal, S. (2017). Towards a green school resource book on education for Sustainable development for elementary schools. New Delhi. NCERT.
- Yunus, M. (2018). A world of three Zeros. Gurugram. Hachette India.

FE- X.4: Emerging Technologies in Education

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

The course is designed to use Information and Communication Technology in a classroom as an important 21st century skill and an important step for ICT enabled education of the country. The course explores various ICT approaches and its integration in Pedagogy, Assessment and Management. The course will help student teachers to know and apply online and offline software applications and it will enhance their understanding related to social, economic, and ethical issues associated with the use of ICT.

Learning Outcome

After studying this course, student teachers will be able to:

- describe the need and uses of technology in the field of education,
- use various digital technologies for creating the resources,
- provide learning experiences for all types of learners including differently abled.
- create learning environment in the class room,
- understand the role of ICT to enhance the creativity of students,
- view the use of massive open online courses (MOOCs),
- explain the role of ICT in authentic and alternative assessment,
- discuss the social, economic, and ethical issues associated with the use of ICT.

UNIT – I: Technology in Education and Pedagogy

- Approaches of integration of Technology in teaching and learning.
- Subject specific ICT tools for creating and facilitating learning.
- Subject specific online resources and their uses in lesson Planning.
- Technology integrated learning experiences and creating learning Environment.

- Use of Technology for children with special needs: Assistive Technology, Tools and processes; Universal Design for Learning.
- E-learning: Concept, Tools and Standards, Resources and Approaches.

UNIT – II: Online and Offline Software Applications

- Application software- meaning and types.
- Word processing, spreadsheet, presentation: Features and educational applications.
- Drawing tools: diagrams, concept maps, timelines, flow charts. Educational applications of these tools.
- Web 2.0 technology: meaning, characteristics; uses for creating, sharing, collaborating, and networking.
- Social networking and social book marking: Educational Applications.
- Blog and micro blog: reflective journaling and other educational applications.
- Wiki, YouTube, TED (Technology, Entertainment, Design), Skype – collaborative authoring and projects.
- Online forums/discussion groups and chats: educational applications.
- Social media sharing – video, presentations, audio (podcasts), graphics, and text.

UNIT – III: E-content

- E-content: concept, principles, and stages.
- Identifying and organizing course content: need analysis (learner, content, and task), learning objectives and course sequence.
- Designing instructional media, evaluation, and delivery strategies.
- Creating interactive content: story board, courseware outline, interactivity, and interface
- Multimedia tools: Audio editing, video editing, screen casting, graphic editing, and basics of animation, and creating interactive media.
- Reusable learning objects (RLO): meaning, types and characteristics, RLO repositories, metadata and standards.
- E-content authoring tools- open source and proprietary alternatives.
- Open Educational Resources: Meaning and importance, various OER initiatives, creative common licensing.

UNIT – IV: ICT in Teaching-Learning and Assessment

- Concept, Approaches to integrating ICT in teaching and learning: Technological Pedagogical Content Knowledge (TPCK), Technology Integration Matrix (TIM).
- Implication of Learning Theories in ICT in Education: Behaviourism, Cognitivismand Constructivism.
- Developing functional skills to use discipline specific ICT tools: Geogebra, PhET, Stellarium, Open Street Map, Marble, Turtle Art, Technological tools for Mind mapping etc.
- ICT and Assessment- Concept and types; Electronic assessment portfolio, e-portfolio tools.
- Online and offline assessment tools: Rubrics, survey tools, puzzle makers, test generators, reflective journal, and question bank.
- ICT applications for Continuous and Comprehensive Evaluation (CCE).
- ICT application and multiple intelligence.

Unit-V: Technology for Administration and CPD

- ICT for personal management: email, task, events, diary, networking
- ICT for educational administration: scheduling, record keeping, student information, electronic grade book, connecting with parents and community
- ICT for continuous professional development: tools and opportunities
- Action research and design based research in technology integration and its implications for professional development
- Major Institutions of Educational Technology in India and their role in education: CIET, EMMRC (AVRC, EMRC and MCRC), IGNOU, SIET, Consortium for Educational Communication (CEC)-UGC

UNIT – VI: Emerging Technologies in Education

- E-learning Concept, methods, and media (LMS, Virtual Universities, Massive Open Online Course (MOOCs), Indian MOOCs, Types of MOOCs: cMOOCs, xMOOCsand LMOOCs).
- Open Education Resources (Creative Commons, Concept, and application).
- Meaning, history, importance, tools and uses:Augmented reality, Virtual reality, Artificial intelligence, Mixed Reality andGamification in education.
- Cloud Computing and Internet of Things - Meaning, importance and uses.
- Ethical issues and safety in ICT- (Teaching, Learning and Research, Cyber bullying, Cyber security literacy and data protection, online identity and privacy).

Suggestive Practicum

- Creating an account in wikispace/wikipedia/mediawiki and adding/editing content.
- Developing an educational blog in www.blogger.com, www.wordpress.com.
- A critical study of some ***e-learning*** course.
- Developing a multimedia e-content for a topic.
- Field visits to the EDUSAT center and take part in teleconferencing.

- Planning and creating digital rubrics for any topic
- Organizing web conferencing using Skype/Yahoo/ Messenger/ Google+.
- Interview of computer hardware engineer/ICT specialist regarding Hardware planning, evaluation, maintenance, and up gradation
- Review of NEP, National ICT policy and curriculum in the context of Technology in Education.
- Enrolling and completing some MOOC courses of interest.
- Developing technology integrated unit/lesson plans and trying them out in schools.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

FE- X.5: Gender Education

About the Course

The course Gender Education seeks to develop understanding and interlinkages between gender and education. The course is designed to develop a conceptual understanding of the overall gender discourse with special emphasis on issues such as gender bias, gender stereotypes in school, curriculum and in textual materials. The course also addresses gender sexuality, sexual violence, abuse, and legal perspectives.

Objectives

After completion of this course the student teacher will be able to:

- State the key concepts related to the gender issues.
- Understand the gradual paradigm shift from women's studies to gender studies and some important landmarks in connection with gender and education in the historical and contemporary period.
- Identifies key gender issues in school, curriculum, textbooks, and pedagogical process.
- Examine school environment, curriculum, and pedagogy with reference to gender relatedissues
- Provide adequate knowledge and skills about the causes, characteristics, identification,and assessment of students with special needs.
- Understands the ways to address gender issues in and out of school context.

UNIT – I: Gender-Related Concept

- Key concepts: sex and gender, masculinity and feminity, patriarchy, gender bias, gender parity, gender asymmetry, Sexuality, transgender, gender stereotyping, Gender Discrimination, Gender Dynamics, Gender Needs, Gender Equality and Equity
- Gender identity construction – Influence of home, society, culture
- Gendered Education: Schools as Sites of Gendered Socialisation: critical understanding.
  - Gendered Environment at School
  - Gendered Attitudes
  - Gendered Educational Experience
  - Gendered Choices
  - Implications

UNIT – II: Gender Studies - Paradigm Shifts

- Historical backdrop: Some landmarks from social reform movements of the nineteenth andtwentieth centuries with a focus on women's experiences of education.
- Shifting from women's studies to Gender Studies
- Feminism and Contemporary Feminist Discourses

UNIT – III: Gender Roles

- Understanding Gendered Socialization and Gender Roles
- Gender Roles and Patriarchy in Indian Perspective
  - Theories and Identity of Gender & Education (Indian context): Socialisation Theoryand Structural Theory
  - Household Labor and its Tyranny
- Social and Cultural Perspectives of Gender Identity: role of family and school, media and other formal and informal organizations/agencies.

UNIT – IV: Gender and Pedagogical Practices

- Gender Auditing of Classroom Transactions
- Approaches for Creating Gender-Sensitive Teaching and Learning Environment
  - Gender Sensitivity through the Teaching of Languages
  - Gender Sensitivity through Teaching of Mathematics and Science
  - Gender Sensitivity through Teaching Social science and Environmental Studies
  - ICT pedagogy for gender-sensitive school curriculum
  - Teacher as a Facilitator for Creating Gender Sensitivity
- Changing Power Equations in the Classroom

UNIT – V: Gender Issues in Curriculum/Pedagogical Issues

- Analysing Curriculum from Gender Perspective: Learning outcomes, textual materials, teaching-learning processes, language used, teaching aids, and assessment strategies.
- Questioning and Challenging Existing Curriculum, Attitudes, Social Practices, and Beliefs from the Perspective of Gender
- Gender inequality in the school context: Access, Enrolment, Retention, Participation, and Overall Achievement, role assignments, Gendered Language, inadequate gender-sensitive facilities
- Sexual violence in formal and informal institutions: Child sexual abuse from pre-primary stage to secondary stage

UNIT – VI: Addressing Gender Issues

- Intervention and strategies · Role of family, school, community, and media in addressingthe issues.
- Addressing Sexual Harassment in School (providing accurate information on child sexualabuse, helping, and identifying signs of sexual abuse in children).
- Policy, provisions, and Progarmmes Addressing Gender Equality - NPE (1986/92), NEP(2020), NCF (2005), NCF (2023), RTE (2009), State Women's Policy.
- Legal perspective: Human Rights and Women's Rights, Laws for safety and Security ofgirls and women, Implementation of POCSO Act

Scheme of Evaluation

- The performance of each student-teacher shall be assessed internally out of 40 marks andexternally out of 60 marks at semester end examination.
- Sessional work shall be assessed internally based on class tests and WrittenProjects/Assignment.

Tasks and Assignments

Each student-teacher is required to submit any two assignments from the following:

- Surveys of five families on role distribution among family members and preparationreport
- Preparation of a report on gender-based roles and practices of the students and staff ·
- Analysis of a secondary-level textbook from a gender perspective
- Make a reflection on various provisions for gender equality in Indian constitution.

