Syllabus, Lesson Plan and Course outcome of Physics (Honours)

Semester-I

Course Code: BPHSCCHC101 Course Title: Mathematical Physics I
Course Type CC-1 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Calculus
Lectures: 21 Hours: 21

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). **(2 Lectures)**

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(13 Lectures)**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.
(6 Lectures)

Module-II Vector Calculus
Lectures: 33 Hours: 33

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields. **(5 Lectures)**

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(8 Lectures)**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **(14 Lectures)**

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(6 Lectures)**

Module-III Introduction to probability
Lectures: 6 Hours: 6

Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing. **(4 Lectures)**

Dirac Delta function and its properties
Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **(2 Lectures)**

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Module-IV Practical
Instructor: Dr. Sahazada Aziz
Class: 10 Hours: 20

Introduction and Overview
Computer architecture and organization, memory and Input/output devices

Basics of scientific computing
Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Errors and error Analysis
Truncation and round off errors, Absolute and relative errors, Floating point computations.

Introduction to programming in python
Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iteration, compound statements, indentation in python, the if-else-if-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object oriented programming.

Programs
Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search

Introduction to plotting graphs with Gnuplot
Basic 2D and 3D graph plotting, plotting functions and datafiles, fitting data using gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, Surface and contour plots, exporting plots.

Numerical Methods
1. Solution of Algebraic and Transcendental equations (Bisection, Newton-Raphson method)
2. Numerical differentiation (Forward and Backward difference formula)
3. Numerical Integration (Trapezoidal and Simpson rules)

Course Outcome

- Recapitulate calculus they have learned in higher-secondary level.
- Students will learn vector calculus and differential calculus: two of the most important skill one can have to solve real life problems. Vector calculus has direct applications in solving problems related to Mechanics, Electrostatics, Magnetostatics etc.
- Most of the problems of Engineering and Physics boil down to solving a diffrential equation subjected to initial or boundary conditions. In this course students will learn some basic methods of solving the equations.
- Students will learn to solve simple problems of probability and statistics which will help them to analyze large data.
- Learning Dirac-delta function will help understanding quantum mechanics better.
- Not all the problems are solved exactly using conventional methods-we have to take resort to resort to Numerical Methods then, to solve the problems numerically. In the practical sections students learn to solve such problems.
- Learning Programming language is a must for modern day professionals: in the practical section students learn the basics of PYTHON programming. Their basic computer skills are also bound to enhance through this.
- For data visualization they are acquainted with GNUPlot- a free software for graph plotting.
- In summary, learning Mathematical Physics I course will open the window of the whole science and technology to the students and enhance the mathematical and computational skill sets to a greater deal.

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Course Code: BPHSCCHC10 Course Title: Mechanics Course Type: CC-2 Credit: 6
Instructor: Mr. Ujjal Bid

Theory

Module-I: Fundamentals of Dynamics
Lectures/Class: 25 Hours: 25

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **(6 Lectures)**

Work and Energy
Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Qualitative study of one dimensional motion from potential energy curves. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. **(4 Lectures)**

Collisions
Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. **(3 Lectures)**

Rotational Dynamics
Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. **(12 Lectures)**

Module-II: Properties of Matter and Gravitation
Lectures/Class: 11 Hours: 14

Elasticity
Relation between Elastic constants. Twisting torque on a Cylinder or Wire. **(3 Lectures)**

Fluid Motion
Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **(2 Lectures)**

Gravitation and Central Force Motion
Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. **(3 Lectures)**
Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(6 Lectures)**

Module-III Oscillations and Non-Inertial Systems
Lectures/Class: 11 Hours: 11

Oscillations
SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(7 Lectures)**

Non-Inertial Systems:
Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. **(4 Lectures)**

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Module-IV Special Theory of Relativity
Lectures/Class: 10 Hours: 10

Special Theory of Relativity
Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Concept of zero rest mass of photon. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. (10 Lectures)

Module-V Practical
Lectures/Class: 10 Hours: 20

List of Practicals (at least six practicals)

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.

2. To study the random error in observations.

3. To determine the Moment of Inertia of a Cylinder.

4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

5. To determine the Young's Modulus of a Wire by Flexural/ Optical Lever Method.

6. To determine the value of g using Kater's Pendulum.

7. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

8. To determine the elastic Constants of a wire by Searle's method.

9. To study the Motion of Spring and calculate, (a) Spring constant, (b) g and (c) Modulus of rigidity.

Course Outcome

The students would learn about the behaviour of physical bodies it provides the basic concepts related to the motion of all the objects around us in our daily life. They will also learn about various properties of matter which are used in our everyday life, like viscosity, surface-tension and elasticity. The course builds a foundation of various applied field in science and technology; especially in our day-to-day life. The course comprises of the study vectors, laws of motion, momentum, energy, rotational motion, gravitation, fluids, elasticity and special relativity.

LAB: Students would perform basic experiments related to mechanics and also get familiar with various measuring instruments would learn the importance of accuracy of measurements.

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<u>**Semester-II**</u>

Course Code: BPHSCCHC201 Course Title: Electricity and Magnetism Course Type: CC-3 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Electrostatics
Lectures/Class: 30 Hours: 30

Electric Field and Electric Potential
Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.**(6 Lectures)**

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.**(6 Lectures)**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Uniqueness theorem (statement). Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. **(10 Lectures)**

Dielectric Properties of Matter
Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. **(8 Lectures)**

Module-II Magnetostatics and Electromagnetic Induction
Lectures/Class: 21 Hours: 21

Magnetic Field
Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole).
(5 Lectures)

Ampere's Circuital Law and its application to (1) infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid. Properties of B: curl and divergence. Axial vector property of B and its consequences. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.
(5 Lectures)

Magnetic Properties of Matter
Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis.
(4 Lectures)

Electromagnetic Induction
Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.
(7 Lectures)

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Module-III Electric Circuits
Lectures/Class: 9 Hours: 9

Electrical Circuits

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.
(5 Lectures)

Network theorems

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.
(4 Lectures)

Module-IV Practical
Lectures/Class: 10 Hours: 20
Electrical Circuits

General topic

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

List of Practicals (at least 6)

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To determine the resistance of a galvanometer by half deflection method.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
8. To determine self-inductance of a coil by Anderson's bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonantfrequency and (b) Quality factor Q.

<u>Course Outcome</u>

- In this course students understand one of the four fundamentals and most commonly felt force of nature and its manifestations: electrostatics, magnetostatics, electricity and magnetism.
- They learn the origin of electric and magnetic field and potentials. The course also teach them to solve real life problems involving charge and currents. These have direct bearings to technology.
- Students learn that changing electric field produces magnetic field and vice-versa. These principles used in most of the electrical equipment and machines starting with fans, motors to turbines, electrical engines etc.
- Students learn to work with both DC and AC currents and their circuits.
- All the factories, Research labs, Defense labs, Large and Small engines, communications have electrical and magnetic components; These course help the students to acquire the skills and basic working knowledge to handle those equipment.
- The practicals performed in the departmental laboratory equip them to handle more complicated and heavy electrical set ups of the real world and also help them to understand the theories they learn in the classroom.

Course Code: BPHSCCHC202 Course Title: Waves and Optics Course Type: CC-3 Credit: 6
Course Instructor: Dr. Soumendra Nath Ruz
Total class allotted: 70 Total Hours: 80

Module-I Oscillations and Waves
Lectures/Class: 25 Hours: 25

Superposition of Collinear Harmonic oscillations
Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). **(2 Lectures)**

Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **(2 Lectures)**

Superposition of two perpendicular Harmonic Oscillations
Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(3 Lectures)**

Wave Motion
Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. **(4 Lectures)**

Velocity of Waves
Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **(6 Lectures)**

Superposition of Two Harmonic Waves
Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. **(7 Lectures)**

Module-II Wave Optics
Lectures/Class: 36 Hours: 36

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **(3 Lectures)**

Interference
Division of amplitude and 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. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(9 Lectures)**

Interferometer
Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer. **(4 Lectures)**

Diffraction and Holography
Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) **(2 Lectures)**

Fraunhofer diffraction
Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **(8 Lectures)**

Fresnel Diffraction
Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. **(7 Lectures)**

Holography
Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms. **(3 Lectures)**

Module-III Practical
Lectures/Class: 10 Hours: 20

Practical
List of Practicals
1. To determine refractive index of the Material of a prism using sodium source.
2. To determine the wavelength of sodium source using Michelson's interferometer.
3. Familiarization with: Schuster`s focusing; determination of angle of prism.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.
8. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda 2$ –T law.
9. To investigate the motion of coupled oscillators.
10. To study Lissajous Figures.

COURSE OUTCOME

The course comprises of the study of superposition of harmonic oscillations, waves motion (general), oscillators, sound, wave optics, interference, diffraction, polarization. The course is important for the students to make their career in various branches of science and engineering, especially in the field of photonic engineering.
LAB: The practical knowledge of wave motion doing experiments: Tuning fork, electric vibrations. They would also learn optical phenomena such as interference, diffraction and dispersion and do experiments related to optical devices: Prism, grating, spectrometers.

SEMESTER-III

Course Code: BPHSCCHC301 Course Title: Mathematical Physics-II Course Type: CC-5 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Fourier Series
Lectures/Class: 10 Hours: 10

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

Module-II Frobenius Method and Special Functions
Lectures/Class: 28 Hours: 28

Frobenius Method and Special Functions
Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality. **(24 Lectures)**

Some Special Integrals
Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(4 Lectures)**

Module-III Variational Calculus
Lectures/Class: 6 Hours: 6

Variational calculus in physics
Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangian fomulation. Euler’s equations of motion for simple systems: harmonics oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates. Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. Applications to simple systems. **(6 Lectures)**

Module-IV Partial Differential Equations
Lectures/Class: 14 Hours: 14

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

Module-IV Practical
Lectures/Class: 10 Hours: 20

Introduction to Numerical computation using numpy and scipy
Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Basic linear algebra using the linalg submodule. Introduction to online graph plotting using matplotlib. Introduction to the scipy module. Uses in optimization and solution of differential equations.

Solution of Ordinary Differential Equations (ODE), First order Differential equation (Runge-Kutta (RK) second and fourth order methods)

First order differential equation
► Radioactive decay

► Current in RC, LC circuits with DC source
► Newton's law of cooling
► Classical equations of motion
► Harmonic oscillator (no friction)
►Damped Harmonic oscillator a) Over damped b) Critical damped
►Oscillatory Motion
►Forced Harmonic oscillator
►Transient and Steady state solution
►Apply above to LCR circuits also

Partial differential equations
1. Wave equation
2. Heat equation
3. Poisson equation
4. Laplace equation

Second order differential equation Fixed difference method

Solution of Linear system of equations (Gauss elimination method and Gauss Seidal method)

1. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems
2. Solution of mesh equations of electric circuits (3 meshes)
3. Solution of coupled spring mass systems (3 masses)

COURSE OUTCOME

This course comprise some topics on mathematical physics-the topics are Fourier series, solution of differential eqaution by series solution method, Legendre and Bessel's polynomial, Beta and Gamma functions and variational calculus, After studying this course students will gain the mathematical skill to solve the problems related to wave motion, solution of longitudinal and transverse waves, solution of Schroedinger equation in Hydrogen atoms, kinetic theories etc. Variational calculus is the backbone of Lagrangian and Hamiltonian mechanics which is the most fundamental branch of physics.
In the practical section students learn to apply the numerical techniques and Python programming to solve problems of differential equtions.

Course Code: BPHSCCHC302 Course Title: Thermal Physics Course Type: CC-6 Credit: 6
Course Instructor: Dr. Soumendra Nath Ruz
Total class allotted: 70 Total Hours: 80

Module-I Introduction to Thermodynamics
Lectures/Class: 18 Hours: 18

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. **(8 Lectures)**

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of temperature and its Equivalence to Perfect Gas Scale. **(10 Lectures)**

Module-II Entropy and Thermodynamic Potential
Lectures/Class: 21 Hours: 21

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of

Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **(7 Lectures)**

Thermodynamic Potentials

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature, Magnetic Work. Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations. **(7 Lectures)**

Maxwell's Thermodynamic Relations

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van derWaal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **(7 Lectures)**

Module-III Kinetic Theory and Real Gases
Lectures/Class: 21 Hours: 21

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **(7 Lectures)**

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. **(4 Lectures)**

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling. **(10 Lectures)**

Module-III Practical
Lectures/Class: 10 Hours: 20

List of Practicals

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

COURSE OUTCOME

The course makes the students able to understand the basic physics of heat and temperature and their relation with energy, work, radiation and matter. The students also learn how laws of thermodynamics are used in a heat engine to transform heat into work. The course contains the study of laws of thermodynamics, thermodynamic description of systems, thermodynamic potentials, kinetic theory of gases, theory of radiation and statistical mechanics.

LAB: Students would gain practical knowledge about heat and radiation, thermodynamics, thermo emf, RTD etc. and perform various experiments.

Course Code: BPHSCCHC303 Course Title: Analog Systems and Applications Course Type: CC-7 Credit: 6
Course Instructor: Mr. Ujjal Bid
Total class allotted: 70 Total Hours: 80

Module-I Semiconductor Diodes
Lectures/Class: 16 Hours: 16

Semiconductor Diodes
P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. **(10 Lectures)**

Two-terminal Devices and their Applications
Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **(6 Lectures)**

Module-II BJT and FET
Lectures/Class: 10 Hours: 10

Bipolar Junction transistors
n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. **(8 Lectures)**

Field Effect transistors
Basic principle of operations only. **(2 Lectures)**

Module-III Amplifiers and Oscillators
Lectures/Class: 19 Hours: 19

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier. **(8 Lectures)**

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(3 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(4 Lectures)**

Sinusoidal Oscillators:
Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(4 Lectures)**

Module-IV Operational Amplifiers and Oscillator
Lectures/Class: 15 Hours: 15

Operational Amplifiers (Black Box approach):
Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **(4 Lectures)**

Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Weinbridge oscillator. Non-linear – (1) inverting and non-inverting comparators, (2) Schmidt triggers. **(8 Lectures)**

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) **(3 Lectures)**

Module-IV Practical
Class: 10 Hours: 20

List of Practicals (at least 6 experiments)

1. To study V-I characteristics of PN junction diode, and Light emitting diode.

2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.