References

- Abishek (2008) Destiny of Women – Rummy Nandlal –Chandigarh.
- Agnes, Flavia (2004) Women and Law in India, Oxford University Press.
- Bhattacharya S. et al (Ed). The Development of Women's Education in India - 1850- 1920; Kanishka Publishers Distributors: New Delhi.
- Chakravarti, Uma. (2003). Gendering cast through a feminist lens. Calcutta, Bhatkal and Sen.
- Dube Leela. 1988. "On the Construction of Gender: Hindu Girls in Patrilineal India". Karuna Chanana (ed.), Socialisation, Education and Women: Explorations in Gender Identity. New Delhi: Orient Longman
- Dube Leela. 2001. Anthropological Explorations in Gender: Intersecting Fields. NewDelhi: Sage Publications.
- Forbes, Geraldine (1996). 'Education for Women', Women in Modern India. (pp. 32-63).Cambridge University Press.
- Gender and the Curriculum in Wyse, D., Hayward, L and Pandya J (Eds.) The SageHandbook of Curriculum, Pedagogy and Assessment. SAGE.
- Gokilvani (1997) Reaching the unreachable – Srilakshmi printers Karaikudi. Govt. of India (1992). National policy on education 1986/92. New Delhi: MHRD, Govt.of India,
- Indira Kulishreshtha 'Noopur' (1989) Women's Studies in School Education- SterlingPublishers Private Limited.
- Janaki, D. (ud) Women's Issues- Dhan Publications 924, 17th main road Anna NagarChennai.
- Jone, Mary E. (Ed.) (2008). Women's studies in India: A reader. New Delhi : PenguinBooks.
- Kamla Singh (1992) Women Entrepreneurs- Ashish publishing house.
- Karlekar Malavika. 2000. "Girls' Access to Schooling: An Assessment". Rekha Wazir (ed.) The Gender Gap in Basic Education: NGOs as Change Agents. New Delhi: Sage Publications
- Kaufman Gloria, Juan Luis. 1978. "Vives on the Education of Women, Signs", Virginia Walcott Beauchamp, Elizabeth H. Hageman and Margaret Mikesell (eds) The Instruction of a Christian Woman. Vol. 3
- Levtov, R. (2014). Addressing Gender Inequalities in Curriculum and Education: Review of Literature and Promising Practices to Inform Education Reform Initiatives in Thailandin Women's Voce and Agency Research Series 2014 No.9, The World Bank.
- Maithreyi Krishna Raj (1988) Women and –Shubhada saraswati- developmentprakasham, PUNE.
- Manju Gupta (Compiled and Edited) (2006) Handbook of Women Health - Khel SahityaKendra –New Delhi.
- Minault, Gail (1998). 'Role Models: Educated Muslim Women: Real and Ideal', SecludedScholars, Women's Education and Muslim Social Reform in colonial India. Oxford University Press.
- Mlama, P., Dioum, M., Makoye, H., Murage, L., Wagah, M., & Washika, R. (2005). Gender Responsive Pedagogy: A Teacher's Handbook. Nairobi, Kenya: Forum for African Women Educationalists (FAWE).
- Nalini Mishra (2008) Woman Laws against Violence and abuse- Pearl Books –New Delhi.
- National Council of Educational Research &Training (NCERT). Gender Analysis ofNCERT Primary Textbooks of Classes I to V Overall Analysis. Report 2013-14. New Delhi: Department of Women Studies. NCERT.
- National Focus Group on Gender Issues in Education (Position Paper) (2006). NewDelhi: NCERT
- Nayar, U. & Duggal, J. (1997). Women's equality and empowerment through thecurriculum: A handbook for teachers at primary stage. New Delhi: NCERT
- NCERT (2005). National Curriculum Framework 2005. New Delhi: NCERT.
- Nirantar. 2009. Textbook Regimes: A Feminist Critique of Nation and Identity. NewDelhi: Nirantar.
- Nirmala Jayaraj (2001) Women and Society – Lady Doak College Madurai.
- Raj Kumari Chandrasekar (1992) Women's resource and National Development aperspective-Sterling Publishers

Private Limited New Delhi. □

- Ram Shankar Singh (2009)– Encyclopaedia on women and children Trafficking –Volume 1 to 3- Anmol Publications. □
- Sarojini Reddy, P. (2002) Justice for Women – Sai Sreenivasa printers. □
- Srivastava, Gouri (1997). Women who created history: Exemplar materials for textbookwrites and teachers. New Delhi: NCERT
- UNDP. 2008. Good Practices in Gender Mainstreaming- Case Studies from India. NewDelhi: UNDP
- Veena Gandotra and Sarjoo Patel (Edited) (2009) Women Working Condition andEfficiency –New Century Publication. □

Videos

- Gender-Responsive Teacher Education: http://www.youtube.com/ watch?v=eZuUY4Vwh3k
- Gender Stereotyping in the Classroom: ttp://www.youtube.com/ watch?v=i3BFwRG0Id4
- How to Avoid Gender Stereotypes: http://www.youtube.com/ watch?v=9ZFNsJ0-aco
- UNICEF: To Educate a Girl: http://teachunicef.org/explore/media/watch/ educate-girl-feature-length-film
- Chuppi Todo, Plan India

FE- X.6: Education for Peace

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100
Internal: 40
External: 60

About the Course

The course is designed to develop a holistic and critical understanding of the theoretical and practical bases of education for peace in National and Global perspectives both. The aim is to inculcate values and attitudes required to become a reflective peace practitioner who promotes peace and harmony in society. The course further enhances the contribution of various leaders or educationists in promoting culture of peace.

Learning Outcomes

After the completion of this course students will be able to:

- Acquire a holistic and critical understanding of the theoretical and practical bases of education for peace,
- Trace the historical development and status of the education for peace field,
- Searching and identifying the best ways to follow peace in life,
- Show ability to select and use appropriate method of resolving conflict,
- Become critical learners and reflective peace practitioners,
- appreciate the foundations of just and peaceful societies,
- understand and practice the positive action and non-violent conflict resolution in society.
- enhance students' intellectual flexibility, creativity & problem-solving capacities,
- connect course content to current public events and issues worldwide.

UNIT – I: Concepts and concerns, Education for peace

- Meaning importance and goal of Education for peace.
- Foundation of peace and its components
- Types of Peace: positive, negative, inner, social and with nature.
- Education for peace, Education for peace.
- Initiative: International, National, and local
- Highlights of various philosophies of Peace: M.K. Gandhi, Krishnamurthy, Arobindo, Gijubhai, Badheka, Dalai Lama
- Challenges to education for peace.

UNIT II: Toward the Global Culture of Peace

- Ancient Indian views
- UNO role for Global Education for peace

- Process of Peace Building
- Culture of peace vs Culture of war
- Approaches to Education for peace
- Conflict analysis and resolution
- Role of social and religious foundation and peace building
- Respect for differences: Socio-economic, Gender, Caste, Religion. Culture, Languages and Regions etc.
- Activities for education for peace

UNIT III: Understanding Conflicts

- Nature of conflict: causes for conflict
- Need theory-Maslow
- Skills and strategies for conflict resolution
- Developing capabilities for mediation and conflict transformation
- The media and violence, Attitude towards balance media exposure

Unit IV: Empowerment of Self

- Positive experiences, nurturing ethical behavior
- Yoga, Meditation, Transcending past negative experiences
- Self-management, Anger, stress management
- Critical self-reflection, discipline
- Personality formation-Knowledge, Values, Skills and Attitude.

Unit V: Orienting Education for Peace Building

- Teacher as peace builder- listening skills, questioning, Providing feedback
- Classroom for promoting peace
- Critical pedagogy of education for peace, promoting dialoguing, decision making
- Integration of peace in different subjects
- Skills of giving emotion support for encouraging appreciation, and co- operation
- Agencies for peace: Home, School, Local Community

UNIT-VI: Pedagogical Issues for Education for peace

- Pedagogical skills, Strategies for developing peace.
- Assessing curriculum policy for social and civic reconstruction.
- Comparative and historical perspective on school knowledge and peace.
- Teachers' perceptions of the effects of young people's war experiences and pandemic.
- Critical analysis of school curriculum at school level in the light of peace building process.
- Challenges of Pedagogical issues of Education for peace.

References:

- Gangrade K.D. (2001) Religion and peace. A Gandhian Perspective, Gandhi Smriti and Darashan samiti, New Delhi.
- Harris. I.M. 1998. Education for peace, McFarland, North Carolina, NCERT, New Delhi
- Kaur, B. 2006. Peace Lines. Penguin Publications, New Delhi, (in Press)
- Kumar, K. (2007), Santi Shiksha Aur Gandhi. (in Hindi) Maharishi Valmiki College of Education, Delhi University
- Krishnamurti.J. 1997. The Flame of Attention. Krishnamurti Foundation Trust Ltd., London.
- Ministry of Human Resource Development. 1993. Learning without Burden: A Report of the Advisory Committee, (MHRD), Department of Education, New Delhi.
- NCERT 2005. National Curriculum Framework. NCERT, New Delhi
- NCERT 2005 position paper on Educational for Peace NCERT, New Delhi
- Prasad, D (2005), Education for living creatively and peacefully. Spark India Hyderabad, A.P.
- Hant, T.N. (2004). Being Peace. Nice Printing Press, Delhi
- UNESCO (2001). Learning the way the Peace- A Teacher's Guide to Education for peace. A.S. Balasooriya, UNESCO, New Delhi
- UNESCO (2002). Learning to Be. A Holistic and Integrated Approach to value Education for Human Development Bangkok.
- Well Pierre 2002- The art of living in peace, UNESCO publication, UNIPALK.

FE- X.7: Sports, Health and Fitness Education

Credits: 4
Contact Hours: 4 hrs per week
Maximum Marks: 100

Internal: 40
External: 60

About the Course
The course seeks to develop a comprehensive and holistic understanding about the concept of health, its various dimensions, and determinants. The course traces the evolution of Health and Physical Education, historical development of the discipline with special reference to Indian Education and its relation to other subjects. It further highlights the importance of physical fitness policies, programs and services addressing health initiatives in school context.

Learning Outcomes
After completion of this course the students will be able to:
- understand the concept of holistic health, its various dimensions, and determinants,
- develop positive attitude towards health physical education and yoga as individual,
- sensitize, motivate, and help them to acquire the skills for physical fitness, learn correct postural habits and activities for its development,
- create interest for the practice of yogasana and meditations,
- understand various policies and programmes related to health, physical education and yoga,
- help them to understand the process of assessment of health and physical fitness.

UNIT – I: Evolution of Health and Physical Education
- Health and Physical Education: Conceptual Clarity (locally as well as globally), importance and aims.
- Place in School Curriculum: Historical Development as a subject, Objectives with special reference to Indian Education and its relationship with other subjects.
- Status of Health and Physical Education**:** From primary to secondary education in a global perspective, ayurvedic and yogic concept of Health Education, legal perspective of Health and Health Education in India.

UNIT – II: Health Education
- Concept, dimensions, and determinants of health with special to India.
- Psycho-social concerns of children and adolescents including differently able children.
- Impact of Physical activities, games, sports and yoga on different body systems.
- Food and nutrition, nutrients and their functions,

UNIT –III: Understanding Basic Concept of Anatomy and Physiolgy
- Understanding the anatomical and physiological functions of the human body
- Common health problems and diseases: causes, prevention and cure, immunization.
- First Aid: Need and importance of first aid in sports, Principles of first aid.
- Body Composition: Fat Free Mass Index, Body Mass Index, Somatotypes

UNIT – IV: Games and Fitness
- Physical fitness and its components: athletics (general physical fitness exercises), games (lead-up games, relays, and major games), Rhythmic activities, gymnastics, and their impact on health.
- Development of physical fitness: postures deformities, and basic corrective Exercise, Motor Development tests; Resources and services for games and sports and Health.
- Fundamentals skills of sports (Indoor & Outdoor Sports): Sports for recreation and competition; Sports awards and scholarships, Indigenous and self-defense activities.

UNIT – V: Sports Injuries and School Health Programmes
- Sports Injuries and their precautions in Sports, Acute and chronic Disease
- School and family, health services, policies and major health and physical education-related programmes, blood banks, role of media in sports.
- School Health Programme: school health services, health promoting schools, global school health initiatives.

UNIT VI: Policies, Programmes and Assessment
- Policies, programmes, and services for addressing health needs.
- Yoga: Meaning, initiation, historicity, classification, streams, and schools of yoga, Need and importance and role of yoga for healthy life and living, Yoga as a Psychotherapy.
- POCSO (Protection of Children from Sexual Offences Act, 2012), PWD 2016, the Integrated Child Protection Scheme.
- Assessment of health performance testing in games and sports, reporting of health condition and performance of child in the sport fields.

Suggestive Practicum

- Recognizing important indicators of health and wellbeing of children and mental health.
- Undertaking a survey, understanding local food related matters, and understanding the importance of the right to food.
- Analyzing NEP, 2020 with reference to Games Oriented Education.
- Planning activities for development of physical fitness.
- Organization of games and sports tournaments
- Learning and performing basic yogic activities, asanas, and pranayama, Kriyas and Meditation. Celebration of yoga day, yoga week.
- Preparation of inventories on myths on exercises and different types of food.
- Preparation of First Aid kit.
- A critical review of YOGA-SUTRA.
- Measuring body temperature, Heart rate, blood pressure, Pulse rate and resting Respiratory Rate.

Suggestive Mode of Transaction

The course content transaction will include the following:

- Planned lectures infused with multimedia /power-point presentations.
- Small group discussion, panel interactions, small theme-based seminars, group discussions, cooperative teaching and team teaching, selections from theoretical readings, case studies, analyses of educational statistics and personal field engagement with educationally marginalized communities and groups, through focus group discussion, surveys, short term project work etc.
- Hands on experience of engaging with diverse communities, children, and schools.

Suggestive Mode of Assessment

The assessment will be based on the tests and assignments.

Suggestive Reading Materials

- Teachers may suggest books/readings as per the need of the learners and learning content.
- Sharma, R. D. (1979). Health and physical education, Gupta Prakashan.
- Singh, S. (1979). Anatomy of physiology and health education. Ropar: Jeet Publications
- Fink H.H., Burgoon A. Lisa and Mikesky E. Alan : Practical Applications in Sports Nutrition, Jones and Bartlett Publishers, Inc. 2006
- Jeukendrup Asker (Ed.) : Sports Nutrition : From Lab to Kitchen, Meyer and Meyer Sport (UK) Ltd., 2010.
- Clark Nancy : Sports Nutrition Guidebook - Third Edition, Human Kinetics, 2003.
- Fink H.H., Burgoon A. Lisa and Mikesky E. Alan : Practical Applications in Sports Nutrition, Jones and Bartlett Publishers, Inc. 2006
- Nemir, A. (n.d.). The school health education. New York: Harber and Brothers.
- Physical and Health Education- Mr. V.D. Shamra & Granth Singh.
- Anderson, B., Stretch Yourself for Health & Fitness, Delhi: UBSPD, 2002.
- Saraswati S.S.(2008) Asana Pranayama & Mudra Bandha, Yoga publication Trust,Munger Bihar
- Shankar,G.(1998). Holistic approach of yoga. New Delhi:Aditya Publishers.
- IyengerB.K.S.(2017) Light on Yoga: The Definitive Guide to Yoga Practice. Harper Thorsons publisher.

AE&VAC- XI: Yoga and Understanding Self

Credits: 2
Contact Hours: 2 hrs per week
Maximum marks: 50
Internal: 20
External: 30

About the Course

This course focuses on the benefits of Yoga for healthy living and the importance of the practice of yoga for promoting the optimal state of physical, emotional, intellectual, social, and spiritual wellbeing of a person. Yoga as a way of life is characterized by peace and tranquillity, harmony and health, love and happiness, precision, and efficiency. The course seeks to engage student teachers with these ideas. The focus of the course is on being mindful of self (body, mind, emotions, thoughts, and actions). Course components will include brief history of yoga, principles and different types and streams of yoga, practices (Kriyas, Āsana, Prāṇāyāma, Bandha & mudra, Dhāraṇa&Dhyāna, etc), meditation and reflective practices, and the importance of these aspects in becoming an effective teacher. It lays equal weightage to the theory and practicum.

Learning Outcomes

After completion of the course, the student teachers will be able to

- explain the importance of Yoga and how it helps an individual in understanding Self,
- describe the importance of practicing Yoga Asana,
- practice basic Yoga Asanas/ Kriyas.

UNIT - I

Philosophy and Historical Perspective of Yoga

- Concept and Meaning of Yoga, Philosophy of Yoga,
- Brief history and development of Yoga (Classical Yoga, Post Classical Yoga and Modern Period)
- Importance of Yoga for healthy living, Yoga and its relevance in the modern times, Traditions in Yoga.

UNIT - II

Schools of Yoga

- Different streams \schools of Yoga (Gnana, Bhakthi, Karma).
- Construction of Yoga Practice for all round development.
- Principals of Yoga: - Ahimsa, Satya, Asteya, Brachmacharya, Aparigraha, Shoucha, Santhosha, Tapas, swadyaya and Isvara Paridhana.

UNIT - III

Modern Principles of Yoga and Meditation

- Modern Principles: Human Body is a holistic entity, Individuals and their need are Dhāraṇa&Dhyāna, etc, meditation and reflective practices, and the importance of these aspects in becoming an effective teacher, unique Self-empowering, the quality and state of an individual mind is crucial to healing.
- Meditation: - its Importance, Types, and Process, Pranayama: its importance, types and process, Yoga as a Way of life for Peace, Harmony, Health love and happiness.Yoga in Indian philosophy for understanding Self.

Suggestive Practicum

- Practice of Basic Yoga Asanas/ Kriyas.

Suggestive Mode of Transaction

- Reflective reading of different Yoga practicing Personalities, Learning by doing, Relaxation
- Techniques for imparting concentration**,** Understanding Self and personality development.

Suggestive Mode of Assessment

- Assessment of practicum; Assessment of practice of basic Yoga Asanas/ Kriyas; Assessment of Reflective level Readings.

Suggested Reading Materials

Teachers may suggest books/readings as per the need of the learners and learning content.

- Brown, F. Y. (2000). How to use yoga. Delhi: Sports Publication.
- Gharote, M. L. &Ganguly, H. (1988). Teaching methods for yogic practices. Lonawala: Kaixydahmoe Publishers. IyengerB.K.S.(2017) Light on Yoga: The Definitive Guide to Yoga Practice. Harper Thorsons publisher.
- Rajjan, S. M. (1985). Yoga strentheningofrelexation for sports man. New Delhi:Allied
- Saraswati S.S.(2008) Asana Pranayama & Mudra Bandha, Yoga publication Trust,Munger Bihar
- Shankar,G.(1998). Holistic approach of yoga. New Delhi:Aditya Publishers.
- Shekar,K. C. (2003). Yoga for health. Delhi: Khel Sahitya Kendra.

E-References:

- https://www.parmarth.org/yoga/yoga-definition/
- https://swamiyoga.in/book/
- https://www.india.com/travel/articles/top-9-yoga-centres-in-india-that-will-leave-you-feeling-refreshed-3237147/
- https://en.wikipedia.org/wiki/Asana
- https://www.yogaindailylife.org/system/en/bandhas
- https://en.wikipedia.org/wiki/Bandha_(yoga)

AE&VAC- XII: Citizenship Education, Sustainability, and Environmental Education

Credits: 2
Contact Hours: 2 hrs per week
Maximum Marks: 50

Internal: 20
External: 30

About the Course

This course seeks to orient student teachers to the Constitution of India with a particular emphasis on Fundamental Rights and Fundamental Duties, and to prepare them for their roles and responsibilities as responsible, productive, and effective citizens of India. The course also seeks to enable student teachers to understand the interconnected and interdependent world, India's rich heritage and philosophical foundation of "Vasudaiva Kutumbakam" (Whole world is one family), acquire the knowledge, capacities, values, and dispositions needed to understand global issues and become active promoters of more peaceful, harmonious and sustainable societies. The course also seeks to create among student teachers an awareness of responsible global citizenship required for responding to contemporary global challenges.

The sustainability aspect of the course seeks to develop among student teachers an understanding of the idea of 'Sustainability' in all fields of human activities, including achieving sustainable development in its three dimensions – economic, social, and environmental – in a balanced manner. The environmental education component of the course aims at creating an awareness among student teachers of environmental issues, including actions required for mitigating the effects of climate change, environmental degradation and pollution, and initiatives required for effective waste management, conservation of biological diversity, management of biological/natural resources, forest and wildlife conservation, and sustainable development and living. The course will also deepen the knowledge and understanding of India's environment in its totality, their interactive processes, and effects on the future quality of people's lives.

Learning Outcomes

After completion of the course, student teachers will be able to:

- explain the concept of citizenship and citizenship education,
- describe the aims of and approaches to citizenship education,
- explain the concept and aims of Global Citizenship and Global Citizenship Education,
- describe the aims of and approaches to global citizenship education,
- explain the concept of 'Sustainability' in all fields of human activities, and approaches to achieving sustainable development in its three dimensions – economic, social and environmental – in a balanced manner,
- demonstrate an awareness of environmental issues, and actions required for mitigating the effects of climate change, environmental degradation and pollution, and initiatives required for effective waste management, conservation of biological diversity, management of biological/natural resources, forest and wildlife conservation, and sustainable development and living.

UNIT – I: Citizenship Education

- Concept of citizenship and citizenship education.
- Aims of and approaches to citizenship education.
- Concept of Global Citizenship and Global Citizenship Education.
- Aims of and approaches to global citizenship education.
- Concept of *Vasudhaiva Kutumbakam*, its importance in development of a holistic perspective towards local and global communities.