3. To study the characteristics of a Bipolar Junction Transistor in CE configuration.

4. To design an inverting amplifier using Op-amp (741) for dc voltage of given gain

5. To design inverting amplifier using Op-amp (741) and study its frequency response

6. To design non-inverting amplifier using Op-amp (741) & study its frequency response

7. To add two dc voltages using Op-amp in inverting and non-inverting mode

8. To investigate the use of an op-amp as an Integrator.

9. To investigate the use of an op-amp as a Differentiator.

10. To study the various biasing configurations of BJT for normal class A operation.

11. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.

COURSE OUTCOME

At the end of this course, students will be able to
1. To analyze the BJT and MOS amplifiers.
2. To analyze the differential amplifiers.
3. To analyze negative feedback amplifiers.
4. To analyze the power amplifiers.

Course Code: BPHSCCHC305 Course Title: Renewable Energy and Energy harvesting Course Type: SEC-1 Credit: 2
Course Instructor: Dr. Soumendra Nath ruz
Total class allotted: 20 Total Hours: 20

Module-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. **(3 Lectures)**

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. **(6 Lectures)**

Wind Energy harvesting

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **(3 Lectures)**

Ocean Energy

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(3 Lectures)**
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(2 Lectures)**

Geothermal Energy

Geothermal Resources, Geothermal Technologies. (2 Lectures)

Hydro Energy

Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (2 Lectures)

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, Human power. (4 Lectures)

Electromagnetic Energy Harvesting

1. Linear generators, physics mathematical models, recent applications . (2 Lectures)

2. Carbon captured technologies, cell, batteries, power consumption (2 Lectures)

3. Environmental issues and Renewable sources of energy, sustainability. (1 Lectures)

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.

COURSE OUTCOME

This course helps the student to understand the concepts of energy sources and their technologies. To learn the environmental pollution and climate change. To understand the basic need of carbon free energy. Student will acquire enough knowledge about the renewable energy sources. To understand the different kinds of Energy sources to study the basis of solar energy, solar radiation measurement and applications of solar energy to learn the fundamental principles and theory of wind energy conversion system. To understand the biogas production from biomass and to study the additional alternate energy sources.

Semester-IV

Course Code: BPHSCCHC401 Course Title: Mathematical Physics III
Type: CC-8 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Complex Analysis
Lectures/Class: 30 Hours: 30

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, DeMoivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Module-II Integrals Transforms
Lectures/Class: 15 Hours: 15

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Module-III Matrices
Lectures/Class: 15 Hours: 15

Matrices
Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product. **(8 Lectures)**

Eigen-values and Eigenvectors
Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix. **(7 Lectures)**

Module-IV Practical
Class: 10 Hours: 20

List of Practicals

1. Solve differential equations:

2. Dirac Delta Function:

3. Fourier Series

4. Generation of Special functions using User defined functions (Generating and plotting Legendre Polynomials Generating and plotting Bessel function)

5. Frobenius method and Special functions: recursion relations.

6. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

7. (i) Evaluation of trigonometric functions e.g. sin θ, (ii) Given Bessel's function at N points find its value at an intermediate point. (iii) Complex analysis: Integrate 1/(x2+2) numerically and check with computer integration.

8. Compute the nth roots of unity for n = 2, 3, and 4.

9. Find the two square roots of −5+12j.

10. Integral transform: FFT of exp(-x2)

COURSE OUTCOME

This is a mathematical physics course that enhances the mathematical skill and analytical thinking of a student. The course comprises the techniques of solving problems of complex variable, matrices and Fourier transform. Techniques learnt here will be very useful to tackle real life problems, especially the problems of electricity, quantum mechanics, classical dynamics etc. In practicals students learn to apply the techniques of numerical methods and Python programming to solve various problems.

Course Code: BPHSCCHC402 Course Title: Elements of Modern Physics
Type: CC-9 Credit: 6
Course Instructor: Dr. Soumendranath Ruz
Total class allotted: 70 Total Hours: 80

Module-I Origin of Quantum Physics
Lectures/Class: 14 Hours: 14

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. (14 Lectures)

Module-II Uncertainty Principle and Schroedinger equation
Lectures/Class: 15 Hours: 15

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. **(5 Lectures)**

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(10 Lectures)**

Module-III Some simple quantum systems
Lectures/Class: 10 Hours: 10

One dimensional infinitely rigid box- energy eigenvalues and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier. (10 Lectures)

Module-IV Nuclear and laser Physics
Lectures/Class: 21 Hours: 21

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. **(6 Lectures)**

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay-energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation:

electron-positron pair creation by gamma photons in the vicinity of a nucleus. **(8 Lectures)**

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions). **(3 Lectures)**

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing. **(4 Lectures)**

Module-V Practical
Lectures/Class: 10 Hours: 20

List of Practicals (at least 6)

1. To determine the Planck's constant using LEDs of at least 4 different colours.

2. To determine the ionization potential of mercury.

3. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

4. To show the tunneling effect in tunnel diode using I-V characteristics.

5. To determine the wavelength of laser source using diffraction of single slit.

6. To determine the wavelength of laser source using diffraction of double slits.

7. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

COURSE OUTCOME

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

After getting exposure to this course, the following topics would be learnt:
Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics.
Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.
The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing The properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.
Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.

LAB: The students will get opportunity to measure Planck's constant, verify photoelectric effect, determine e/m of electron, Ionization potential of atoms, study emission and absorption line spectra. They will also find wavelength of Laser sources by single and Doubleslit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.

Course Code: BPHSCCHC403 Course Title: Digital Systems and Applications
Type: CC-10 Credit: 6
Course Instructor: Mr. Ujjal Bid
Total class allotted: 70 Total Hours: 80

Module-I IC and Digital Circuits
Lectures/Class: 14 Hours: 14

Integrated Circuits
Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs. **(6 Lectures)**

Digital Circuits
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **(8 Lectures)**

Module-II Boolean algebra
Lectures/Class: 10 Hours: 10

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Module-III Data processing circuits
Lectures/Class: 10 Hours: 30

Data processing circuits
Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(4 Lectures)**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(5 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **(8 Lectures)**

Timers
IC 555: block diagram, Operation and applications: Astable multivibrator and Monostable multivibrator. **(5 Lectures)**

Registers
Shift registers Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **(4 Lectures)**

Counters (4 bits)
Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **(4 Lectures)**

Module-IV Computer Organization
Lectures/Class: 6 Hours: 6

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Module-V Practical
Class: 10 Hours: 20

List of Practicals

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.

2. To test a Diode and Transistor using a Multimeter.

3. To design a switch (NOT gate) using a transistor.

4. To verify and design AND, OR, NOT and XOR gates using NAND gates.

5. To design a combinational logic system for a specified Truth Table.

6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.

8. Half Adder, Full Adder and 4-bit binary Adder.

9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.

11. To build JK Master-slave flip-flop using Flip-Flop ICs

12. To design a monostable multivibrator of given specifications using 555 Timer.

COURSE OUTCOME

After studying this course the students would gain enough knowledge
1. Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
2. To understand and examine the structure of various number systems and its application in digital design.
3. The ability to understand, analyze and design various combinational and sequential circuits.
4. Ability to identify basic requirements for a design application and propose a cost effective solution.
5. The ability to identify and prevent various hazards and timing problems in a digital design.
6. To develop skill to build, and troubleshoot digital circuits.

Course Code: BPHSSEHT405 Course Title: Computational Physics Skills
Type: SEC-2 Credit: 2
Course Instructor: Dr. Soumendranath Ruz
Total class allotted: 20 Total Hours: 20

Introduction
Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(3 Lectures)**

Scientific Programming
Some fundamental Linux Commands (Internal and External commands). **(2 Lectures)**

Basic elements of C programming:

UNIT-I (3 Lectures)

1. Fundamentals of C language: C character set-Identifiers and Keywords-Constants -Variables-Data types-Declarations of variables-Declaration of storage class-Defining symbolic constants- Assignment statement.

2. Operators: Arithmetic operators-Relational operators-Logic operators-Assignment operators- Increment and decrement operators-Conditional operators.

UNIT-II (8 Lectures)

3. Expressions and I/O Statements: Arithmetic expressions-Precedence of arithmetic operators-Type converters in expressions-Mathematical (Library) functions - Data input and output-The getchar and putchar functions-Scanf-Printf simple programs.

4. Control statements:If -Else statements -Switch statements - The operators - GO TO - While, Do - While, FOR statements - BREAK and CONTINUE statements.

UNIT-III (6 Lectures)

5. Arrays: One dimensional and two dimensional arrays - Initialization - Type declaration - Inputting and outputting of data for arrays - Programs of matrices addition, subtraction and multiplication

6. Structure, Disk I/O Statements, open a file, writing in a file, reading from a file

Visualization

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot. **(4 Lectures)**

Scientific word processing: Introduction to LaTeX

TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(4 Lectures)**

Hands on exercises

Write a program that reads an alphabet from keyboard and display in the reverse order.

Write a program for converting centigrade to Fahrenheit temperature and Fahrenheit temperature centigrade.

To print out all natural even/ odd numbers between given limits.

To find maximum, minimum and range of a given set of numbers.

Write a program for generation of even and odd numbers up to 100 using while, do-while and for loop.

To find a set of prime numbers and Fibonacci series.

Write a program to find the largest element in an array.

To compile a frequency distribution and evaluate mean, standard deviation etc.

To evaluate sum of finite series and the area under a curve.

Motion of a projectile using simulation and plot the output for visualization.

To write program to open a file and generate data for plotting using Gnuplot.

Plotting trajectory of a projectile projected horizontally.

Plotting trajectory of a projectile projected making an angle with the horizontally.

Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.

Motion of a projectile using simulation and plot the output for visualization.

Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.

Motion of particle in a central force field and plot the output for visualization.

To find the roots of a quadratic equation.

Write a program to solve the quadratic equation using Bisection method.

Write a program for integration of function using Trapezoidal rule.

Write a program for solving the differential equation using Simpson's 1/3 rule

COURSE OUTCOME

This course would introduce students with the basic knowledge of computers their applications in solving common and scientific problems, the course includes scientific programming languages, scientific word processing and graphical analysis.

Semester-V

Course Code: BPHSCCHC501 Course Title: Quantum Mechanics & Applications
Type: CC-11 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Basics of quantum Mechanics
Lectures/Class: 28 Hours: 28

Schrodinger Equation
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; Expectation values of position and momentum. Wave Function of a Free Particle. **(6 Lectures)**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. **(10 Lectures)**

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-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(12 Lectures)**

Module-II Quantum theory of hydrogen-like atoms
Lectures/Class: 10 Hours: 10

Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,shells.

Module-III Atoms in Electric & Magnetic Fields and Many electron atoms
Lectures/Class: 22 Hours: 22

Atoms in Electric & Magnetic Fields
Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(8 Lectures)**

Atoms in External Magnetic Fields
Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(4 Lectures)**

Many electron atoms
Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(10 Lectures)**

Module-IV Practicals
Class: 10 Hours: 20

Practical
1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom
2. Solve the s-wave radial Schrodinger equation for an atom
3. Solve the s-wave radial Schrodinger equation for a particle of mass m
4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule

COURSE OUTCOME

Quantum Mechanics is the most fundamental subject ever developed by humans. After learning the subject students will appreciate that all of the microscopic physics and many macroscopic phenomenon like magnetism, superconductivity can find its explanation to Quantum Mechanics. This course is a continuation to the earlier modern physics course. In this undergraduate course students learn the basics mathematics behind quantum theory and its application to Hydrogen atom problem-which is the only exactly solvable real problem. Apart from this, students learn the basic concept of spin of particles and many effects of electric and magnetic field on atoms, and lasly many electron atom and a little bit of atomic physics.

Course Code: BPHSCCHC502 Course Title: Solid State Physics
Type: CC-12 Credit: 6
Course Instructor: Mr. Ujjal Bid
Total class allotted: 70 Total Hours: 80

Module-I Crystal structure and lattice vibration
Lectures/Class: 22 Hours: 22

Crystal Structure
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis –Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **(12 Lectures)**

Elementary Lattice Dynamics
Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. 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. T3 law . (**10 Lectures)**

Module-II Magnetic, Dielectric and Ferroelectric properties
Lectures/Class: 22 Hours: 22

Magnetic Properties of Solids
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. **(8 Lectures)**

Dielectric Properties of Solids
Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. **(8 Lectures)**

Ferroelectric Properties of Solids
Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. **(6 Lectures)**

Module-III Electron states and Superconductivity
Lectures/Class: 16 Hours: 16

Electron States in Solids
Sommerfeld's free electron theory of metals. Free electron gas in three dimensions. Fermi energy, temperature, velocity, and momentum. Concepts of energy bands in solids: Periodic potential and Bloch theorem (proof not required). Qualitative discussion on Kronig-Penny model, energy band structure. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **(10 Lectures)**

Superconductivity
Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) **(6 Lectures)**

Module-IV Practicals
Class: 10 Hours: 20

List of Practical

1. To determine the Hall coefficient of a semiconductor sample.

2. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.

3. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.

4. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)

5. To measure the Dielectric Constant of a dielectric materials with frequency

COURSE OUTCOME

After completing this course the students should be able to
1. Understand the historic development of solid-state physics and how they explain specific heat of solids.
2. The details about the vibrations in the atomic chain and the applications of scattering experiments in solids.
3. 3. The details about the vibrations in the atomic chain and the applications of scattering experiments in solids.
4. 4. Summarize the details of band theory and the developments of semiconductor physics and bandgap engineering.
5. differentiate between different Lattice types and explain the concepts of reciprocal lattice and crystal diffraction.
6. predict electrical and thermal properties of solids and explain their origin.
7. explain the concept of energy bands and effect of the same on electrical properties.
8. explain superconductivity, its properties, important parameters related to possible applications.