UNIT – II: Sustainability

- Concept of 'Sustainability' in all fields of human activities.
- Approaches to achieving sustainable development in its three dimensions – economic, social, and environmental.
- Sustainable development goals.
- Sustainable management of natural resources.
- School- and community-based activities.
- Education for sustainable development

UNIT – III: Environmental Education

- Environmental issues.
- Actions required for mitigating the effects of climate change, reducing environmental degradation, pollution etc.
- Initiatives required for effective waste management, conservation of biological diversity, management of biological/natural resources, forest and wildlife conservation, and sustainable development and living.
- Approaches to delivering Environmental Education
- Role of Mass Media and Technology in delivering environmental education.
- Roles Governmental and Non-Governmental Organizations in promoting Environmental Education.
- School and community-based environmental education activities.

Suggestive Practicum

1. Write a report on the roles of governmental and non-governmental organizations in promoting Environmental Education.

Suggestive Mode of Transaction
Lecture-cum- discussion, Focus Group discussions, in-class seminars, Library Work, Assignments, Project Work, Lesson Plan Development, Interaction with different stakeholders, ICT based educational materials, Group Work, critical reflections, group-work, case-based approaches, and enquiry-based learning.

Suggestive Mode of Assessment
Assessment of practicum and assessment of reflective level readings.

Suggestive Reading Materials
Teachers may suggest books/readings as per the need of the learners and learning content.

SE- V: Post-Internship

Credits: 2
Contact Hours: One Week
Maximum marks: 50
Internal: 50

About the Course
After successful completion of internship programme in 7th semester, student teachers compile the learnings, discuss with peers about their experiences, reflect on the experiences, refine the artifacts developed during internship and prepare comprehensive internship report during post internship in 8th semester.

Learning Objectives
After completion of the activities, the student teachers will be able to:
- Develop comprehensive understanding of the school ecosystem,
- Describe their learning from internship with the peers and teacher educators,
- Reflect on school internship sharing learning experiences on each activity undertaken.

Suggestive Mode of Transaction
- Discussion
- Presentation, Gallery walks and Exhibition.
- Report Writing

Activities:
Experience Sharing and Reflective Learning
- Presentation of reflective journal summary
- My Learning Journey: by each student-teacher
- Gallery walks (Exhibition): TLMs, display of participation in school activities (photos/stories) and other artefacts created during the internship by student teachers.
- Sharing of best practices (PPTs, Videos.)
- Survey and collect the local stories and rhymes from the parents and community (in the context of the foundational stage)
- Holding a training workshop for the parents and community and encouraging them to act as volunteers.
- Awareness and advocacy programme in FLN for parents and community: Role play with parents and community on conducting specific FLN activities.
- Organizing a parents /community mela/fair on homemade TLM for FS children

Submission of Internship Report
- Reflective Journal
- Lesson Plans and TLMs
- Observation records (Teacher Educator, Mentor, school heads, Teachers, Parents)
- Assessment records and Student Portfolio
- Action research report/case study
- Comprehensive internship report.

Suggestive Mode of Assessment

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
Artefacts created during the internship. My Learning Journey	Exhibition & Presentation	Teacher-Educator	1	25
Comprehensive Internship Report	Review	Teacher-Educator	1	25

Learning Outcomes

The student teachers will be able to:

- Demonstrate/Exhibit/Manifest comprehensive understanding of the school ecosystem.
- Reflect on school internship experiences in a report.
- Share their learning from school internship with peers and teacher educators.

SE- VI: Creating Teaching Learning Material (TLM)/Work Experience

Credits: 2
Contact Hours: One Week
Maximum Marks: 50
Internal: 50

About the Course

Having developed an understanding of education's philosophical, sociological, and psychological perspectives and gained hands-on experiences from pre-internship school observation and internship phases, the student teachers have developed a comprehensive understanding of education. By utilizing these experiences and understanding, the Student teachers will be in a position to develop/create Teaching Learning Materials (in various forms, Programed Learning Materials, Educational videos, teachers' handbooks, flashcards, story books, toys, games, posters, collages, innovative lesson plans using different pedagogies, to mention a few) which in turn may be helpful to both the school students with whom he/she has interacted during school experiences and the student teachers. Schools provide a systematic teaching environment for the learners to acquire the knowledge, skills and attitude required to meet the varied aspirational needs and educational goals. Work experience fosters basic knowledge, skills and disposition among the students that prepare them to think of becoming skilled entrepreneurs. To orient the school students on work education, the student teachers need exposure to visit the local vocational artisans, crafts person and entrepreneurs and prepare learning resources to enhance their professional skills and competencies. Teaching Learning Materials of good quality with (i) innovations, (ii) the use of low-cost materials, (iii) local context and (iv) modern technology (for digital learning materials) will enhance students' engagement, interest, and practical learning.

Learning Objectives

After completion of the activities, the student teachers will be able to:

- Assess the need for Teaching Learning Materials and prepare innovative TLM,
- Develop an understanding of the importance of work experience and competencies of a local crafts person, artisans and entrepreneurs,

Suggestive Mode of transaction

- Workshop
- Group discussion
- Field visits and interaction
- Analysis of existing local-specific learning resources, toys
- Exhibition of TLM and presentation of reflective reports on the use of learning resources, including toys.

Content

- Understanding how students learn at different stages.
- Knowledge of toys and other TLMs from different parts of the countries
- Knowledge of relevant TLMs for specific groups of children- CWSN, kinesthetic learners, visual learners, auditory learners addressing individual differences.

Activities to be conducted.

The following are a few suggestive activities:

- Orientation workshop on work experience and development of learning resources
- Field visit for interaction with local artisans, craftspeople, and entrepreneurs.

- Observe Traditional work practices and their integration into Local Technologies and Ideas.
- Analysis of available local specific, indigenous learning resources, including toys and their use in the learning-teaching process
- Development of at least two low-cost learning resources as per the local contexts (foundational/preparatory/middle/secondary) and presentation/exhibition
- Prepare the manual of TLM highlighting the objectives that will be achieved by its use, the material used, the process of its development and its use during classroom transaction.

Mode of Assessment

Competence/Artifact	Method of assessment	Assessed By	Credits	Marks
TLM developed	Presentation/Exhibition	Teacher Educators (panel of three experts including an external expert)	1.5	35
Manual	Presentation	Teacher Educator	0.5	15

Outcomes

The student teachers will:

- Demonstrate the use of TLM for enhanced learning,
- Explain the importance of work experience and competencies of local crafts person.

CES: COMMUNITY ENGAGEMENT AND SERVICE

(This component is common to student teachers across Stage Specialization)

Credits: 2
Contact Hours: One Week
Maximum Marks: 50
Internal: 50

About the Course

The curricular component of 'community engagement and service' seeks to expose student teachers to the socio-economic issues in society and community-supported development activities so that classroom learnings can be supplemented by life experiences to generate solutions to real-life problems. This course is designed to develop insights into the functions of the community, enhance the ability of student teachers to enlist community support to and participation in school-related activities, make the community aware of the importance of education, issues associated with schooling, gender inequity, health & wellness of children, initiatives for supporting lifelong education etc. It aims at sensitizing the student teachers to initiate actions with the support of the community members to address the social, cultural and educational problems, and develop social leadership skills through community service. The component seeks to enable student teachers to be acquainted with various community development initiatives and organize activities such as *street plays*, *advocacy activities*, *door-to-door campaigns*, *and prabhat-pheris* etc. to mobilize community participation in development initiatives.

This curricular component envisages participation of student-teacher in activities undertaken under the National Service Scheme (NSS), New India Literacy Programme, Student the mentoring initiatives, etc. Some of the activities include: Survey of community resources for participation in different school activities, Study of the situation with regard to school dropout and the reason thereof (Stage wise); Survey of a specific settlement to study the socioeconomic and educational status; Survey of non-literates in a specific settlement, including identification of 4-5 non-literate adults who will be supported by student teachers to become literate; training of local youth in First-Aid and other relevant activities; assessment of the situation with regard to Health and wellness of children in a locality, creating awareness of the importance of sustainable development, making the community members aware of the importance of environmental protection, creating awareness of rainwater harvesting, mentoring school students with learning deficits, guidance and counselling to school students etc.

Learning Outcomes

On successful completion of the 'Community Engagement and Service' programme, the student-teacher should be able to:

- recognize the socio-economic issues in the community and identify initiatives that could help solve problems faced by the community,
- demonstrate an awareness of the functions of the community, and the measures required for enlisting community participation in school-related activities,
- undertake initiatives that are required to make the community aware of the importance of education, issues associated with schooling, gender inequity, health & wellness of children, illiteracy among youth and adults in the community etc.,

- suggest actions in collaboration with community members to address the social, cultural and educational problems in the community,
- organize activities such as *street plays, advocacy activities, door-to-door campaigns, and prabhat-pheris* etc. to mobilize community participation in development initiatives,
- demonstrate social leadership quality through community services,
- organize interactions between schools and local communities for generating solutions to problems such as dropout and learning deficits,
- facilitate partnerships between local communities to enhance participation of the community in school-related activities such as PTA meetings,
- recognize the fault lines of the society, such as casteism, social taboos and superstitions etc. and work towards bridging them to establish harmony in the society,
- demonstrate positive feelings towards the local community and appreciate traditional knowledge and practices,
- Recognize the values of public service and active citizenship.

Approach to curriculum transaction

The student teachers will be provided opportunities to have exposure to community life for ten days in total, two days in Preparation for Community Engagement & Service in the institution, seven days working with the community, and the last day in the institution for sharing their experiences and reflections. The activities may be conducted in groups or individually as appropriate.

Days 1-2: Preparation for community services (In the institution)

- Orientation of student teachers on Community Engagement & Services through discussion and group activities.
- Workshop for developing tools for different activities during the programme.

Days 3-9: Engagement with the community (Mandatory onsite stay with the community)

Students will be divided into smaller groups; they would participate in the planned activities with defined roles for seven days on a rotation basis. These activities include:

- participation of student teachers in activities undertaken under the National Service Scheme (NSS), New India Literacy Programme, Student mentoring initiatives, etc.
- Survey of community resources for supporting school activities.
- Study of the situation regarding school dropout and the reason thereof (Stage wise).
- Survey of specific settlement to assess the situation about non-literates in the settlement, including identification of 4-5 non-literate youth and adults who will be supported by student teachers to become literate,
- Training of local youth in First Aid and other relevant interventions,
- Assessment of the situation about Health and wellness of children in a locality,
- Creating awareness of the importance of sustainable development, and making the community members aware of the need to support initiatives to ensure environmental protection, creating awareness of rainwater harvesting, mentoring school students with learning deficits, guidance and counselling to school students etc.)
- Visit and interact with local artisans and craftsperson.

The above activities typically will include working with the community, collecting data, playing local games, community awareness programmes like nukkad natak, rallies, organizing and participating in the cultural programmes with the community members etc.

The student teachers shall conduct different pre-scheduled activities throughout the day. Morning sessions will be used for activities with the community and data collection. The afternoon session will be devoted to data analysis and preparation of the report, and participation in games & sports activities. Evening session will involve cultural activities with community members.

Day 10: Feedback session and Reflection **(:** In the Institution)

- Sharing experiences and discussion on activities carried out.
- Presentation and submission of report on the activities carried out.
- Evaluation of the activities by collecting feedback on the effectiveness of the campaign from the mentor and the students.
- Reflection of experience (individual/group) of organizing community service

Assessment components and weightage

- Involvement and active participation in activities relating to Community Engagement and Service: (Assessment method: Observation by teacher educator, teacher and community members); Weightage: 75%; Assessed by the teacher educator, teacher and community members),

- Group Report & Reflections: Method of assessment: Presentation by student teachers); Weightage: 25% (Assessed by Teacher Educator)

Suggestive Links

- Ministry of Education (2021).Vidyanjali: Guidelines for Promoting Community and Voluntary Participation for Enhancing Quality School Education, Government of India. https://vidyanjali.education.gov.in/assets/pdf/Final_Guidelines_Vidyanjali_%20December.pdf
- RIE Bhubaneswar (2020). Handbook on Field Engagement in Pre-service Teacher Education, Bhubaneswar, Regional Institute of Education.

DISCIPLINARY COURSES MINOR (DCM)

PHYSICS

Semester-I

DCM- I: Mechanics

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to

1. To solve problems on applications of Newton's laws of motion and finding the solution of a single particle under central force and system of particles
2. Solve problems of rigid and deformable bodies under gravitational, tensile and compressible force.
3. To understand Newtons's law of Gravitation and Kepler's law of planetary motion and generalise it to satellites.
4. To understand the principles of elasticity, basic equations of elasticity and solve two dimensional problems in Cartesian and polar coordinates
5. To understand the phenomena of relativity

Unit 1

Vectors: Vector algebra. Derivatives of a vector with respect to a parameter. Scalar and vector products of two, three and four vectors. Gradient, divergence and curl of vectors fields. Polar and Axial vectors.

Ordinary Differential Equations:1st order homogeneous differential equations, exact and non-exact differential equations, 2nd order homogeneous and non-homogenous differential equations with constant coefficients (Operator Method Only).

Unit 2

Laws of Motion: Review of Newton‟s Laws of motion. Dynamics of a system of particles. Concept of Centre of Mass, determination of center of mass for discrete and continuous systems having cylindrical and spherical symmetry (1-D, 2-D, 3-D objects).

Work and Energy:Motion of rocket.Work-Energy theorem for conservative forces. Force as a gradient of Potential Energy. Conservation of momentum and energy. Elastic and in-elastic Collisions.

Unit 3

Rotational Dynamics: Angular velocity, Angular momentum, Torque, Conservation of angular momentum, Moment of Inertia. Theorem of parallel and perpendicular axes (statements only). Calculation of Moment of Inertia of discrete and continuous objects (1- D, 2-D and 3-D). Kinetic energy of rotation. Motion involving both translation and rotation.

Gravitation: Newton‟s Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler‟s Laws (statements only). Satellite in circular orbit and applications. Geosynchronous orbits.

Unit 4

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions.Kinetic and Potential Energy, Total Energy and their time averages. Compound pendulum. Differential equations of damped oscillations and forced oscillations and their solution.

Unit 5

Special Theory of Relativity: Frames of reference. Gallilean Transformations. Inertial and Non-inertial frames. Outcomes of Michelson Morley‟s Experiment. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic transformation of velocity. Relativistic variation of mass. Mass-energy equivalence. Transformation of Energy and Momentum

Suggested Readings:

- University Physics.FW Sears, MW Zemansky & HD Young13/e, 1986.Addison-Wesley
- Mechanics Berkeley Physics course,v.1:Charles Kittel,et.al. 2007, Tata McGraw-Hill
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley

- Engineering Mechanics, Basudeb Bhattacharya, 2ndedn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Practicals
DCM- I: Mechanics

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

1. Measurements of length (or diameter) using Vernier calliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the motion of the spring and calculate (a) Spring constant and, (b) g.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique.
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille‟s method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flintand H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

Semester-III
DCM- II: WAVES AND OPTICS

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to
1. Explain the phenomena pertaining to the concept of waves, their relationship with various forms and wave propagation.
2. Explain formation of images and various defects of images.
3. Discuss the phenomena of interference, diffraction and polarization.
4. Design experiments to observe different optical phenomena and relate them with daily life.

Unit 1

Superposition of Two Collinear Harmonic oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit 2

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.
Sound: Sound waves, production and properties. Intensity and loudness of sound. Decibels. Intensity levels. General idea of musical notes and musical scale. Acoustics of buildings (General idea).

Unit 3

Wave Optics: Electromagnetic nature of light.Definition and Properties of wave front. Huygens Principle.
Interference: Division of amplitude and division of wavefront. Young‟s Double Slit experiment. Lloyd‟s Mirror and Fresnel‟s Biprism. Phase change on reflection: Stokes‟ treatment. Interference in Thin Films: parallel and wedge-shaped films. Newton‟s Rings: measurement of wavelength and refractive index.

Unit 4

Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Unit 5

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization (General idea).

Suggested Readings:

- Vibrations and Waves, A.P. French, 1 stEd., 2003, CRC press.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications
- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

Practicals

DCM- II: WAVES AND OPTICS

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

Learning Outcomes:

1. To investigate the motion of coupled oscillators
2.To determine the Frequency of an Electrically Maintained Tuning Fork by Melde‟sExperiment and to verify λ2 – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Refractive Index of the Material of a Prism using Sodium Light.
6. To determine Dispersive Power of the Material of a Prism using Mercury Light
7. To determine the value of Cauchy Constants.
8. To determine the Resolving Power of a Prism.
9. To determine wavelength of sodium light using Fresnel Biprism.
10. To determine wavelength of sodium light using Newton‟s Rings.
11. To determine the wavelength of Laser light using Diffraction of Single Slit.
12. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
13. To determine the Resolving Power of a Plane Diffraction Grating.
14. To determine the wavelength of laser light using diffraction grating.

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Semester-IV

DCM- III: THERMAL PHYSICS AND STATISTICAL MECHANICS

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes:

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

1. Acquaint themselves with the concept of ideal and real gas.
2. Describe historical development of laws of thermodynamics.
3. Appreciate the concept of probability.
4. Develop and understand the statistical basis of thermodynamics.
5. Explain the fundamental difference between classical and quantum statistics.

6. Appreciate the concept of indistinguish-ability of particles.
7. Understand Bose- Einstein and Fermi-Dirac Statistics.

Unit 1: Laws of Thermodynamics:
Thermodynamic description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, Conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General relation between C_P and C_V, Work done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law ogf thermodynamics, Entropy, Carnot's cycle & theorem, Entropy changes in reversible and irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit 2: Thermodynamical Potentials:
Free energy (Gibb's and Helmhotz), Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Peltier effect Clausius Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V, TdS equations.

Unit 3: Kinetic Theory of Gases:
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases.

Unit 4: Theory of Radiation:
Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law & Wien's displacement law from Planck's law.

Unit 5: Statistical Mechanics
Entropy and Thermodynamic Probability - Phase space - Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (Fermi Dirac and Bose Einstein statistics), Fermi-Dirac distribution law - Bose-Einstein distribution law - photon gas - comparison of three statistics.

Suggested Readings:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Searsand G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Practicals

DCM- III: THERMAL PHYSICS AND STATISTICAL MECHANICS (credit-3)

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 25

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 Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Semester-VI

DCM- IV: ELECTRICITY AND MAGNETISM

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: This course will enable the students to

- Understand the Concept of Electric Potential and Its Calculation
- Apply Gauss's Theorem to Analyze Electric Fields in Various Configurations
- Understand Dielectric Properties and Their Impact on Capacitors
- Analyze Capacitance Configurations and Energy Storage in Capacitors
- Understand Fundamental Concepts in Magnetostatics and Magnetic Fields
- Analyze Magnetic Fields Using Fundamental Laws and Properties
- Understand and Apply Maxwell's Equations in Electromagnetism
- Analyze Energy Aspects and Continuity of Current in Electromagnetic Systems
- Apply Maxwell's Equations to Analyze Electromagnetic Field Energy Density
- Understand the Characteristics of Electromagnetic Waves and Their Propagation
- Analyze the Propagation and Interaction of Electromagnetic Waves

Unit 1

Vector Analysis: Vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit 2

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit 3

Magnetism: Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. 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 4

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit 5

Introduction to Maxwell`s equations: Maxwell’s equations in differential form, Derivation of Maxwell’s equations, Maxwell’s equations in some particular cases. The wave equation, Plane electromagnetic wave in (i) free space, (ii) non conducting isotropic medium, (iii) non conducting anisotropic medium, conducting medium. Poynting theorem.

Suggested Readings:

- Vector analysis – Schaum’s Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2nd Edn., 2009, McGraw- Hill Education
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity & Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D. J. Griffiths, Introduction to Electrodynamics, 3rd Edn. , 1998, Benjamin Cummings.

Practicals

DCM- IV: ELECTRICITY AND MAGNETISM

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

1. Ballistic Galvanometer:
(i) Measurement of charge and current sensitivity
(ii) Measurement of CDR

(iii) Determine a high resistance by Leakage Method
(iv) To determine Self Inductance of a Coil by Rayleigh's Method.
2. To compare capacitances using DE 'Sauté's bridge.
3. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
4. To study the Characteristics of a Series RC Circuit.
5. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
6. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor
7. To determine a Low Resistance by Carey Foster's Bridge.
8. To verify the Thevenin and Norton theorems
9. To verify the Superposition, and Maximum Power Transfer Theorems
10. Current-voltage characteristics of unknown material by electrometer.

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

MATHEMATICS
SEMESTER – I
DCM – I: Algebra, Trigonometry and Ordinary Differential Equations

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- find eigenvalues and corresponding eigenvectors for a square matrix.
- solve problems in the subject of algebra
- Formulate Differential Equations for various Mathematical models.
- Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.