Course Code: BPHSDSHT2 Course Title: Classical Dynamics
Type: DSE-1 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 75 Total Hours: 75

Module-I Classical Mechanics
Lectures/Class: 25 Hours: 25
Classical Mechanics of Point Particles:
Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields-motion in uniform electric field, magnetic field, gyro-radius and gyro-frequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities.

Recap of Lagrangian mechanics. Lagrange's undetermined multipliers, Lagrange's equation for non-holonomic systems, Virial theorem, Principle of mechanical similarity. Hamiltonian Mechanics, Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field-conservation of angular momentum and energy. Effective potential. The Laplace-Runge-Lenz vector.

Module-II Small Amplitude Oscillations
Lectures/Class: 10 Hours: 10

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Module-II Special Theory of Relativity
Lectures/Class: 30 Hours: 30

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Module-III Fluid Dynamics
Lectures/Class: 10 Hours: 10

Density and pressure in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

COURSE OUTCOME

The course deals with the fundamental principles of Physics and Technology.

- The students recapitulate the basic principles of mechanics
- learn how a charged particle moves in electric and magnetic field
- gain appreciable knowlede of small oscillations and motion of coupled system
- students acquire enough knowledge of Lagrangian and Hamiltonian mechanics to apply in other fields
- they get an ample exposure to special theory of relativity- one of the cornerstones of science and technology
- Students are introduced to Fluid dynamics.

Course Code: BPHSDSHT3 Course Title: Astronomy & Astrophysics
Type: DSE-2 Credit: 6
Course Instructor: Dr. Soumendranath Ruz
Total class allotted: 75 Total Hours: 75

Greek Astronomy, Astronomy in the Era of Copernicus, Tycho, Kepler, and Galileo; Kepler's Laws of Planetary Motion, Introduction to Electromagnetic Waves; Doppler Effect, Atomic Spectra spectra. **(5 Lectures)**

Basic concepts of positional astronomy:
Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Concept of Constellations. **(15 Lectures)**

Astronomical Scales:
Astronomical Distance, Mass and Time Scales, Brightness, Radiant Flux and Luminosity, Basic Parameters of Stars,

Stellar Radii, Masses of Stars, Stellar Temperature.
Measurement of Astronomical Quantities: Determination of Distance by Parallax Method; Distance Measurement using Cepheid Variables, Apparent and Absolute magnitude scale, Determination of Temperature and Radius of a star; Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation. **(10 Lectures)**

Astronomical techniques:
Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). **(5 Lectures)**

The sun:
Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Solar cycle.
The solar family: Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. **(10 Lectures)**

Stellar spectra and classification Structure:
Stellar Spectral Classification, Hertzsprung-Russell Diagram. Luminosity Classification.
Stellar structure: Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem, Sources of Stellar Energy, Nuclear Reactions in Stars, Modes of Energy Transport.
Star formation: Basic composition of Interstellar medium, Interstellar Gas, Formation of Protostar, Jeans criterion.
Stellar evolution and Nucleosynthesis: Cosmic Abundances, Stellar Nucleosynthesis, Evolution of Stars, Evolution to the Main Sequence, Difference between Jupiter and Sun, Evolution beyond the Main Sequence, Redgiant, Supernovae, Planetary Nebula.
Compact stars: Basic Familiarity with Compact Stars, Degenerate Pressure of Fermions, White Dwarfs and the Chandrasekhar Limit (qualitatively), Neutron Star (Detection of Neutron Star: Pulsars), Black Holes. **(15 Lectures)**

The milky way:
Basic Structure, size and Properties of the Milky Way (Bulges, Disks, Galactic Halo), Nature of Rotation of the Milky Way, Nature of the Spiral Arms, Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus, Rotation Curve of Galaxy and the Dark Matter.
Galaxies: Galaxy Morphology, Elliptical Galaxies. Spiral and Lenticular Galaxies, Clusters of Galaxies. **(15 lectures)**

COURSE OUTCOME

The Course would be helpful in understanding our composition and universe, the dynamics of stars including our solar system and radiation. This Course provides an opportunity to students to know about various experimental techniques astronomical observations; these include Detectors, Photometry and spectroscopic observational instruments, radio astronomical telescope, interferometer etc. Students would also learn about the Galactic system, extragalactic systems, cosmology and gravitation.
The knowledge of representation of very large and small distances and their practical units are introduced. The students gain knowledge of the different techniques to measure distance of a star and formulas for measuring distances. It is taught here that the sun is a controlled thermonuclear reactor with a variety of new physics that emerged out of the study of the light and neutron coming out of it. The sun has two faces one that exists for a few days/months and other that exist for millions of years. The use of quantum mechanics, nuclear physics and statistical mechanics are learned by them here.
It is shown here that they need Einstein’s General theory of Relativity for describing the phenomena of the universe and in the case of neutron stars and Black holes. They also learn how the universe originated in the past (Big Bang theory) and what are the different phases. The experimental tests upon which the cosmological theories are built up. The different cosmological parameters for understanding the observed universe

The students learn to solve problems to determine the surface temperature of a star in terms of the surface temperature of the sun if the luminosity of the star is determined. They determine the age of the universe, the density of an X-ray Pulsar from the knowledge of its time period of rotation, many features of the universe which are not understood by STR and Classical Mechanics, life history of a star, Galaxy, clusters and superclusters.

Semester-VI

Course Code: BPHSCCHC601 Course Title: Electro-magnetic Theory
Type: CC-13 Credit: 6
Course Instructor: Dr. Soumendra Nath Ruz
Total class allotted: 70 Total Hours: 80

Maxwell Equations
Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. **(12 Lectures)**

EM Wave Propagation in Unbounded Media
Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. **(9 Lectures)**

Dispersion: Equation of motion of an electron in a radiation field : Lorentz theory of dispersion - normal and anomalous; Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width. **(3 Lectures)**

EM Wave in Bounded Media
Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence) **(8 Lectures)**

Polarization of Electromagnetic Waves
Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light. **(12 Lectures)**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **(5 Lectures)**

Wave guides
Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.
(8 Lectures)

Optical Fibres
Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). **(3 Lectures)**

Practical

List of Practicals

1. To verify the law of Malus for plane polarized light.

2. To determine the specific rotation of sugar solution using Polarimeter.

3. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

4. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.

5. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.

6. To verify the Stefan`s law of radiation and to determine Stefan's constant.

COURSE OUTCOME

The study of electromagnetic theory provides basic foundation for the students to understand advanced courses of physics. The course involves the study of electromagnetic theory, Maxwell's equations and electromagnetic waves, radiations from moving charges, solar and stellar systems.

Course Code: BPHSCCHC602 Course Title: Statistical Mechanics
Type: CC-14 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 70 Total Hours: 80

Module-I Classical Statistical Mechanics
Lectures/Class: 18 Hours: 18

Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. Grand canonical ensemble and chemical potential.

Module-II Classical and Quantum Theory of Radiation
Lectures/Class: 15 Hours: 15

Classical Theory of Radiation
Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **(9 Lectures)**
Quantum Theory of Radiation
Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(6 Lectures)**

Module-III Bose-Einstein Statistics
Lectures/Class: 12 Hours: 12

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Module-IV Fermi-Dirac Statistics
Lectures/Class: 15 Hours: 15

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. (15 Lectures)

Module-V Practical
Lectures/Class: 10 Hours: 20

List of Practicals

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
b) Study of transient behavior of the system (approach to equilibrium)
c) Relationship of large N and the arrow of time
d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
e) Computation and study of mean molecular speed and its dependence on particle mass
f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function Z(ß) for examples of systems with a finite number of Single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:
a) Study of how Z(ß), average energy <E>, energy fluctuation 👎E, specific heat at constant volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b) Ratios of occupation numbers of various states for the systems considered above
c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures
a) Maxwell-Boltzmann distribution
b) Fermi-Dirac distribution
c) Bose-Einstein distribution

COURSE OUTCOME

Statistical mechanics is the physics behind the thermal science. Students learn classical and quantum statistical distribution of very large number of systems and their interactions. They learn BE and FD statistics which help them to understand the many natural phenomena occurred in nature, for example specific heat of gases, Black body radiation and CMB, physics of stars, nuclear models etc.

Course Code: BPHSDSHT4 Course Title: Nuclear and Particle Physics
Type: DSE-3 Credit: 6
Course Instructor: Dr. Sahazada Aziz
Total class allotted: 75 Total Hours: 75

Module-I Nuclear properties and Models
Lectures/Class: 22 Hours: 22

General Properties of Nuclei
Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, chargedensity (matter density), binding energy, average binding energy and its variation with massnumber, main features of binding energy versus mass number curve, N/A plot, angularmomentum, parity, magnetic moment, electric moments, nuclear excites states. **(10 Lectures)**

Nuclear Models

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.**(12 Lectures)**

Module-II Radioactivity, Nuclear reactions and Interaction of Nuclear Radiation with matter
Lectures/Class: 26 Hours: 26

Radioactivity decay

Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, Beta decay: energy kinematics for delay, positron emission, electron capture, neutrino hypothesis. Gamma decay: Gamma rays emission and kinematics, internal conversion. **(10 Lectures)**

Nuclear Reactions

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Interaction of Nuclear Radiation with matter

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.
(8 Lectures)

Module-III Detectors and Accelerators
Lectures/Class: 13 Hours: 13

Detector for Nuclear Radiations

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GMCounter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.**(8 Lectures)**

Particle Accelerators

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.**(5 Lectures)**
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Module-IV Particle physics
Lectures/Class: 14 Hours: 14

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Leptonnumber, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

COURSE OUTCOME

Nuclear and Particle physics deals with the most fundamental constituents of matter.
After learning and understanding the course students will able to know

- Basic nuclear properties and practical applications of quantum mechanics and statistical mechanics
- About the various nuclear models
- about nuclear force and strong interactions
- how radioactive decay happens and their applications-how sun emits energy etc.
- How the charged particles are accelerated and detected in laboratory
- Some working idea about the four fundamental interactions
- All the fundamental particles of the universe and an idea about their production, decay and interactions.

Course Code: BPHSDSHT5 Course Title: Communication Electronics
Type: DSE-4 Credit: 6
Course Instructor: Mr. Ujjal Bid
Total class allotted: 75 Total Hours: 75

Module-I Electronic communication and Analog Modulation
Lectures/Class: 20 Hours: 20

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 communicationsystem in India (TRAI). Electromagnetic communication spectrum, band designations and usage.Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio. **(8 Lectures)**
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. **(12 Lectures)**

Module-II Pulse Modulation
Lectures/Class: 20 Hours: 20
Analog Pulse Modulation
Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.**(10 Lectures)**

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), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK). **(10 Lectures)**

Module-II Communication
Lectures/Class: 20 Hours: 20

Satellite Communication– Introduction, need, Geosynchronous satellite orbits geostationarysatellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), pathloss, ground station, simplified block diagram of earth station. Uplink and downlink. **(10 Lectures)**
Mobile Telephony System
Basic concept of mobile communication, frequency bands used inmobile 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) **(10 Lectures)**

Module-IV Practical
Lectures/Class: 10 Hours: 20

List of Practicals

1. To design an Amplitude Modulator using Transistor.

2. To study Pulse Amplitude Modulation (PAM)

3. To study Pulse Width Modulation (PWM)

4. To study AM Transmitter and Receiver

5. To study FM Transmitter and Receiver

6. To study Time Division Multiplexing (TDM)

7. To study envelope detector for demodulation of AM signal

COURSE OUTCOME

At the end of this course Students will be able to

· 1.Design system components that meet the requirement of public safety and offer solutions to the societal and environmental concerns.

· 2.Apply research based knowledge to design and conduct experiments, analyze, synthesize and interpret the data pertaining to Electronics and Communication Engineering problems and arrive at valid conclusions.

· 3.Construct, choose and apply the techniques, resources and modern engineering tools required for Electronics and Communication Engineering applications.

· 4.Apply the contextual knowledge to assess societal, health, safety and cultural issues and endure the consequent responsibilities relevant to the professional practice.

· 5.Examine the impact of engineering solutions in global and environmental contexts and utilize the knowledge for sustained development.

· 6.Develop consciousness of professional, ethical and social responsibilities as experts in the field of Electronics and Communication.

· 7.Perform effectively as a member/leader

Teacher-in-Charge
Ramananda Centenary College
P.O. - Laulara, Dist.-Purulia

Syllabus and Course outcome of Chemistry

B.ScHons. (Sem I)

Title: Organic Chemistry I   **Course Code**: BCEMCCHC101

Bonding and Physical Properties (25L)

Valence Bond Theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp3, sp2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases).

Electronic displacements: inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ^*, π, π^*, n – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

General Treatment of Reaction Mechanism I (15L)

Mechanistic classification: ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.

Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilicbehavior of reactive intermediates (elementary idea).

Stereochemistry-I (20L)

Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

Concept of chirality and symmetry: symmetry elements and point groups (Cv, Cnh, Cnv, Cn, Dh, Dnh, Dnd, Dn, Sn(Cs,Ci); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; syn/anti nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- andE/ Z- isomerisms: Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

Practical

Separation

Based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/p-Toluidine; p-Nitrobenzoic acid/p- Aminobenzoic acid; p-Nitrotolune/p-Anisidine; etc.

Determination of boiling point

Determination of boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc. [Boiling point of the chosen organic compounds should preferably be less than 160°C]

Identification of a Pure Organic Compound

Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds:

formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene.

Course Outcome

After successful completion of course a Student should be able to:

- Understand the valence bond theory.
- Understand the basics of electronic displacements.
- Understand the concepts of a Molecular Orbital theory.
- Understand the physical properties of the organic compounds.

- Gain basic knowledge of stereochemistry of organic molecules.
- Know structure and bonding of compounds of carbon and factors that control their reactivity such as inductive effect, resonance, hyperconjugation etc.
- To understand experimentally how to determine the boiling points of organic liquid compounds and also learn experimentally about the separation of compounds from a solidbinary mixture by using common laboratory reagents

Title: Physical Chemistry I **Course Code**: BCEMCCHC102

Kinetic Theory and Gaseous state (24 L)

Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion

Maxwell’s distribution of speed and energy (without derivation): Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy $\geq \varepsilon$.

Real gas and virial equation: Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea)

Chemical Thermodynamics (18 L)

Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, H; relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence.

Thermochemistry: Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature.

Chemical kinetics (18 L)

Ratelaw, order and molecularity:

Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and nth order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order)

Role of T and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Practical

1. Determination of heat of neutralization of a strong acid by a strong base
2. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate
3. Study of kinetics of decomposition of H2O2
4. Determination of heat of solution of oxalic acid from solubility measurement

Course Outcome

After successful completion of course a Student should be able to:

- Understand the basic concept of kinetic theory of gases and know how tosolve numerical problems related to that topic.

- Understand rate laws, rate equations of different types of reactions,determine rate constant values, order of reactions, effect of temperature and otherfactors on reaction rate, homogenouscatalysis, catalytic effect on reaction rate,equations related to chemical catalysis.
- Study the kinetics of decomposition of H2O2, acid-catalyzed hydrolysis ofmethyl acetate, viscosity measurement of unknown liquids.
- Gain the knowledge about Zeroth and 1st law of thermodynamics and thermochemistry.

B.Sc Program (Sem I)

Title: Organic Chemistry I **Course Code**: BCEMCCRC101

Bonding and Physical Properties (25L)

Valence Bond Theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp3, sp2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases).

Electronic displacements: inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]-annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation.

General Treatment of Reaction Mechanism I (15L)

Mechanistic classification: ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea); electrophilicity and nucleophilicity in terms of FMO approach.

Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).

Stereochemistry-I (20L)

Bonding geometries of carbon compounds and representation of molecules: Tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.Concept of chirality and symmetry: symmetryelements and point groups (Cv, Cnh, Cnv, Cn, Dh, Dnh, Dnd, Dn, Sn(Cs,Ci); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).Relative and absolute configuration: D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; syn/anti nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- andE/ Z- isomerisms: Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates);

resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

Practical

Separation

Based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. NaHCO3, etc., of components of a binary solid mixture; purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/p-Toluidine; p-Nitrobenzoic acid/p- Aminobenzoic acid; p-Nitrotolune/p-Anisidine; etc.

Determination of boiling point

Determination of boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc. [Boiling point of the chosen organic compounds should preferably be less than 160°C]

Identification of a Pure Organic Compound

Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds:

formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Course Outcome

After successful completion of course a Student should be able to:

- Understand the valence bond theory.
- Understand the basics of electronic displacements.
- Understand the concepts of a Molecular Orbital theory.

- Understand the physical properties of the organiccopounds.
- Gain basic knowledge of stereochemistry of organic molecules.
- Know structure and bonding of compounds of carbon and factors that control their reactivity such as inductive effect, resonance, hyperconjugation etc.
- To understand experimentally how to determine the boiling points of organic liquid compounds and also learn experimentally about the separation of compounds from a solidbinary mixture by using common laboratory reagents

B.Sc Generic (Sem I)

Title: Atomic Structure, Chemical Periodicity, Acids

And Bases, Redox Reactions, General Organic

Chemistry & Aliphatic Hydrocarbons **Course Code**: BCEMGEHC7

Inorganic Chemistry (24L)

1. Atomic Structure

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many- electron atoms, Aufbau principle and its limitations.

2. Chemical Periodicity

Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

3. Acids and bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

4. Redox reactions

Balancing of equations by oxidation number and ion-electron method oxidimetry and reductimetry.

Organic Chemistry (36L)

1. Fundamentals of Organic Chemistry

Electronic displacements: inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

2. Stereochemistry

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

3. Nucleophilic Substitution and Elimination Reactions

Nucleophilic substitutions: SN1 and SN2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs substitution.

4. Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.

5. Alkanes: (up to 5 Carbons). Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: mechanism for free radical substitution: halogenation.

6. Alkenes: (up to 5 Carbons). Preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alkaline KMnO4) and trans- addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

7. Alkynes: (up to 5 Carbons). Preparation: acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

8. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Practical

Inorganic Chemistry

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

Qualitative Analysis of Single Solid Organic Compound(s)

1. Detection of special elements (N, Cl, and S) in organic compounds.
2. Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH)
3. Detection of functional groups: Aromatic-NO_2, Aromatic -NH_2, -COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

Experiments 1 to 3 with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.

Course Outcome

After successful completion of course a Student should be able to:

- Gain basic knowledge of stereochemistry of organic molecules.
- Know structure and bonding of compounds of carbon and factors that control their reactivity such as inductive effect, resonance, hyperconjugation etc.
- Gather an in-depth knowledge about atomic structure,
- Study in detail about modern periodic table, physical and chemical properties of the elements along a group or period, factors influences those properties, relativistic effects and inert pair effect..
- Understand the concepts of a redox reaction and acid base reactions.
- Study the Aliphatic Hydrocarbons alkanes, alkenes and alkynes, their preparations and reactions.

B.ScHons. (Sem II)

Title: Inorganic Chemistry I **Course Code**: BCEMCCHC201

Extra nuclear Structure of atom (20L)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. 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. 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 rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

Chemical periodicity (15L)

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred- Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

Acid-Base reactions (15L)

Acid-Base concept: Arrhenius concept, theory of solvent system (in H2O, NH3, SO2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-baseequilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

Redox Reactions and precipitation reactions (10L)

Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples)

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Practical

Acid and Base Titrations

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents.

Oxidation-Reduction Titrimetric

1. Estimation of Fe(II) using standardized $KMnO_4$ solution
2. Estimation of oxalic acid and sodium oxalate in a given mixture
3. Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.
4. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution
5. Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$.
6. Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$.

Course Outcome

After successful completion of course a Student should be able to:

- Gather an in-depth knowledge about atomic structure,
- Study in detail about modern periodic table, physical and chemical properties of the elements along a group or period, factors influences those properties, relativistic effects and inert pair effect..
- Understand the concepts of a redox reaction.

- Understand the acid base phenomenon and also study the HSAB concepts of acids and bases.
- Study the estimation of ions or salts by acid-base titration method andoxidation-reduction titration method.

Title: Organic Chemistry II **Course Code**: BCEMCCHC202

Stereochemistry II (22L)

1. Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls; related configurational descriptors (Ra/Sa and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect.

2. Concept of prostereoisomerism: prostereogenic centre; concept of (pro)n-chirality: topicity of ligands and faces (elementary idea); pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre.

3. Conformation: conformational nomenclature: eclipsed, staggered, gauche, syn and anti; dihedral angle, torsion angle; Klyne-Prelog terminology; P/M descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; butane gauche interaction; conformational analysis of ethane, propane, n-butane,

4. 2-methylbutane and 2,3-dimethylbutane; haloalkane, 1,2-dihaloalkanes and 1,2-diols (up to four carbons); 1,2-halohydrin; conformation of conjugated systems (s-cis and s-trans).

General Treatment of Reaction Mechanism II (22L)

1. Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions.
2. Concept of organic acids and bases: effect of structure, substituent and solvent on acidity and basicity; proton sponge; gas-phase acidity and basicity; comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid-baseequilibria.

3. Tautomerism: prototropy (keto-enol, nitro - aci-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enoltautomerism; application of thermodynamic principles in tautomericequilibria.

4. Reaction kinetics: rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (kH /kD); principle of microscopic reversibility; Hammond's postulate.

Substitution and Elimination Reactions (16L)

1. Free-radical substitution reaction: halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate.
2. Nucleophilic substitution reactions: substitution at sp3 centre: mechanisms (with evidence), relative rates &stereochemical features: SN1, SN2, SN2', SN1' (allylic rearrangement) and SNi; effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP; role of crown ethers and phase transfer catalysts; [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides].

3. Elimination reactions: E1, E2, E1cB and Ei (pyrolytic syn eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity; comparison between substitution and elimination; importance of Bredt's rule relating to the formation of C=C.

Practical

Organic Preparations

A. The following reactions are to be performed, noting the yield of the crude product:

1. Nitration of aromatic compounds

2. Condensation reactions
3. Hydrolysis of amides/imides/esters
4. Acetylation of phenols/aromatic amines
5. Benzoylation of phenols/aromatic amines
6. Side chain oxidation of aromatic compounds
7. Diazo coupling reactions of aromatic amines
8. Bromination of anilides using green approach (Bromate-Bromide method)
9. Redox reaction including solid-phase method
10. Green 'multi-component-coupling' reaction
11. Selective reduction of m-dinitrobenzene to m-nitroaniline

Students must also calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

B. Purification of the crude product is to be made by crystallisation from water/alcohol, crystallization after charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted.

Course Outcome

After successful completion of course a Student should be able to:

- Learn stereochemistry of chiral compounds arises due to presence ofstereo-axis; concept of prostereoisomerism and concept of conformations of stereoisomers.
- Understand the concept, types, reaction mechanism and examples of elimination, free-radical and nucleohilic substitution reactions.
- Learn experimentally how to synthesize, calculate the yield and determine the melting point of pure organic compounds in the laboratory.
- Understand reaction kinetics, reaction thermodynamics and tautomerism of organic compounds.

B.Sc Program (Sem II)

Title: Inorganic Chemistry I **Course Code**: BCEMCCRC201

Extra nuclear Structure of atom (20L)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. Wave mechanics: de Broglieequation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. 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 rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

Chemical periodicity (15L)

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred- Rochow's scales) and factors influencing these properties, group electronegativities. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

Acid-Base reactions (15L)

Acid-Base concept: Arrhenius concept, theory of solvent system (in H2O, NH3, SO2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

Redox Reactions and precipitation reactions (10L)

Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples)

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Practical

Acid and Base Titrations

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents.

Oxidation-Reduction Titrimetric

1. Estimation of Fe(II) using standardized KMnO4 solution
2. Estimation of oxalic acid and sodium oxalate in a given mixture
3. Estimation of Fe(II) and Fe(III) in a given mixture using K2Cr2O7 solution.
4. Estimation of Fe(III) and Mn(II) in a mixture using standardized KMnO4 solution
5. Estimation of Fe(III) and Cu(II) in a mixture using K2Cr2O7.
6. Estimation of Fe(III) and Cr(III) in a mixture using K2Cr2O7.

Course Outcome

After successful completion of course a Student should be able to:

- Understand Gather an in-depth knowledge about atomic structure,
- Study in detail about modern periodic table, physical and chemical properties of the elements along a group or period, factors influences those properties, relativistic effects and inert pair effect..
- Understand the concepts of a redox reaction.
- Understand the acid base phenomenon and also study the HSAB concepts of acids and bases.

- Study the estimation of ions or salts by acid-base titration method andoxidation-reduction titration method.

B.Sc Generic (Sem II)

Title: States of Matter & Chemical Kinetics,

Chemical Bonding & Molecular Structure,

P- Block Elements **Course Code**: BCEMGEHC7A

Physical Chemistry

1. Kinetic Theory of Gases and Real gases (16L)

a. Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion

b. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

c. Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states

d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

2. Liquids (6L)

a. Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

3. Solids (8L)

a. Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

4. Chemical Kinetics (10L)

a. Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions

b. Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision theory; Lindemann theory of unimolecular reaction; outline of
Transition State theory (classical treatment)

Organic Chemistry

1. Chemical Bonding and Molecular Structure (15L)

a. 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, 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.

b. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear,trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

c.Concept of resonance and resonating structures in various inorganic and organic compounds.

d.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^+. Comparison of VB and MO approaches.

2.Comparative study of p-block elements (5L)

a.Group trends in electronic configuration, modification of pure elements,common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

i. B-Al-Ga-In-Tl

ii. C-Si-Ge-Sn-Pb

iii. N-P-As-Sb-Bi

iv. O-S-Se-Te

v. F-Cl-Br-I

Practical

Physical Chemistry

1. 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

2. 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

3. Study the kinetics of the following reactions

a. Initial rate method: Iodide-persulphate reaction b. Integrated rate method:

i. Acid hydrolysis of methyl acetate with hydrochloric acid

ii. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Inorganic Chemistry

Qualitative semi-micro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Acid Radicals: Cl-, Br-, I-, NO2-, NO3-, S2-, SO42-, PO43-, BO33-, H3BO3.

Basic Radicals: Na+, K+, Ca2+, Sr2+, Ba2+, Cr3+, Mn2+, Fe3+, Ni2+, Cu2+, NH4+.

Course Outcome

After successful completion of course a Student should be able to:

- Understand the basic concept of kinetic theory of gases and know how to solve numerical problems related to that topic.
- Understand rate laws, rate equations of different types of reactions, determine rate constant values, order of reactions, effect of temperature and other factors on reaction rate.
- Study the kinetics of decomposition of H2O2, acid-catalyzed hydrolysis of methyl acetate, viscosity measurement of unknown liquids.
- Thorough understanding of Chemical Bonding with special Emphasis on Ionic, Covalent bonding and Concepts of weak bonds like Hydrogen Bond, van der Waals bond.
- Understanding the concepts of Molecular Orbit Theory.
- Study experimentally the qualitative detection of acid and basic in a mixture.

B.ScHons. (Sem III)

Title: Physical Chemistry II **Course Code**: BCEMCCHC301

Transport processes (16 L)

1. Diffusion; Fick's law: Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties.
2. Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; Temperature variation of viscosity of liquids and comparison with that of gases.
3. Conductance and transport number: Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye –Huckel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect and

electrophoretic effect; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations.

4. Transport number, Principles of Hittorf's and Moving-boundary method; Wien effect, Debye-Falkenhagen effect, Walden's rule.