Unit- I

- Matrices- symmetric, skew symmetric, Hermitian and skew Hermitian matrices.
- Elementary operations on matrices, Inverse of a matrix. Linear independence of row and column matrices,
- Row rank, column rank and rank of a matrix, Equivalence of column and row ranks.

Unit- II

- Eigenvalues, eigenvectors and the characteristics equation of a matrix.
- Cayley Hamilton theorem and its use in finding inverse of a matrix.
- Applications of matrices to a system of linear (both homogeneous and non-homogeneous) equations.
- Theorems on consistency of a system of linear equations.

Unit- III

- Logarithm of a complex quantity
- Expansion of trigonometrical functions
- Gregory's series, summation of series

Unit- IV

- Order and Degree of differential equations.
- Equations of first order and first degree, separation of variables, Homogeneous equations.
- Linear equations and equations reducible to the linear form.
- Linear differential equations with constant coefficients.

Unit- V

- Exact differential equations. First order and higher degree equations solvable for p, x, y. Clairaut's form and singular solutions.
- Geometrical meaning of a differential equation. Orthogonal trajectories.
- Homogeneous linear ordinary differential equations.
- Linear differential equations of second order.
- Transformation of the equation by changing the dependent variable and independent variable.

Suggested Readings:

- S.L. Loney, Plane Trigonometry Part II, Mc Millan & Co.
- Dickson, Leonard Eugene (1922). *First Course in The Theory of Equations*. John Wiley & Sons, Inc. New York. The Project Gutenberg E-Book.
- Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
- Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
- Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India

Practical

DCM – I: Algebra, Trigonometry and Ordinary Differential Equations

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:
The learner will be able to-

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEMESTER – III

DCM – II: Partial Differential Equation, Vector Calculus and Mechanics

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods; andapply these methods in solving some physical problems.

Unit- I

- Partial differential equations of the first order.
- Lagrange's method, Standard forms- I, II, III and IV. Charpit` method.

Unit- II

- Partial differential equations of second and higher orders.
- Classification of linear partial differential equations of second order. Homogenous and non-homogenous equations with constant coefficients.
- Partial differential equations reducible to equations with constant coefficients. Monge's methods.

Unit- III

- Scalar and vector product of three vectors, Product of four vectors,
- Reciprocal Vectors. Vector differentiation,
- Gradient, divergence and curl.

Unit- IV

- Catenary
- Stable and unstable equilibrium

Unit- V

Motion in a resisting medium.

Suggested Readings:

- Myint-U, Tyn & Debnath, Lokenath. (2007). *Linear Partial Differential Equation forScientists and Engineers* (4th ed.). Springer, Third Indian Reprint, 2013.
- Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, DoverPublications. Indian Reprint.
- Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introduction with Mathematica and MAPLE* (2nd ed.). World Scientific.
- S.L. Loney, Statics, Mc Millan & Co
- S.L. Loney, Dynamics, Mc Millan & Co

Practical

DCM – II: Partial Differential Equation, Vector calculus and Mechanics

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:
The learner will be able to:

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEMESTER – IV

DCM – III: Group and Ring Theory

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:

- Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc;
- Link the fundamental concepts of Groups and symmetrical figures;
- Analyze the subgroups of cyclic groups;
- Explain the significance of the notion of cosets, normal subgroups, and factor groups.
- The fundamental concept of Rings, Fields, subrings, integral domains and thecorresponding morphisms.
- Appreciate the significance of unique factorization in rings and integral domains.

Unit- I

- Group: Definition, examples, properties of groups.
- Subgroup: Definition, examples, algebra of subgroups, Centralizer, Normalizer, Center of a group.
- Order of a group. Order of an element of a group.
- Cyclic group: Definition, examples and properties. Classification of subgroups of cyclic groups, Generator of cyclic groups.

Unit- II

- Coset decomposition, Lagrange's theorem and its consequences.
- Fermat's and Euler's theorems.

Unit- III

- Homomorphism, Automorphisms and inner automorphism, Isomorphism and their computations.
- Normal-subgroups, Quotient groups.
- Conjugacy relation, Counting principle and the Class equation of a finite group.
- Fundamental theorem of Homomorphism.

Unit- IV

- Ring: Definition and examples and its properties.
- Subring: Definition and examples and its properties.
- Characteristics of rings.

Unit- V

- Ideals, Ideal generated by a subset of a ring, Factor rings. Operations on ideals, Prime and maximal ideals.

- Integral domains and fields: Definition and examples and its properties.

Suggested Readings:

- Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th ed.). CengageLearning India Private Limited, Delhi. Fourth impression, 2015.
- I.N. Heirstein, Topics in Algebra wiley Eastern limited
- John B Fraleigh, A First Course in Abstract Algebra,Pearson
- Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.

Practical

DCM – III: Group and Ring Theory

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25

Learning Outcomes:

The learner will be able to:
- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

SEMESTER – VI

DCM-IV: Linear Algebra and Real Analysis

Credits: 4 (3+1)
Contact Hours: 5 hours per week (Theory: 3 hrs.+ Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
External: 60
Practical (Internal): 25

Learning Outcomes: This course will enable the students to:
- Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms offunctions from $\mathbb{N}$ to a subset of
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and tocalculate their limit superior, limit inferior, and the limit of a bounded sequence.
- Apply the ratio, root, alternating series and limit comparison tests for convergence andabsolute convergence of an infinite series of real numbers.

Unit- I
- Vector Spaces: Definition, examples and its properties, Subspaces, Algebra of subspaces.
- Linear sum and Direct sum of subspaces. Linear span. Linear dependence, independence and their properties.
- Basis, Dimension of Vector spaces. Existence and Extension theorem for basis.

Unit- II
- Existence of complementary subspace of a subspace of a finite dimensional Vector space.
- Quotient spaces, Fundamental Theorem of Vector Spaces.

Unit- III
- Linear transformations and their representation as matrices.
- The Algebra of linear transformations. Rank-Nullity theorem.
- Change of basis, Dual space, Bidual spaces.
- Adjoint of a linear transformation.

Unit- IV

- Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number.
- Bounded above and bounded below sets, Supremum and Infimum of a nonempty subset of $\mathbb{R}$.
- Countable and Uncountable set
- Completeness property of $\mathbb{R}$, Archimedean property of $\mathbb{R}$, Definition and types of intervals, Nested intervals and its properties.
- Neighborhood of a point in Open and closed sets in $\mathbb{R}$, Conceptof cluster points and Bolzano-Weierstrass theorem, Density of rational numbers.

Unit- V

- Sequences, Theorems on limits of sequences. Bounded and monotonic sequences., limit superior and limit inferior.
- Convergence and Divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence.
- Series of positive terms, Integral test, Comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Alternating series, Leibniz test, Absolute and conditional convergence.

Suggested Readings:

- I.N. Heirstein Topics in Algebra Wiley Eastern
- Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). *LinearAlgebra* (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.
- Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis
- (4th ed.). Wiley India Edition. New Delhi
- Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
- Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
- Ross, Kenneth A. (2013). *Elementary Analysis*: *The theory of calculus* (2nd ed.).Undergraduate Texts in Mathematics, Springer. Indian Reprint.
- Thomson, Brian S., Bruckner, Andrew. M., & Bruckner, Judith B. (2001). *ElementaryReal Analysis.* Prentice Hall

Practical

DCM- IV: Linear Algebra and Real Analysis

Credit: 1
Contact Hours: 2 hrs.
Max. Marks: 25
Internal: 25
Learning Outcomes:

The learner will be able to:

- verify the concept in paper by using Mathematical software or computer programming languages.
- connect basic concepts of paper with new ideas.
- increase their skills of analysis and problem solving using Mathematical software or computer programming languages.
- visualize some important theorems and concepts of the paper using Mathematical software or computer programming languages.
- use various applications of paper with daily life problems.

CHEMISTRY

Semester- I

DCM- I: Inorganic Chemistry-I and Organic Chemistry-I

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing this course the students will be able to:

1. know the basic knowledge of quantum chemistry and will gain the wave mechanical significance of quantum number.
2. develop the skill of calculating lattice energy using Born-Haber cycle and other methods.

3. draw molecular orbital diagram of homonuclear and heteronuclear molecules and also molecular structure corresponding to various hybridization.
4. gain fundamental knowledge of electron displacement around carbon-carbon bond and confirmation of ethane, butane and cyclohexane.
5. get deeper insight of the chemistry of alkanes, alkenes, alkynes and aromatic hydrocarbons.
6. learn the technique of volumetric analysis and purification and separation of organic compounds.

Note: Both Sections Carries equal weightage.

Section-A

Atomic Structure, Bonding

Atomic Structure: Review of: Bohr's theory and its limitations, Heisenberg Uncertainty principle.

Dual behaviour of matter and radiation, de-Broglie's relation. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy (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: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O, NH_3, PCl_5, SF_6, ClF_3, SF_4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of 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^+.

Section-B

Fundamentals of Organic Chemistry

Electronic

Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Reaction intermediates: Carbocations, Carbanions and free radicals. Electrophiles and nucleophiles Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations physical property & chemical reactions) to be studied with mechanism in context to their structure.

Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) andtrans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds

Aromatic hydrocarbons

Preparation (benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (benzene): Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.

Suggested Readings:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.17
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand
- Atkins, Overton, Rourke, Weller, Armstrong, Shriver and Atkins Inorganic Chemistry, Oxford

Practicals
DCM- I

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Organic Chemistry

1. Purification of OC by crystallisation (from water and alcohol) and distillation.
2. Criteria of purity: Determination of Mpt/Bpt
3. Detection of extra elements (N, S, Cl, Br, I) in organic compounds
4. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Suggested Readings:

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

Semester- III
DCM- II: Physical Chemistry-I & Organic Chemistry-II

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing this course the students will be able to:

1. know the details of thermochemical calculation of standard enthalpies of formation, bond energy and resonance energy.
2. calculate absolute entropy using third law of thermodynamics.
3. utilize principles of thermodynamics to derive the law of chemical equilibrium and equilibrium constant.
4. understand the importance of common ion effect in explaining various concepts like buffer solution, solubility product, ionization of acids and bases etc.
5. get detailed knowledge of the chemistry of alkyl and aryl halides
6. differentiate the reactivity of alcohols and phenols.
7. correlate the presence of carbonyl group with its reactivity with reference to aliphatic and aromatic aldehydes and ketones.
8. learn the technique of using calorimeter to determine enthalpy and analyzing and synthesizing organic compounds.

Note: Both Sections Carries equal weightage.