Applications of Thermodynamics – I (24L)

1. Second Law: Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of §dQ/T and Clausius inequality; Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.
2. Thermodynamic relations: Maxwell's relations; Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations
3. Partial properties and Chemical potential: Chemical potential and activity, partial molar quantities, relation between Chemical potential and Gibb's free energy and other thermodynamic state functions; variation of Chemical potential (μ) with temperature and pressure; Gibbs-Duhem equation; fugacity and fugacity coefficient; Variation of thermodynamic functions for systems with variable composition; Equations of states for these systems, Change in G, S H and V during mixing for binary solutions
4. Chemical Equilibrium: Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of KP, KC and KX; van't Hoff's reaction isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle and its derivation
5. Dissociation of weak electrolyte. Solubility equilibrium

6. Nernst’s distribution law; Application- (finding out Keq using Nernst dist law for KI+I2 = KI3 and dimerization of benzene

Foundation of Quantum Mechanics (20L)

1. Beginning of Quantum Mechanics: Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof)
2. Wave function: Schrodinger time-independent equation; nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function
3. Concept of Operators: Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Hermitian operator; Postulates of Quantum Mechanics
4. Particle in a box: Setting up of Schrodinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution); Expectation values of x, x2, px and px2 and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels
5. Simple Harmonic Oscillator: setting up of the Schrodinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features

Practical

1. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water
2. Determination of partition coefficient for the distribution of I2 between water and CHCl3
3. Determination of Keq for KI + I2 = KI3, using partition coefficient between water and CHCl3
4. Conductometric titration of an acid (strong, weak/ monobasic, dibasic) against base strong
5. Study of saponification reaction conductometrically
6. Verification of Ostwald’s dilution law and determination of Ka of weak acid

Course Outcome

After successful completion of course a Student should be able to:

- Understand Chemical and Phase Equilibrium
- To study the fundamentals of Quantum Mechanics.

- Gather knowledge about Schrodinger time-independent equation.
- Helps to understand about the applications of Thermodynamics in ColligativeProperties and Phase Equilibrium.
- Understand the Le Chatelier’s principle from thermodynamics.
- Study the Transport processes and their applications.

B.Sc Hons. (Sem III)

Title: Inorganic Chemistry II **Course Code**: BCEMCCHC302

Chemical Bonding-I (20L)

1. Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and 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. Defects in solids (elemementary idea).). Solubility energetics of dissolution process.

2. Covalent bond: Polarizing power and polarizability, ionic potential, Fazan’s rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent’s rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

Chemical Bonding-II (25L)

1. Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi- bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing,. MO diagrams of H2, Li2, Be2, B2, C2, N2, O2, F2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO+, CN-, HF, BeH2, CO2 and H2O. Bond properties: bond orders, bond lengths.

2. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

3. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

Radioactivity (15L)

1. Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory.
Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers.

2. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and uses of isotopes.

3. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

Practical

Iodo / Iodimetric Titrations

1. Estimation of Cu(II)
2. Estimation of Vitamin C
3. Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
4. Estimation of available chlorine in bleaching powder

Estimation of metal content in some selective samples

1. Estimation of Cu in brass.
2. Estimation of Cr and Mn in Steel.
3. Estimation of Fe in cement.

Course Outcome

After successful completion of course a Student should be able to:

- Understandings of radioactivity and stability of any nucleus.
- Knowledge of radio carbon dating.
- Thorough understanding of Chemical Bonding with special Emphasis on Ionic, Covalent bonding and Concepts of weak bonds like Hydrogen Bond, van der Waals bond.

➢ Understanding the concepts of Molecular Orbit Theory.

B.Sc Hons. (Sem III)

Title: Organic Chemistry III **Course Code**: BCEMCCHC303

Chemistry of alkenes and alkynes (12L)

1. Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, syn and anti-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of E - and Z - alkenes; contra-thermodynamic isomerization of internal alkenes.

2. Addition to C≡C (in comparison to C=C): mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration- demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non- terminal alkynes.

Aromatic Substitution (10L)

1. Electrophilic aromatic substitution: mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt); Ipso substitituion.

2. Nucleophilic aromatic substitution: addition-elimination mechanism and evidences in favour of it; SN1 mechanism; cine substitution (benzyne mechanism), structure of benzyne.

Carbonyl and Related Compounds (30L)

1. Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in

nucleophilic additions; formation of hydrates, cyano hydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.

2. Exploitation of acidity of α-H of C=O: formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence): halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol, Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction, Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines, aza-enolates and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

3. Elementary ideas of Green Chemistry: Twelve (12) principles of green chemistry; planning of green synthesis; common organic reactions and their counterparts: reactions: Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.

4. Nucleophilic additio to α,βunsaturated carbonyl system: general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation.

5. Substitution at sp^2 carbon (C=O system): mechanism (with evidence): $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (in connection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

Organometallics (8L)

Grignard reagent; Organolithiums; Gilman cuprates: preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed ortho metalation of arenes using organolithiums, conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behavior of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatsky reaction;

Blaise reaction; concept of umpolung and base-nucleophile dichotomy in case of organometallic reagents.

Practical

Qualitative Analysis of Single Solid Organic Compounds

1. Detection of special elements (N, S, Cl, Br) by Lassaigne's test
2. Solubility and classification (solvents: H_2O, 5% HCl, 5% NaOH and 5% $NaHCO_3$)
3. Detection of the following functional groups by systematic chemical tests:
4. aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic – OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O); only one test for each functional group is to be reported.
5. Melting point of the given compound
6. Preparation, purification and melting point determination of a crystalline derivative of the given compound
7. Identification of the compound through literature survey.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (at least six) organic compounds.

Course Outcome

After successful completion of course a Student should be able to:

- Study Chemistry of alkenes and alkynes, their properties, reactions and mechanism.
- Understand the Aromatic Substitution, their mechanism and reactivity.
- Gather knowledge about Carbonyl and Related Compounds, their preparation, reactions, mechanism and reactivity.
- Study the Organometallics compounds, their preparation and reactions.

B.Sc Hons. (Sem III)

Title: Basic Analytical Chemistry **Course Code**: BCEMSEHT305

Introduction

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil

Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

1. Determination of pH, acidity and alkalinity of a water sample.
2. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products

Nutritional value of foods, idea about food processing and food preservations and adulteration.

1. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
2. Analysis of preservatives and colouring matter.

Chromatography

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

1. Paper chromatographic separation of mixture of metal ion (Fe3+ and Al3+).
2. To compare paint samples by TLC method.

Ion-exchange

1. Column, ion-exchange chromatography etc.

2. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics

Major and minor constituents and their function

1. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
2. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration

Suggested Applications (Any one)

1. To study the use of phenolphthalein in trap cases.
2. To analyse arson accelerants.
3. To carry out analysis of gasoline.

Suggested Instrumental demonstrations

1. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
2. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
3. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks

Course Outcome

After successful completion of course a Student should be able to:

- Gather the basic Knowledge about analytical Chemistry.
- Get knowledge about various topics of analytical chemistry such as Errors and Evaluation of measurements.
- Study about sampling.
- Know the applications of different chromatographic techniques.
- Understand the composition of soil and measurement of important parameters of soil.
- Measurement of important water quality parameters and adulterants in food items.

B.Sc Program (Sem III)

Title: Physical Chemistry II **Course Code**: BCEMCCRC301

Kinetic Theory and Gaseous state (24 L)

1. Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion
2. Maxwell's distribution of speed and energy (without derivation): Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy $\geq \varepsilon$.
3. Real gas and virial equation: Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea)

Chemical Thermodynamics (18 L)

1. Zeroth and 1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, H; relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence
2. Thermochemistry: Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions; Adiabatic flame temperature; explosion temperature

Chemical kinetics (18 L)

1. Rate law, order and molecularity:

Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and nth order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order)

2. Role of T and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation; Rate-determining step and steady-state approximation – explanation with suitable examples; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Practical

1. Determination of heat of neutralization of a strong acid by a strong base
2. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate
3. Study of kinetics of decomposition of H2O2
4. Determination of heat of solution of oxalic acid from solubility measurement

Course Outcome

After successful completion of course a Student should be able to:

- Understand the basic concept of kinetic theory of gases and know how tosolve numerical problems related to that topic.
- Understand rate laws, rate equations of different types of reactions,determine rate constant values, order of reactions, effect of temperature and otherfactors on reaction rate, homogenouscatalysis, catalytic effect on reaction rate,equations related to chemical catalysis.
- Study the kinetics of decomposition of H2O2, acid-catalyzed hydrolysis ofmethyl acetate, viscosity measurement of unknown liquids.
- Gain the knowledge about Zeroth and 1st law of thermodynamics and thermochemistry.

B.Sc Generic (Sem III)

Title: Atomic Structure, Chemical Periodicity, Acids

And Bases, Redox Reactions, General Organic

Chemistry & Aliphatic Hydrocarbons **Course Code**: BCEMGEHC7

Inorganic Chemistry (24L)

1. Atomic Structure

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many- electron atoms, Aufbau principle and its limitations.

2. Chemical Periodicity

Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

3. Acids and bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

4. Redox reactions

Balancing of equations by oxidation number and ion-electron method oxidimetry and reductimetry.

Organic Chemistry (36L)

1. Fundamentals of Organic Chemistry

Electronic displacements: inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

2. Stereochemistry

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

3. Nucleophilic Substitution and Elimination Reactions

Nucleophilic substitutions: SN1 and SN2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs substitution.

4. Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.

5. Alkanes: (up to 5 Carbons). Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: mechanism for free radical substitution: halogenation.

6. Alkenes: (up to 5 Carbons). Preparation: elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alkaline KMnO4) and trans- addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

7. Alkynes: (up to 5 Carbons). Preparation: acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

8. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alkaline KMnO4.

Practical

Inorganic Chemistry

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO4.

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

Qualitative Analysis of Single Solid Organic Compound(s)

1. Detection of special elements (N, Cl, and S) in organic compounds.
2. Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH)
3. Detection of functional groups: Aromatic-NO_2, Aromatic -NH_2, -COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

Experiments 1 to 3 with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.

Course Outcome

After successful completion of course a Student should be able to:

- Gain basic knowledge of stereochemistry of organic molecules.
- Know structure and bonding of compounds of carbon and factors that control their reactivity such as inductive effect, resonance, hyperconjugation etc.
- Gather an in-depth knowledge about atomic structure,
- Study in detail about modern periodic table, physical and chemical properties of the elements along a group or period, factors influences those properties, relativistic effects and inert pair effect..
- Understand the concepts of a redox reaction and acid base reactions.
- Study the Aliphatic Hydrocarbons alkanes, alkenes and alkynes, their preparations and reactions.

B.Sc Hons. (Sem IV)

Title: Physical Chemistry III **Course Code**: BCEMCCHC401

Applications of Thermodynamics – II (20L)

1. Binary mixture: Chemical potential of individual components. Thermodynamic parameters of mixing ideal solution; Colligative properties: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; 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; Abnormal colligative properties
2. Phase rule: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO2, Sulphur
3. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use; Liquid vapour equilibrium for two component systems; Phenol-water system
4. Binary solutions: Ideal solution; Positive and negative deviations from ideal behaviour; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Azeotropic solution; Liquid-liquid phase diagram using phenol- water system; Solid-liquid phase diagram; Eutectic mixture

Applications of Thermodynamics – III (20L)

1. Ionic equilibria: Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Huckel limiting law-brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law; Mean ionic activity coefficient; Applications of the Debye-Huckel equation and its limitations.
2. Electromotive Force: Quantitative aspects of Faraday’s laws of electrolysis, 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/Sb2O3 electrodes

3. Concentration cells with and without transference, liquid junction potential; determination ofactivity coefficients and transference numbers; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

Surface & nanoscience (20L)

1. Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension
2. Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions;
3. Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation
4. Nanomaterials: Importance of nano-systems; confinement and dimensionality with example (dot, wire etc.); Different approaches for preparation of nanomaterials.

Practical

1. Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)
2. Potentiometric titration: (a) weak acid vs. base, (b) Redox, determination of E0
3. Study of phenol-water phase diagram
4. Spectrophotometric determination of CMC
5. Determination of surface tension of a liquid using Stalagmometer

Course Outcome

After successful completion of course a Student should be able to:

- Know Basic concept of phase rule in a binary liquid mixture
- Know Basic knowledge about colligative properties of solutions
- Study phase equilibria and phase diagrams of eutectic systems,
- Introduction on electrochemistry, electrochemical cell formation, electrode potentials
- Study the surface tension of a liquid using Stalagmometer.

B.Sc Hons. (Sem IV)

Title: Inorganic Chemistry III **Course Code**: BCEMCCHC402

General Principles of Metallurgy (10L)

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. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Chemistry of s and p Block Elements (18L)

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.

Noble Gases (10L)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2 and XeF4). Xenon-oxygen compounds. Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers (10L)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.

Coordination Chemistry-I (12L)

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Practical

Complexometric titration

1. Zn(II)
2. Zn(II) in a Zn(II) and Cu(II) mixture.
3. Ca(II) and Mg(II) in a mixture.
4. Hardness of water.

Inorganic preparations

1. [Cu(CH3CN)4]PF6/ClO4
2. Cis and trans K[Cr(C2O4)2 (H2O)2]
3. [Cu(CH3CN)4]PF6/ClO4
4. Cis and trans K[Cr(C2O4)2 (H2O)2]
5. Potassium dioxalatodiaquachromate(III)
6. Tetraamminecarbonatocobalt (III) ion
7. Potassium tris(oxalate)ferrate(III)
8. Tris-(ethylenediamine) nickel(II) chloride.
9. [Mn(acac)3] and Fe(acac)3] (acac= acetylacetonate)

Course Outcome

After successful completion of course a Student should be able to:

- Study general principles of metallurgy and the applications various metallurgical processes
- Explore basic chemistry of s- and p- block elements and also study electronic configurations, their properties and reactions etc.
- Explore chemistry of hydrides, oxides, oxoacids, halides and oxoacids of non-metals and to understand various aspects of liquid states.