Section-A

Chemical Energetics, Equilibria

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and Go, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.
Ionic Equilibria:
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, 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. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section-B

Functional Organic Chemistry I

Alkyl and Aryl Halides Alkyl Halides.

Preparation: from alkenes and alcohols.

Reactions: Types of Nucleophilic Substitution (SN_1, SN_2 and SNi) reactions, hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic electrophilic and nucleophilic substitution (replacement by – OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions.

Alcohols, Phenols and Ethers

Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3), factors affecting acidity, Oppeneauer oxidation

Diols: oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. acidity and factors affecting Ethers (aliphatic and aromatic). Preparation : Williamson ether synthesis.

Reactions: Cleavage of ethers with HI Aldehydes and ketones (aliphatic and aromatic):

Preparation: from acid chlorides and from nitriles.

Reactions: Nucleophilic addition, Nucleophilic addition – elimination reaction including Reaction with HCN, ROH, $NaHSO_3$, NH_2NH_2 derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Suggested Readings:

- T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Practicals
DCM- II

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of H.

Ionic equilibriapH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Organic Chemistry

1. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

2. Systematic Qualititive organic analyses of organic compounds possessing monofunctional groups (Alcohals, Phenols, Carbonyl, -COOH) and preparation of one suitable derivative.

Reference Books:

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

Semester- IV
DCM- III: Physical Chemistry-II & Organic Chemistry-III

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15

Practicum: 25
External: 60

Learning Outcomes: After completing this course the students will be able to:

1. differentiate between ideal and non-ideal solution.
2. construct and analyze phase diagram of one component and two component systems.
3. learn the technique of determining the transport number of cations and anions.
4. carry out conductometric titration.
5. construct and analyze galvanic cells.
6. understand the details of chemistry of carboxylic acids and its derivatives.
7. differentiate between the chemistry of 1°, 2° and 3° amines.
8. determine critical solution temperature of some partially miscible liquids.
9. determine specific, equivalent and molar conductance.

Note: Both Sections Carries equal weightage.

Section-A

Solutions, Phase Equilibrium, Conductance, Electrochemistry &

Section A: Physical Chemistry-2

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase

Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-componentsystems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transport number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series.

Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section-B

Functional Group Organic Chemistry-II
Chemistry of Carbonyl Compounds - Preparation and properties of Aldehydes and Ketones, Nucleophilic addition reaction, Condensation reaction, Oxidation, Reduction, Aldole condensation and Cannizaro reaction.
Functional group approach for the following reactions (preparations Physical Property & Chemicals reactions) to be studied in context to their structure with machanism.
Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters.
Reactions: Hell – Vohlard - Zelinsky Reaction, Acidity of carboxylic acid, effect of substitution on acid strength.
Carboxylic acid derivatives (aliphatic):
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion claisen condensation .
Reactions: Relative reactivityes of acid derivatives towards nucleophiles, Reformatsky Reaction,
Perkin condensation.
Amines and Diazonium Salts
Amines (Aliphatic and Aromatic):
Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.
Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, reaction with HNO_2,
Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation basic character of amines. .
Reactions: conversion to benzene, phenol, dyes.
Amino Acids, Peptides and Proteins: Zwitterion, Isoelectric point and Electrophoresis
Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis.
Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu_2^+ ions, ninhydrin test.
Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.
Determination of Primary structure of Peptides by degradation Edmann degradation (N- terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C- activating groups and Merrifield solid-phase synthesis.

Suggested Readings:

- G. M. Barrow: Physical Chemistry Tata McGraw Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
- J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
- R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
- Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman

Practicals

DCM- III

Credit: 1
Contact Hours: 2 hrs per week
Max. Marks: 25
External: 25

Physical Chemistry

Distribution
Study of the equilibrium of one of the following reactions by the distribution method:
$I_2(aq) + I^-(aq)\ I_3^-(aq)$
$Cu_2+(aq) + xNH_2(aq)\ [Cu(NH_3)x]^{2}+$
Phase equilibria
a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
i. Strong acid vs. strong base
ii. Weak acid vs. strong base

Organic Chemistry

I. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (amide, nitro, amines, Hydrocorbans, Halo Hydrocorbans) and preparation of one derivative.
II. Determination of the concentration of glycine solution by formylation method

Suggested Readings:

- A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
- F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
- B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Semester-VI
DCM- IV: Inorganic Chemistry-II & Organic Chemistry-III

Credits: 4 (3+1)
Contact Hours: 5 hrs per week (Theory: 3hrs +Practicum: 2hrs)
Max. Marks: 100
Internal: 15
Practicum: 25
External: 60

Learning Outcomes: After completing this course the students will be able to:

1. differentiate between the chemistry of s, p and d block elements.
2. understand the reason behind the complex formation by transition elements.
3. know the details of valence bond and crystal field theory for coordination compounds.
4. know the need for real gas equation and technique to derive and analyze it.
5. differentiate between liquid and solid state on the basis of intermolecular force of attraction.
6. derive the expression for rate constant of first order reaction and learn experimental technique for its determination.
7. analyse inorganic mixture containing four radicals using qualitative inorganic analysis.
8. learn the technique to determine surface tension and viscosities by experimental method.

Note: Both Sections Carries equal weightage.

Section-A

Chemistry of s-, p- and d-Block Elements

s- and p-Block Elements Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Compounds of s- and p-Block Elements

Diborane and concept of multicentre bonding

Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial and environmental chemistry.

Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH) Oxoacids of P, S and Cl.

Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

Inorganic Chemistry: Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu
(coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series.

Section-B
Physical Chemistry-3

States of Matter & Chemical Kinetics

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.
Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics

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. Concept of activation energy and its calculation from Arrhenius equation.

Suggested Readings:

- G. M. Barrow: Physical Chemistry Tata McGraw Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
- J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
- F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.
- Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009 ISBN 978-81-31718858.

Practicals
DCM- IV

Credit: 1
Contact Hours: 2hrs per week
Max. Marks: 25
External: 60

Inorganic Chemistry

Qualitative analysis of mixtures using H_2S or any other scheme- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:
Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+},
Anions : CO_3^{2-}, S^{2-}, SO_3^{2-}, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_2^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$ F^-
(Spot tests should be carried out wherever feasible)

Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).
a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
b) Study of the variation of surface tension of a detergent solution with concentration.
(II) Viscosity measurement (use of organic solvents excluded).
a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
(III) Chemical Kinetics
Study the kinetics of the following reactions.
1. Initial rate method: Iodide-persulphate reaction

2. Integrated rate method:
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
c. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Suggested Readings:

- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

BOTANY
Semester I
DCM- I: Biodiversity of Microbes, Algae, Fungi, Bryophyta and Tracheophyta

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
To gain understanding of classification, structural and functional organization of viruses, bacteria, Algae, Bryophytes, Fungi, Pteridophytes and Gymnosperms.

Unit 1: Microbes and Algae
Viruses – Discovery, general structure, replication (general account), Economic importance.
Bacteria – Discovery, General characteristics and cell structure; Nutrition, Reproduction – vegetative, asexual and recombination-conjugation, transformation and transduction; Economic importance;
General characteristics, structure, reproduction and economic importance of Cyanobacteria.
General characteristics and structure of Mycoplasmas.
Algae- General characteristics; Classification of algae; Distribution; Morphology and life-cycles of the following: *Volvox, Oedogonium, Vaucheria, Sargassum, Polysiphonia*. Economic importance of algae.
Unit 2: Fungi
Introduction- General characteristics, Classification; Economic importance; Important features and life cycle of *Phytophthora, Mucor, Penicillium, Puccinia, Alternaria;* Symbiotic Associations-Lichens.
Unit 3: Bryophytes
General characteristics, Classification (up to family), Range of thallus organization. Important features in the life history of *Marchantia, Anthoceros* and *Funaria*.; Ecology and economic importance of bryophytes.
Unit 4: Pteridophytes
General characteristics, Classification; Ecological and economical importance of Pteridophytes.
Morphology, anatomy and reproduction of *Rhynia, Lycopodium, Selaginella, Equisetum and Pteris*., Heterospory and seed habit, stelar evolution, telome theory.
Unit 5: Gymnosperms
General characteristics, Ecological and economical importance, Classification, morphology, anatomy and reproduction of *Cycas, Pinus and Ephedra.*

Practicals
DCM- I: Biodiversity of Microbes, Algae, Fungi, Bryophyta and Tracheophyta
Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
2. Gram staining.
3. Study of vegetative and reproductive structures of *Volvox, Oedogonium, Vaucheria, Fucus* and *Polysiphonia* through temporary preparations and permanent slides. (Fucus - Specimen and permanent slides).
4. *Mucor* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
5. *Alternaria*: Specimens/photographs and tease mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus*.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).
9. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs).
10. *Marchantia*- morphology of thallus, W.M. rhizoids and scales, V.S. of thallus through gemma cup W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. of sporophyte (all permanent slides).
11. *Funaria*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridia and archegonial heads.
12. *Selaginella*- morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll (temporary slides), L.S. strobilus (permanent slide).
13. *Equisetum*- morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore, W.M. spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide)

14. *Pteris*- morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores (temporary slides), T.S. rhizome, W.M. prothallus with sex organs and young sporophyte (permanent slide).
15. *Cycas*- morphology (coralloid roots, bulbil, leaf), T.S. coralloid root, T.S. rachis, V.S. leaflet, V.S. microsporophyll, W.M. spores (temporary slides), L.S. ovule, T.S. root (permanent slide).
16. *Pinus*- morphology (long and dwarf shoots, W.M. dwarf shoot, male and female), W.M. dwarf shoot, T.S. needle, T.S. stem, L.S./T.S. male cone, W.M. microsporophyll, W.M. microspores (temporary slides), L.S. female cone, T.L.S. & R.L.S. stem (permanent slide).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Semester III

DCM- II: Taxonomy, Plant Ecology and Economic Botany

Credits: 4
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To provide understanding of origin, evolution and taxonomy of angiosperms and to familiarize the students with different locally available plants of some families

Unit 1: Introduction to plant taxonomy, Botanical nomenclature and hierarchy, and taxonomic evidences

Identification and Documentation: Understanding of Flora and Taxonomical Keys, Binominal system of plant nomenclature, ICBN rules of Botanical Nomenclature.
Herbarium, importance of herbaria and herbaria/botanical gardens of the world and India.
Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

Unit 2: Classification, Biometrics, numerical taxonomy and cladistics

Types of classification-artificial, natural and phylogenetic; Bentham and Hooker, Hutchinson.
Characters; variations; Operational Taxonomical Units (OTUs), character weighting and coding; phylogeny.