- study the different types of isomerism’s associated with coordination compounds .
- .Coordination compounds – Concepts of double salts and complex salts, Werner theory.
- To understand the IUPAC system of nomenclature for coordination compounds.
- Understand the Nature of bonding in noble gas compounds.
- Gain the basic knowledge about polymer and its applications.
- Study the Complexometric titration in the laboratory.

B.Sc Hons. (Sem IV)

Title: Organic Chemistry IV **Course Code**: BCEMCCHC403

Nitrogen compounds (12L)

1. Amines: Aliphatic & Aromatic: preparation, separation (Hinsberg’s method) and identification of primary, secondary and tertiary amines; reaction (with mechanism): Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction; formation and reactions of phenylenediamines, diazomethane and diazoacetic ester.

2. Nitro compounds (aliphatic and aromatic): preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion.

3. Alkylnitrile and isonitrile: preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction.

4. Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann.

Rearrangements (16L)

Mechanism with evidence and stereochemical features for the following:

1. Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement, Demjanov rearrangement, Tiffeneau–Demjanov rearrangement.

2.Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann.

3. Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction.

4. Aromatic rearrangements: Migration from oxygen to ring carbon: Fries rearrangement and Claisen rearrangement.

5. Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement, Fischer-Hepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement.

6. Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.

The Logic of Organic Synthesis (12L)

1. Retrosynthetic analysis: disconnections; synthons, donor and acceptor synthons; natural reactivity and umpolung; latent polarity in bifunctional compounds: consonant and dissonant polarity; illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds), reconnection (1,6-dicarbonyl); protection-deprotection strategy (alcohol, amine, carbonyl, acid).

2. Strategy of ring synthesis: thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique.

3. Asymmetric synthesis: stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity (only definition); enantioselectivity: kinetically controlled MPV reduction; diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh and Zimmermann-Traxler models.

Organic Spectroscopy (20L)

1. UV Spectroscopy: introduction; types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions; chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper-/Hypochromic effects); application of Woodward's Rules for calculation of λmax for the following systems: conjugated diene, α,β-unsaturated aldehydes and ketones (alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); relative positions of λmax considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions.

2. IR Spectroscopy: introduction; modes of molecular vibrations (fundamental and non-fundamental); IR active molecules; application of Hooke's law, force constant; fingerprint region and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring- size, solvent effect, H-bonding on IR absorptions; application in functional group analysis.

3. NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; elementary idea about non-first-order splitting; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds.

4. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.

Practical

1. Estimation of glycine by Sörensen's formol method
2. Estimation of glucose by titration using Fehling's solution
3. Estimation of sucrose by titration using Fehling's solution
4. Estimation of vitamin-C (reduced)
5. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
6. Estimation of phenol by bromination (Bromate-Bromide) method
7. Estimation of formaldehyde (Formalin)
8. Estimation of acetic acid in commercial vinegar
9. Estimation of urea (hypobromite method)
10. Estimation of saponification value of oil/fat/ester

Course Outcome

After successful completion of course a Student should be able to:

- Understand the important concepts of NMR, UV-visible and IR spectroscopy and its role in structure elucidation of organic compounds.
- Study about the Retro synthetic analysis.
- Study the rearrangement reaction, its mechanism and applications.
- Study some nitrogenous compound and their preparation and different reactions.

B.Sc Hons. (Sem IV)

Title: Analytical Clinical Biochemistry **Course Code**: BCEMSEHT405

Review of Concepts from Core Course

1. Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

2. Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

3. Enzymes: Nomenclature, Characteristics (mention of Ribozymes), and 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.

4. 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.

5. Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

6. Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

1. 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.

2. Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Hands On Practical

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Course Outcome

After successful completion of course a Student should be able to:

- Understandings of different types of biomolecules, e.g, amino acids. proteins,Lipids etc, classification, synthesis and properties of these molecules.
- Study the biological importance of different biomolecules
- Understand the Structure of DNA (Watson-Crick model) and RNA and their biological significance.

➢ Know the diagnostic approach by blood/ urine analysis.

B.Sc Program (Sem IV)

Title: Inorganic Chemistry III **Course Code**: BCEMCCRC401

General Principles of Metallurgy (10L)

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. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Chemistry of s and p Block Elements (18L)

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.

Noble Gases (10L)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2 and XeF4). Xenon-oxygen compounds. Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers (10L)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.

Coordination Chemistry-I (12L)

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Practical

Complexometric titration

1. Zn(II)
2. Zn(II) in a Zn(II) and Cu(II) mixture.
3. Ca(II) and Mg(II) in a mixture.
4. Hardness of water.

Inorganic preparations

1. [Cu(CH3CN)4]PF6/ClO4
2. Cis and trans K[Cr(C2O4)2 (H2O)2]
3. [Cu(CH3CN)4]PF6/ClO4
4. Cis and trans K[Cr(C2O4)2 (H2O)2]
5. Potassium dioxalatodiaquachromate(III)
6. Tetraamminecarbonatocobalt (III) ion
7. Potassium tris(oxalate)ferrate(III)
8. Tris-(ethylenediamine) nickel(II) chloride.
9. [Mn(acac)3] and Fe(acac)3] (acac= acetylacetonate)

Course Outcome

After successful completion of course a Student should be able to:

- Study general principles of metallurgy and the applications various metallurgical processes
- Explore basic chemistry of s- and p- block elements and also study electronic configurations, their properties and reactions etc.
- Explore chemistry of hydrides, oxides, oxoacids, halides and oxoacids of non-metals and to understand various aspects of liquid states.
- study the different types of isomerism's associated with coordination compounds .
- .Coordination compounds – Concepts of double salts and complex salts, Werner theory.
- To understand the IUPAC system of nomenclature for coordination compounds.
- Understand the Nature of bonding in noble gas compounds.
- Gain the basic knowledge about polymer and its applications.

➢ Study the Complexometric titration in the laboratory.

B.Sc Generic (Sem IV)

Title: States of Matter & Chemical Kinetics,

Chemical Bonding & Molecular Structure,

P- Block Elements **Course Code**: BCEMGEHC7A

Physical Chemistry

1. Kinetic Theory of Gases and Real gases (16L)

a. Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion

b. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

c. Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states

d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

2. Liquids (6L)

a. Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

3. Solids (8L)

a. Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

4. Chemical Kinetics (10L)

a. Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions

b. Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision theory; Lindemann theory of unimolecular reaction; outline of

Transition State theory (classical treatment)

Organic Chemistry

1. Chemical Bonding and Molecular Structure (15L)

a. 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, 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.

b. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear,trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

c.Concept of resonance and resonating structures in various inorganic and organic compounds.

d.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+. Comparison of VB and MO approaches.

2.Comparative study of p-block elements (5L)

a.Group trends in electronic configuration, modification of pure elements,common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

i. B-Al-Ga-In-Tl

ii. C-Si-Ge-Sn-Pb

iii. N-P-As-Sb-Bi

iv. O-S-Se-Te

v. F-Cl-Br-I

Practical

Physical Chemistry

1. 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

2. 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

3. Study the kinetics of the following reactions

a. Initial rate method: Iodide-persulphate reaction b. Integrated rate method:

i. Acid hydrolysis of methyl acetate with hydrochloric acid

ii. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Inorganic Chemistry

Qualitative semi-micro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Acid Radicals: Cl-, Br-, I-, NO2-, NO3-, S2-, SO42-, PO43-, BO33-, H3BO3.

Basic Radicals: Na+, K+, Ca2+, Sr2+, Ba2+, Cr3+, Mn2+, Fe3+, Ni2+, Cu2+, NH4+.

Course Outcome

After successful completion of course a Student should be able to:

- Understand the basic concept of kinetic theory of gases and know how to solve numerical problems related to that topic.
- Understand rate laws, rate equations of different types of reactions, determine rate constant values, order of reactions, effect of temperature and other factors on reaction rate.
- Study the kinetics of decomposition of H2O2, acid-catalyzed hydrolysis of methyl acetate, viscosity measurement of unknown liquids.
- Thorough understanding of Chemical Bonding with special Emphasis on Ionic, Covalent bonding and Concepts of weak bonds like Hydrogen Bond, van der Waals bond.
- Understanding the concepts of Molecular Orbit Theory.
- Study experimentally the qualitative detection of acid and basic in a mixture.

B.Sc Hons. (Sem V)

Title: Inorganic Chemistry IV **Course Code**: BCEMCCHC501

Coordination Chemistry-II (30L)

VB description and its limitations. Elementary Crystal Field Theory: splitting of dn configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series. Jahn- Teller distortion. Octahedral site stabilization energy (OSSE). Metal-ligand bonding (MO concept, elementary idea), sigma- and pi- bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples). Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of dn ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for 3d1 to 3d9 ions. Racah parameter. Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).

Chemistry of d- and f- block elements (30L)

Transition Elements:

General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.

Lanthanoids and Actinoids:

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

Practical

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

1. Ni (II) and Co (II)
2. Fe (III) and Al (III)

Gravimetry

1. Estimation of nickel (II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN
3. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate)

4. Estimation of chloride

Spectrophotometry

1. Measurement of 10Dq by spectrophotometric method.
2. Determination of max of [Mn(acac)3] and [Fe(acac)3] complexes

Course Outcome

After successful completion of course a Student should be able to:

- Understand about the VBT and its limitation.
- Understand about the structures, stability, colour, magnetism andOrgel diagram of the co-ordination compounds on the basis of modern concepts ofchemical bonding.
- Explain general characteristics and electronic configuration of d and f Block elements.
- Understand the crystal field theory and its application in coordination chemistry.
- Calculate crystal field stabilization energy of coordination complexes. Understand the effect of strong field and weak field ligands on the crystal field splitting of coordination complexes.
- Concept of Jahn-Teller Distortion and application to the Z-in and Z-out chemistry
- Estimate various metals (Ba, Zn, Fe, Ni, Cr, Pb) gravimetrically

B.Sc Hons. (Sem V)

Title: Organic Chemistry V **Course Code**: BCEMCCHC502

Carbocycles and Heterocycles

1. Polynuclear hydrocarbons and their derivatives: synthetic methods include Haworth, Bardhan-Sengupta, Bogert-Cook and other useful syntheses (with mechanistic details); fixation of double bonds and Fries rule; reactions (with mechanism) of naphthalene, anthracene, phenanthrene and their derivatives.

2. Heterocyclic compounds: 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole, thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist- Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine:

Hantzsch synthesis; benzo-fused 5- and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approach and mechanistic details): indole: Fischer, Madelung and Reissert; quinoline: Skraup, Doebner- Miller, Friedlander; isoquinoline: Bischler-Napieralski synthesis.

Cyclic Stereochemistry

Alicyclic compounds: concept of I-strain; conformational analysis: cyclohexane, mono and disubstituted cyclohexane; symmetry properties and optical activity; topomerisation; ring-size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; elimination (E2, E1), nucleophilic substitution (SN1, SN2, SNi, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolyticsyn elimination and fragmentation reactions.

Pericyclic reactions

Mechanism, stereochemistry, regioselectivity in case of

1. Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions.
2. Cycloaddition reactions: FMO approach, Diels-Alder reaction, photochemical [2+2] cycloadditions.
3. Sigmatropic reactions: FMO approach, sigmatropic shifts and their order; [1,3]- and [1,5]- H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements.

Carbohydrates

1. Monosaccharides: Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, HNO3 oxidation, selective oxidation of terminal –CH2OH of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group-interchange of aldoses; acetonide (isopropylidene)

and benzylidene protections; ring-size determination; Fischer's proof of configuration of (+)-glucose.

2. Disaccharides:

Glycosidic linkages, concept of glycosidic bond formation by glycosyl donor-acceptor; structure of sucrose, inversion of cane sugar.

3. Polysaccharides: starch (structure and its use as an indicator in titrimetric analysis).

Biomolecules

1. Amino acids: synthesis with mechanistic details: Strecker, Gabriel, acetamidomalonic ester, azlactone, Büchererhydantoin synthesis, synthesis involving diketopiperazine; isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids.

2. Peptides: peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using N-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: C-terminal and N-terminal unit determination (Edman, Sanger & 'dansyl' methods); partial hydrolysis; specific cleavage of peptides: use of CNBr.

3. Nucleic acids: pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA; mechanism for acid catalysed hydrolysis of nucleosides (both pyrimidine and purine types); comparison of alkaline hydrolysis of DNA and RNA; elementary idea of double helical structure of DNA (Watson-Crick model); complimentary base–pairing in DNA.

Practical

Chromatographic Separations

1. TLC separation of a mixture containing 2/3 amino acids
2. TLC separation of a mixture of dyes (fluorescein and methylene blue)
3. Column chromatographic separation of leaf pigments from spinach leaves
4. Column chromatographic separation of mixture of dyes
5. Paper chromatographic separation of a mixture containing 2/3 amino acids
6. Paper chromatographic separation of a mixture containing 2/3 sugars

Spectroscopic Analysis of Organic Compounds

1. Assignment of labelled peaks in the 1H NMR spectra of the known organic compoundsexplainingthe relative δ-values and splitting pattern.

2. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included).

3. The students must record full spectral analysis of at least 15 (fifteen) compounds from the following list:

a. 4-Bromoacetanilide

b. 2-Bromo-4'-methylacetophenone c. Vanillin

d. 2-Methoxyacetophenone e. 4-Aminobenzoic acid

f. Salicylamide

g. 2-Hydroxyacetophenone h. 1,3-Dinitrobenzene

i. Benzylacetate

j. trans-4-Nitrocinnamaldehyde k. Diethyl fumarate

l. 4-Nitrobenzaldehyde m. 4-Methylacetanilide n. Mesityl oxide

o. 2-Hydroxybenzaldehyde

p. 4-Nitroaniline

q. 2-Hydroxy-3-nitrobenzaldehyde

r. 2,3-Dimethylbenzonitrile

s. Pent-1-yn-3-ol

t. 3-Nitrobenzaldehyde

u. 3-Ethoxy-4-hydroxybenzaldehyde v. 2-Methoxybenzaldehyde

w. Methyl 4-hydroxybenzoate x. Methyl 3-hydroxybenzoate

y. 3-Aminobenzoic acid

z. Ethyl 3-aminobenzoate

aa. Ethyl 4-aminobenzoate

bb. 3-nitroanisole

cc. 5-Methyl-2-nitroanisole

dd. 3-Methylacetanilide

Course Outcome

After successful completion of course a Student should be able to:

- Study chemistry of carbohydrates with special reference to structure and configuration of glucose and fructose
- Know the different synthetic methods for poly nuclear hydrocarbons.
- Study heterocyclic compounds containing 5- and 6-membered rings and its reactivity, orientation and important reactions.
- Gain knowledge about amino acids, peptides and proteins.
- Know the chromatographic separation technique and study the Spectroscopic Analysis of some Organic Compounds
- Understand the different pericyclic reaction and its applications

B.Sc Hons. (Sem V)

Title: Advanced Physical Chemistry **Course Code**: BCEMDSHC1

Crystal Structure (15L)

1. Bravais Lattice and Laws of Crystallography: Types of solid, Bragg's law of diffraction; Laws of crystallography (Haüy's law and Steno's law); Permissible symmetry axes in crystals; Lattice, space lattice, unit cell, crystal planes, Bravais lattice.
2. Crystal planes: Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of dhkl; Relation between molar mass and unit cell dimension for cubic system;
3. Diffraction of X-ray by crystals, Laue equation, reciprocal lattice, Bragg equation, determination of crystal structure: Powder method; Structure of NaCl and KCl crystals, elementary idea of structure factor.

Statistical Thermodynamics (12L)

1. Configuration: Macrostates, microstates and configuration; calculation with harmonic oscillator; variation of W with E; equilibrium configuration
2. Boltzmann distribution: Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation); Applications to barometric distribution
3. Partition function: molecular partition function and thermodynamic properties, Maxwell's speed distribution; Gibbs' paradox

Third law of thermodynamics and properties near 0K (15L)

1. Specific heat of solid: Coefficient of thermal expansion, thermal compressibility of solids; Dulong –Petit's law; Equipartition theorem and heat capacities; Perfect Crystal model, Einstein's theory – derivation from partition function, limitations; Debye's T3 law – analysis at the two extremes
2. 3rd law: Absolute entropy, Plank's law, Calculation of entropy, Nernst heat theorem
3. Adiabatic demagnetization: Approach to zero Kelvin.
4.

Quantum Chemistry (18L)

1. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component; Rigid rotator model of rotation of diatomic molecule; Schrödinger equation, transformation to spherical polar coordinates; Separation of variables. Spherical harmonics; Discussion of solution
2. 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; Orbitals and their shapes; Setting up of Schrödinger equation for many-electron atoms (He, Li), atomic units

Practical

Computer Programming based on numerical methods for:

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid)
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations)
3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values
4. Matrix operations (Application of Gauss-Siedel method in colourimetry)
5. Simple exercises using molecular visualization software

Course Outcome

After successful completion of course a Student should be able to:

- Understand the limitation and origin of Quantum Chemistry
- Understands the basic postulates of quantum chemistry, Schrodinger equation and its solutions for one electron system
- Significance of wave function, its normalization and various applications in dealing with rigid rotor and harmonic oscillator
- Understand the crystal structure and its different law.
- Understand Boltzmann distribution law, Fermi – Dirac statistics, Bose – Einstein Statistics.

- Understand the Third law of thermodynamics and its applications.

B.Sc Hons. (Sem V)

Title: Inorganic Materials of Industrial Importance **Course Code**: BCEMDSHC2

Silicate Industries (15L)

1. Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

2. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

3. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Fertilizers (6L)

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings (15L)

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Batteries (8L)

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Alloys (6L)

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Ar and heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Catalysis (6L)

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives(4L)

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Practical

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.

7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Course Outcome

After successful completion of course a Student should be able to:

- Explain the raw materials and manufacturing processes involved in preparation of various inorganic material of industrial importance.
- Describe the properties of inorganic material of industrial importance such as glass, ceramic, cement, chemical explosives etc.
- Give and explain the methods of application of metal coatings.
- Know about different type of fertilizers.

B.Sc Program (Sem V)

Title: Inorganic Materials of Industrial Importance **Course Code**: BCEMDSRC1

Silicate Industries (15L)

1. Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

2. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

3. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Fertilizers (6L)

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings (15L)

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Batteries (8L)

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Alloys (6L)

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Ar and heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Catalysis (6L)

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives(4L)

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Practical

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Course Outcome

After successful completion of course a Student should be able to:

- Explain the raw materials and manufacturing processes involved in preparation of various inorganic material of industrial importance.
- Describe the properties of inorganic material of industrial importance such as glass, ceramic, cement, chemical explosives etc.
- Give and explain the methods of application of metal coatings.
- Know about different type of fertilizers.

B.Sc Hons. (Sem IV)

Title: Physical Chemistry III **Course Code**: BCEMCCHC401

Applications of Thermodynamics – II (20L)

5. Binary mixture: Chemical potential of individual components. Thermodynamic parameters of mixing ideal solution; Colligative properties: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; 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; Abnormal colligative properties
6. Phase rule: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO2, Sulphur
7. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use; Liquid vapour equilibrium for two component systems; Phenol-water system
8. Binary solutions: Ideal solution; Positive and negative deviations from ideal behaviour; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Azeotropic solution; Liquid-liquid phase diagram using phenol- water system; Solid-liquid phase diagram; Eutectic mixture

Applications of Thermodynamics – III (20L)

4. Ionic equilibria: Chemical potential of an ion in solution; Activity and activity coefficients of ions in solution; Debye-Huckel limiting law-brief qualitative description of the postulates involved, qualitative idea of the model, the equation (without derivation) for ion-ion atmosphere interaction potential. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law; Mean ionic activity coefficient; Applications of the Debye-Huckel equation and its limitations.
5. Electromotive Force: Quantitative aspects of Faraday's laws of electrolysis, 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/Sb2O3 electrodes
6. Concentration cells with and without transference, liquid junction potential; determination ofactivity coefficients and transference numbers; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

Surface & nanoscience (20L)

5. Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension
6. Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant); Zero order and fractional order reactions;
7. Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Determination of Avogadro number by Perrin's method; Stability of colloids and zeta potential; Micelle formation

8. Nanomaterials: Importance of nano-systems; confinement and dimensionality with example (dot, wire etc.); Different approaches for preparation of nanomaterials.

Practical

6. Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)
7. Potentiometric titration: (a) weak acid vs. base, (b) Redox, determination of E0
8. Study of phenol-water phase diagram
9. Spectrophotometric determination of CMC
10. Determination of surface tension of a liquid using Stalagmometer

Course Outcome

After successful completion of course a Student should be able to:

- Know Basic concept of phase rule in a binary liquid mixture
- Know Basic knowledge about colligative properties of solutions
- Study phase equilibria and phase diagrams of eutectic systems,
- Introduction on electrochemistry, electrochemical cell formation, electrode potentials
- Study the surface tension of a liquid using Stalagmometer.

B.Sc Hons. (Sem VI)

Title: Inorganic Chemistry V **Course Code**: BCEMCCHC601

Bioinorganic Chemistry (20L)

Elements of life: essential and beneficial elements, major, trace and ultratraceelements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na+, K+, Mg2+, Ca2+, Fe3+/2+, Cu2+/+, and Zn2+). Metal ion transport across biological membrane Na+/ K+-ion pump. Dioxygen molecule in life. Dioxygen management proteins: Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Electron transfer proteins: Cytochromes and

Ferredoxins. Hydrlytic enzymes: carbonate bicarbonate buffering system and carbonic anhydrase and carboxyanhydrase A. Biological nitrogen fixation, Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only)

Organometallic Chemistry (18L)

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 18-electron and 16-electron rules (pictorial MO approach). Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. General methods of preparation of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls. Pi-acceptor behaviour of CO, synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation, structure, evidences of synergic effect. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions.

Catalysis by Organometallic Compounds (10L)

Study of the following industrial processes

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Hydroformylation
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Ziegler-Natta catalysis for olefin polymerization.

Reaction Kinetics and Mechanism (12L)

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Practical

Qualitative semimicro analysis

Qualitative semimicro analysis of mixtures containing four radicals. Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition.

Cation Radicals: Na+, K+, Ca2+, Sr2+, Ba2+, Al3+, Cr3+, Mn2+/Mn4+, Fe3+, Co2+/Co3+, Ni2+, Cu2+, Zn2+, Pb2+, Cd2+, Bi3+, Sn2+/Sn4+, As3+/As5+, Sb3+/5+, NH4+, Mg2+.

Anion Radicals: F-, Cl-, Br-, BrO3-, I-, IO3-, SCN-, S2-, SO42-, NO3-, NO2-, PO43-, AsO43--, BO33-, CrO42- / Cr2O72-, Fe(CN)64-, Fe(CN)63-.

Insoluble Materials: Al2O3(ig), Fe2O3(ig), Cr2O3(ig), SnO2, SrSO4, BaSO4, CaF2, PbSO4.

Course Outcome

At the end of the course students will be able to:

- To interpret the stability of metal carbonyls and organometallic compounds. To generalise the methods of preparation, properties and bonding in organometallic compounds.
- To study the different types of magnetic behaviour.
- Discuss the measurement of magnetic Susceptibility.
- Calculate the magnetic moments of transition metal complexes.
- Define stability constants of reactions in terms of thermodynamic and kinetic stability.
- Know the various factors affecting the stability constants of complexes.
- Know the types of substitution reaction mechanisms of octahedral complexes and understand the trans effect to apply it to square planar complexes.
- Learn how metal ions function in biological systems, paying special attention to thefunctioning of the sodium-potassium pump in organisms.
- Understand Catalysis involving organometallic compounds.
- Study Metalloenzymes.
- Understand chemistry of Photosynthesis.
- Understand transport and storage of dioxygen through different carriers.
- Study Electron Transfer in Biology involving metaloproteins and cytochromes.
- Biological nitrogen fixation.
- Study experimentally the qualitative detection of acid and basic in a mixture.

B.Sc Hons. (Sem VI)

Title: Physical Chemistry IV **Course Code**: BCEMCCHC602

Molecular Spectroscopy (18L)

1. Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation
2. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution
3. 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; Diatomic vibrating rotator, P, Q, R branches
4. 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

Photochemistry (16L)

1. Lambert-Beer's law: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients; Laws of photochemistry, Stark-Einstein law of photochemical equivalence quantum yield, actinometry, examples of low and high quantum yields
2. Photochemical Processes: Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra; Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonskii diagram;
3. Rate of Photochemical processes: Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H2-Br2 reaction, dimerisation of anthracene; photosensitised reactions, quenching; Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence

Resonance Spectroscopy: NMR, ESR & Electrical Properties of Molecules (20L)

1. Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules
2. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals
3. Dipole moment and polarizability: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole moments

Catalysis (6L)

Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Primary kinetic salt effect; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number; Autocatalysis; periodic reactions

Practical

1. Determination of CMC from surface tension measurements
2. Verification of Beer and Lambert's Law for $KMnO_4$ and $K_2Cr_2O_7$ solution
3. Study of kinetics of $K_2S_2O_8$ + KI reaction, spectrophotometrically
4. Determination of pH of unknown buffer, spectrophotometrically
5. Effect of ionic strength on the rate of Persulphate – Iodide reaction

Course Outcome

At the end of the course students will be able to:

- Learn about the fundamental concepts, important equations, properties andapplications of polarizability and dipole moment.
- Learn in detail about molecular spectroscopy(Rotational, Vibrational and Electronic Spectroscopy)
- Understand about the basic principles and laws of Photochemistry and alsoget idea about the theory of reaction rate.

B.Sc Hons. (Sem VI)

Title: Green Chemistry **Course Code**: BCEMDSHC5

Introduction to Green Chemistry (5L)

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis (25L)

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

1. 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.

2. Prevention/ minimization of hazardous/ toxic products reducing toxicity.

risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

3. Green solvents– supercritical 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.

4. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

5. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

6. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

7. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

8. Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Examples of Green Synthesis/ Reactions and some real world cases (22L)

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 CO2 for precision cleaning and dry cleaning of garments.

5. Designing of Environmentally safe marine antifoulant.

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

Future Trends in Green Chemistry (8L)

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

Practical

Safer starting materials

1. Preparation and characterization of nanoparticles of gold using tea leaves.

Using renewable resources

1. Preparation of biodiesel from vegetable/ waste cooking oil.

Avoiding waste

Principle of atom economy.

1. Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

2. Preparation of propene by two methods can be studied

a. Triethylamine ion + OH- → propene + trimethylpropene + water

$$\text{I-propanol} \xrightarrow{H_2SO_4/heat} \text{Propene} + \text{water}$$

b. I-propanol → Propene + water

3. Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice. Mechanochemical solvent free synthesis of azomethines

Alternative sources of energy

1. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
2. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Course Outcome

Upon successful completion of the course, students will beable to understand:

- The basic concept, background and significance of green chemistry, various tools andtwelve principles of green chemistry.
- About the principles of green chemistry.
- How to design and develop green synthetic methodsfor drugs by using principles ofgreen chemistry that reduces the generation of waste and hazardous substances.
- About the examples of green reactions and future trends in greenreaction.
- The concept of green chemistry for production of environmentally advancedpreservative.