Unit 3: Plants and Environment: Environment and Ecological factors

Introduction to environment and ecology; Ecological factors: Biotic and abiotic factors, Edaphic factors, Adaptation of hydrophytes and xerophytes to water, Temperature, Light and Salinity, Adaptation of mesophytes to Temperature, Light and Salinity.

Unit 4: Plant communities, Ecosystem and Phytogeography

Concept of Population, community and its diversity, species; Ecad and Ecotype; Ecotone and edge effect; Succession; Processes and types, Climax community.
Structure; energy flow, trophic organization; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycles; Biogeographical zones of India; Endemism, Endangered and Extinct species, Biodiversity Hotspots.

Unit 5: Economic Botany

Economic importance of plants with special reference to some examples of Food plants, Fibers, Vegetable oils, Medicinal plants, Spices, Timbers, Biofuels.

Practicals

DCM- II: Taxonomy, Plant Ecology and Economic Botany

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25

External: 25

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes.
5. (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method.
7. Quantitative analysis of herbaceous vegetation in the college campus for frequency, density and abundance and comparison with Raunkiaer's frequency distribution law.
8. Description of plant specimen upto species level using taxonomic keys (any 2).
9. Plants and their uses in human welfare.

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8thedition.
3. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Semester IV

DCM- III: Cell Biology, Anatomy and Embryology

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To enable the students to have an understanding about structural and functional properties of cell and its components and their role in cell division of various stages of plant growth.

Unit 1: Structure and functions of cell organelles

Structure of plant cell and organelles: Golgi complex, cytoskeleton, ER, peroxisomes, vacuoles, plastids, mitochondria and ribosomes.

Cell envelopes: plasma membrane models, structure and functions of plasma membrane and cell wall.

Unit 2: Basic Genetics

Mendel's Laws, and deviations from Mendel's laws, Allelic and nonallelic interactions chromosomal theory of inheritance, linkage and crossing over, cytoplasmic inheritance.

Unit 3: Plant Anatomy and Secondary Growth

Root and shoot apical meristems; vascularization of primary shoots, monocots and dicots, branching patterns, Simple and complex tissues.

Structure of dicot and monocot root, stem and leaf diversity, shape and size),

Vascular cambium – structure and function, seasonal activity.

Secondary growth in root and stem, Wood - heartwood and sapwood).

Unit 4: Flower, Pollination and Fertilization

Structure and development of anther and pollen, Pollination mechanisms and adaptations.

Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac, Mechanism of Double fertilization.

Unit 5: Embryo, polyembryony, Apomixis, endosperm and seed structure and dispersal mechanism

Structure and functions of Dicot and monocot embryo.

Introduction to polyembryony and apomixis, Definition, causes, types and practical applications.

General account of Endosperm, Endosperm types, and Embryo- Endosperm relationship.

Seed-structure appendages and dispersal mechanisms.

Practicals
DCM- III: Cell Biology, Anatomy and Embryology

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Electron micrographs of cell organelles.
2. Study of meristems through permanent slides and photographs.
3. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs).
4. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
6. Leaf: Dicot and Monocot leaf (only Permanent slides).
7. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* leaf, stem).
8. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
9. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous /campylotropous.
10. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/ photographs).
11. Ultrastructure of mature egg apparatus cells through electron micrographs.
12. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
13. Dissection of embryo/endosperm from developing seeds.
14. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. Bhojwani, S.S. &Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Semester VI
DCM-IV: Plant Physiology and Metabolism

Credits: 4(3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

To study the biomolecules functions with reference to different physiological processes in various cells and tissues in the plant. To study the various metabolic pathways associated in the cell functional activities and cell signal propagation and reception mechanisms.

Unit 1: Plant-water relations and Mineral Nutrition

Importance of water, water potential and its components; diffusion and osmosis, stomata, Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Translocation of organic solutes and factors affecting translocation.

Essential elements, macro and micronutrients; Role and criteria of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 2: Photosynthesis

Photosynthetic Pigments, Photosynthesis: Photosystem I and II, reaction center, antenna molecules; Non cyclic and cyclic photophosphorylation, C_3 cycle, Electron transport and mechanism of ATP synthesis; C_4 and CAM pathways of carbon fixation.

Unit 3: Respiration

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate cycle, Oxidative Pentose Phosphate Pathway, Photorespiration.

Unit 4: Enzymes and Nitrogen metabolism

Structure and characteristics of enzymes; Classification of enzymes and Enzyme Commission Number; Mechanism of enzyme catalysis and enzyme inhibition.

Biological nitrogen fixation; nitrate and ammonia assimilation.

Unit 5: PGRs and Plant response to light and temperature
Discovery and physiological roles of auxins, gibberellins, cytokinin, ABA, ethylene and their mechanism of action. Photoperiodism, SDP, LDP, Day Neutral Plants; Phytochrome discovery and structure, red and far-red light responses on photomorphogenesis; Vernalization; senescence and abscission, seed dormancy and germination, biological clock.

Practical
DCM-IV: Plant Physiology and Metabolism

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and amylase and study the effect of pH, substrate and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.
9. Separation of pigments by paper chromatography and solvent method

Demonstration experiments
1. Bolting of plants using gibberellins.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5thEdition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley &Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual.Narosa Publishing House, New Delhi

ZOOLOGY
Semester I
DCM- I: ANIMAL DIVERSITY

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100

Internal: 15
Practical: 25
External: 60

Learning Outcomes
Unit 1: Protista to Pseudocoelomates
General characters and classification up to classes
Type study of *Paramecium, Obelia, Taenia solium*
Unit 2: Coelomates
General characters and classification up to classes
Type study of earthworm, starfish and prawn
Unit 3: Chordates
General characters and classification up to subclasses
Type study of Scolidon, Pigeon and rabbit
Unit 4: Comparative anatomy I
Comparative study of integuments, and girdles
Comparative study of heart
Unit 5: Comparative anatomy II
Comparative study of digestive system
Comparative study of urinogenital system

PRACTICALS
DCM- I: ANIMAL DIVERSITY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of the following specimens:
Amoeba, Euglena, Plasmodium, Paramecium, Sycon, and Obelia, Physalia, Aurelia, Tubipora, Taenia solium, Male and female Ascaris lumbricoides, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Julus, Periplaneta, Pila, Unio, Loligo, Sepia, Octopus, , Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Torpedo, Labeo, Exocoetus, Ichthyophis, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Naja, Crocodylus, Gavialis, Any two common birds from different orders, Bat, Funambulus, Loris
2. Study of the following permanent slides:
   T.S. and L.S. of Sycon, Study of life history stages of Taenia,
3. Key for Identification of poisonous and non-poisonous snakes
   An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.
4. Study of Osteology :

a) Disarticulated skeleton of fowl and rabbit
b) Carapace and plastron of turtle /tortoise
c) Mammalian skulls: One herbivorous and one carnivorous animal.

Suggested Readings:

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- 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
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

Semester III
DCM- II: BIOCHEMISTRY AND ANIMAL PHYSIOLOGY

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15

Practical: 25
External: 60

Learning Outcomes

Unit 1:
Structure and functions of Carbohydrates, Proteins, Lipids, Nucleic acids
Enzymes: Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation
Unit 2:
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain
Lipid Metabolism: Biosynthesis and β oxidation of palmitic acid
Protein metabolism: Transamination, Deamination and Urea Cycle
Unit 3:
Structure and function of kidney, ultrafiltration
Male and female reproductive system
Unit 4:
Digestion of carbohydrates, proteins, lipids
Composition of blood, blood groups, Rh factor
Physiology of respiration
Unit 5:
Conduction of nerve impulse
Endocrine system

PRACTICALS
BIOCHEMISTRY AND ANIMAL PHYSIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas,adrenal gland
3. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose,Fructose, Sucrose, Lactose)
4. Estimation of total protein in given solutions by Lowry's method.
5. Study of activity of salivary amylase under optimum conditions

Suggested Readings:

- Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XIIEdition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XIEdition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition,Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.HFreeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IVEdition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper'sIllustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

Semester IV
DCM- III: CYTOGENETICS AND MOLECULAR BIOLOGY

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes

Unit 1:
Structure and Functions of Plasma membrane, Endoplasmic Reticulum, Golgi Apparatus, Ribosomes, Mitochondria
Unit 2:
Structure of nucleus, structure, and composition of chromosomes
Mitosis, Meiosis, Cell cycle and its regulation
Unit 3:
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of GeneticInformation, Principles of Inheritance, Chromosome theory of inheritance
Unit 4:
Sex-linked inheritance, Sex Determination: Chromosomal mechanisms, dosage compensation, Linkage and crossing over Chromosomal Mutations: Gene mutations
Unit 5:
DNA Replication, transcription, translation
Regulation of gene expression

PRACTICALS
CYTOGENETICS AND MOLECULAR BIOLOGY

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

1. Study of mitochondria and Barr bodies
2. Study of cell division, mitosis and meiosis
3. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples
4. Study of Linkage, recombination, gene mapping using the data.
5. Study of Human Karyotypes (normal and abnormal).

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIIIEdition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wileyand Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X
- Edition. Benjamin Cummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin
- Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction toGenetic Analysis. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007).Evolution. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and BartlettPublishers
- Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin,Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Semester VI
DCM- IV: ECOLOGY AND EVOLUTION

Credits: 4 (3 + 1)
Contact Hours: 5 hours per week (Theory: 3 hrs. + Practical: 2 hrs.)
Max. Marks: 100
Internal: 15
Practical: 25
External: 60

Learning Outcomes
Unit 1:
Types of ecosystems, Food chain: terrestrial, aquatic, marine, forest, and grassland, Energy flow in ecosystem, Food web.

Unit 2:
Introduction to Evolutionary Theories: Lamarckism, Darwinism, Neo-Darwinism, Modern Synthetic Theory of Evolution.
Unit 3:
Species Concept: Biological species concept (Advantages and Limitations); Variation, Mutation, Genetic recombination, Speciation, Modes of speciation (Allopatric, Sympatric)
Unit 4:
Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics
Unit 5:
Population genetics: Hardy-Weinberg Law, Natural selection, Genetic Drift, Role of Migration and Mutation in changing allele frequencies.

PRACTICALS
DCM- IV: ECOLOGY AND EVOLUTION

Credit: 1
Contact Hours: 2 hours per week
Max. Marks: 25
External: 25

Study of fossil evidences from plaster cast models and pictures
1. Study of homology and analogy from suitable specimens/ pictures
2. Charts:
a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
b) Darwin's Finches with diagrams/ cut outs of beaks of different species
3. Visit to Natural History Museum and submission of report