B.Sc Hons. (Sem VI)

Title: Polymer Chemistry **Course Code**: BCEMDSHC6

Introduction and history of polymeric materials(4L)

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance(4L)

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

Kinetics of Polymerization(6L)

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity(6L)

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers(3L)

Structure Property relationships.

Determination of molecular weight of polymers(7L)

(Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (Tg) and determination of Tg (5L)

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution (10 L)

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Properties of Polymer (15L)

(Physical, thermal, Flow & Mechanical Properties)

Brief introduction to preparation, structure, propertiesand application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers,

Polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Practical

Polymer Synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
2. Purification of monomer
3. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
4. Preparation of nylon 66/6
5. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
6. Redox polymerization of acrylamide
7. Precipitation polymerization of acrylonitrile
8. Preparation of urea-formaldehyde resin
9. Preparations of novalac resin/ resold resin.
10. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:

a. Polyacrylamide-aq.NaNO2 solution

b. (Poly vinyl proplylidine (PVP) in water

2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) andthe fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers

5. Preparation of polyacrylamide and its electrophoresis

Course Outcome

Upon successful completion of the course, students will beable to:

- Understand chemistry of macromolecules and polymerization reactions.
- Learn about the history, classification and functionality of polymericmaterials.
- Know different types of molecular weights of polymers.
- Know about the kinetics of polymerization, details on crystallization andmorphology of crystalline polymers, determination of crystalline melting point of acrystalline material and the factors effecting crystalline melting point.
- Learn experimentally how to characterize and analyze a polymeric compound or material.

B.Sc Program (Sem VI)

Title: Green Chemistry **Course Code**: BCEMDSRC3

Introduction to Green Chemistry (5L)

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis (25L)

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

1. 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.

2. Prevention/ minimization of hazardous/ toxic products reducing toxicity.

risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

3. Green solvents– supercritical 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.

4. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

5. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

6. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

7. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

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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 CO2 for precision cleaning and dry cleaning of garments.

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7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

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- About the examples of green reactions and future trends in green reaction.
- The concept of green chemistry for production of environmentally advanced preservative.

SIDHO-KANHO-BIRSHA UNIVERSITY
UG CBCS SYLLABUS

MATHEMATICS HONOURS

SEMESTER-I

Paper-BMTMCCHT101

Title: Calculus & Analytical Geometry (2D)

Syllabus:

Module-1: Differential Calculus

Instructor-DR. DEBASIS DES

Lecture: 20 hours

Higher order derivatives, Leibnitz rule of successive differentiation and its applications. Indeterminate forms, L'Hospital's rule.

Basic ideas of Partial derivative, Chain Rules, Jacobian, Euler's theorem and its converse.

Tangents and Normals, Sub-tangent and sub-normals, Derivatives of arc lengths, Pedal equation of a curve.

Concavity and inflection points, curvature and radius of curvature, envelopes, asymptotes, curve tracing in Cartesian and polar coordinates of standard curves.

COUSE OUTCOME:**Explain to Compare and contrast the ideas of continuity and differentiability and to solve algebraic equations and inequalities involving thesequence root and modulus function.**

Module-2: Integral Calculus

Instructor:DR DEBASIS DAS

Lecture-10 hours

Reduction formulae, derivations and illustrations of reduction formulae, rectification & quadrature of plane curves, area and volume of surface of revolution.

Course outcome:On completion of this course the students are able to-

. Evaluation of definite integrals

.Working knowledge of double integral. .Applications: Rectification, Quadrature, volume and surface areas of solids formed by revolution of plane curve and areas problems only.

Module -3: Two-Dimensional Geometry

Instructor: Shishir kr Murmu

Lecture:20 hours

Transformation of Rectangular axes: Translation, Rotation and Rigid body motion, Theory of Invariants.

Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Point of intersection, Angle between pair of lines, Angle bisector, Equation of two lines joining the origin to the points in which a line meets a conic.

General Equation of second degree in two variables: Reduction into canonical form.

Tangents, Normals, chord of contact, poles and polars, conjugate points and conjugate lines of Conics.

Polar Co-ordinates, Polar equation of straight lines, Circles, conics. Equations of tangents, normals Chord of contact of Circles and Conics.

Course outcome: On completion of this course the studente will be able to:

.facillite shape recognition in relation to their environment.

.Model and solve geometric situations using algebric properties.

Paper-BMTMCCHT102

Title: Algebra-I

Syllabus:

Module -1: Classical Algebra

Instructor: Pintu Samui

Lecture-30 hours

Complex Numbers: De-Moivre's Theorem and its applications, Direct and inverse circular and hyperbolic functions, Exponential, Sine, Cosine and Logarithm of a complex number, Definition of (a≠0), Gregory's Series.

Simple Continued fraction and its convergent, representation of real numbers.

Polynomial equation, Fundamental theorem of Algebra (Statement only), Multiple roots, Statement of Rolle's theorem only and its applications, Equation with real coefficients, Complex roots, Descarte's rule of sign, relation between roots and coefficients, transformation of equation, reciprocal equation, binomial equation– special roots of unity, solution of cubic equations–Cardan's method, solution of biquadratic equation–Ferrari's method.

Inequalities involving arithmetic, geometric and harmonic means and

their generalizations, Schwarz and Weierstrass'sinequalities.

Course outcome:

.Learn to solve system of linear equation.

.Learn to find roots of polynomial over rational.

.Learn to find graphs, roots and primes integer.

.Introduction to complex analysis and it's application.

Module-2: Abstract Algebra & Number Theory

Instructor: Pintu Samui

Lecture-20 hours

Mappings, surjective, injective and bijective, Composition of two mappings, Inversion of mapping.Extension and restriction of a mapping ; Equivalence relation and partition of a set, partially ordered relation. Hesse's diagram, Lattices as partially ordered set, definition of lattice in terms of meet and join, equivalence of two definitions, linear order relation;

Principles of Mathematical Induction, Primes and composite numbers, Fundamental theorem of arithmetic, greatest common divisor, relatively prime numbers, Euclid's algorithm, least common multiple.

Congruences: properties and algebra of congruences, power of congruence, Fermat's congruence, Fermat's theorem, Wilson's theorem, Euler – Fermat's theorem, Chinese remainder theorem, Number of divisors of a number and their sum, least number with given number of divisors.

Eulers φ function-φ(n). Mobius μ-function, relation between φ function and μ function. Diophantine equations of the form $ax+by = c$, a, b, c integers.

Course outcome:On completion of the course the students are able to understand…

. Relation: equivalence relation, equivalence classes & partition, partial order relation, poset, linear order relation.

. Mapping: injective, surjective, one to one correspondence, invertible mapping, composition of mappings, relation betwoon the composition of mappings and various set theoretic operations. Well-ordering property of positive integers, Principles of Mathematical √Divisivision algorithm, Euclid's theorem. Congruence relation between integers. Fundamental Theorem of Arithmetic. Chinese remainder theorem.

SEMESTER-II

Paper-BMTMCCHT201

Title: Real Analysis-I

Instructor: Shishir kumar murmur

Lecture-50 hours

Syllabus:

Review of Algebraic and Order Properties of R, ε-neighbourhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets. Suprema and Infima.Completeness Property of R and its equivalent properties. The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, open set, closed set, derived set, Illustrations of Bolzano-Weierstrass theorem for sets.

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, liminf, lim sup. Limit Theorems. Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria. Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Raabe's test, Gauss's test (proof not required), Cauchy's condensation test (proof not required), Integral test. Alternating series, Leibniz test. Absolute and Conditional convergence.

Course outcome: After completion of the course the students are able to…

***Describe the basic difference between the rational and real numbers.**

*** Give the difination of concepts related to metric spaces such as continuity compactness, convergent etc.Give the essence of the proof of bolzanoweistrass theorem.**

***Evaluate the limits of wide class of real sequences.**

*** Determine whether or not real series are convergent by comparision with standard series or using the ratio test.**

Paper : BMTMCCHT 202

Title: Ordinary Differential Equations and Linear Algebra

Instructor:Dr.Debasis das

Lecture-30 hours

Syllabus:

Module -1: Differential Equation   Credit-30 hours

Prerequisite *[Genesis of differential equation: Order, degree and solution of an ordinary differential equation, Formation of ODE, Meaning of the solution of ordinary differential equation, Concept of linear and non-linear differential equations]*.

Picard's existence and uniqueness theorem (statement only) for $dydx=f(x,y)$ with $y = y0$ at $x = x0$ and its applications.

Solution of first order and first degree differential equations:

Homogeneous equations and equations reducible to homogeneous forms, Exact differential equations, condition of exactness, Integrating Factor, Rules of finding integrating factor (statement of relevant results only), equations reducible to exact forms, Linear Differential Equations, equations reducible to linear forms, Bernoulli's equations. Solution by the method of variation of parameters.

Differential Equations of first order but not of first degree: Equations solvable for $p=dydx$, equations solvable for y, equation solvable for x, singular solutions, Clairaut's form, equations reducible to Clairaut's Forms- General and Singular solutions.

Applications of first order differential equations: Geometric applications, Orthogonal Trajectories.

Linear differential equation of second and higher order. Linearly dependent and independent solutions, Wronskian, General solution of second order linear differential equation, General and particular solution of linear differential equation of second order with constant coefficients. Particular integrals for polynomial, sine, cosine, exponential function and for function as combination of them or involving them, Method of variation of parameters for P.I. of linear differential equation of second order

Linear Differential Equations With variable co-efficients: Euler- Cauchy equations, Exact differential equations, Reduction of order of linear differential equation. Reduction to normal form.

Simultaneous linear ordinary differential equation in two dependent variables. Solution of simultaneous equations of the form dx/P = dy/Q = dz/R. Pfaffian Differential Equation Pdx +Qdy+Rdz = 0, Necessary and sufficient condition for existence of integrals of the above (proof not required), Total differential equation.

Course outcome: **On successful completion of the course, Students will be able to..**

***Distinguish between linear, nonlinear, partial and ordinary differential cquations.**

*** Solve basic application problems described by second order linear differential equations with constant coefficients.**

*** Find power series solutions about ordinary points and singular points.**

***Obtain an approximate set of solution function values to a second order boundary value problem using a finite difference equation**.

Unit -2: Linear Algebra

Instructor: Pintu samui

Lecture-20 hours

Vector space, subspaces, Linear Sum, linear span, linearly dependent and independent vectors, basis, dimensions of a finite dimensional vector space, Replacement Theorem, Extension theorem, Deletion theorem, change of coordinates, Row space and column space, Row rank and column rank of a matrix.

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, Existence of solutions of homogeneous system of equations and determination of their solutions, solution sets of linear systems, applications of linear systems, linear independence.

Course outcome:

*** Linear Algebra emphasizes the concept of vector spaces and linear transformations which are essential in simplifying various scientific problems.**

*** It aims at inculcating problem solving skills within students to enable them compute large linear systems.**

***The practical applications of "Linear Algebra" are in demography, archaeology, electrical engineering, fractal geometry and traffic analysis.**

SEMESTER-III

Paper-BMTMCCHT301

Title: Real Analysis-II

Instructor: Shishir kr Murmu

Syllabus:

Module-1: Calculus of Single Variable   Lecture-30 hours

Limits of functions (ε-δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions. Application of Taylor's theorem to inequalities.

Course outcome: On Completion of this course the students will be able to:

✓ Explain the relationship between the derivative of a function as a function and the notion of the derivative as the slope of the tangent line to a function at a point.

✓ Compare and contrast the ideas of continuity and differentiability.

✓To able to calculate limits in inderminate forms by a repeated use of L' Hospital rule.

✓To know the claim rule and use it to find derivatives of composite functions.

✓ To find maxima and minima, critical points and inflection points of functions.

Unit- 2: Multivariable Calculus

Instructor: Shishir kr Murmu

Lecture-20 hours

Functions of several variables, limit and continuity of functions of two or more variables

Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Directional derivatives, the gradient, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals.

Course outcome:After completion of this course the students will be able to.

√ Understand different type of integrals .

√ They learn about, how to find Volume of cylinder ,sherical coordinates etc by using integrals.

√ Also it's useful for solve real life problems.

Paper-BMTMCCHT302

Title: Algebra-II

Instructor: Pintu Samui

Lecture-20 hours

Syllabus:

Group: Uniqueness of identity and inverse element, law of cancellation, order of a group and order of an element, Abelian Group, sub-group – Necessary and sufficient condition, Finite Group. Simple examples.

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Definition and examples of Rings, properties of Rings, Subrings, Integral Domains, Characteristic of a Ring.

Definition and examples Field, Subfield, Finite Field, characteristics of a Field.

Course outcome:

√ Concepts of symmetric groups and permutation groups are used to solve many mathematical puzzles, games; specifically in Rubik's cube.

√ Understand the importance of algebraic properties with regard to working within various number systems.

√ Students will be able to define ring and subrings.

√ Study of ideals and concept related to ideal.

√Study of various integral domain in ring.

Paper:BMTMCCHT 303

Title: Geometry-3D & Vector Analysis

Instructor:Dr. Debasis Das

Syllabus:

Module-1: Three-Dimensional Geometry   Lecture-30 hours

Plane; Straight lines

Sphere: General Equation, Circle, Sphere through circle, Tangent, Normal.

Cone: General homogeneous second degree equation, Enveloping cone, Section of cone by a plane, Tangent and normal, Condition for three perpendicular generators, Reciprocal cone, Right circular cone, Cylinder, Enveloping cylinder, Right circular Cylinder.

Conicoids: Ellipsoid, Hyperboloid, Paraboloid: Canonical equations only. Plane sections of it.

Ruled surface, Generating lines of hyperboloid of one sheet and hyperbolic paraboloid, their properties.

Transformation of Co-ordinates, Invariants, Reduction of general equation of three variables.

Knowledge of Cylindrical and Spherical polar co-ordinates.

Course outcome:

Everything in the real world is in a three- dimensional shape. You can simply look around and observe! Even a flat piece of paper has some thickness if you look sideways. A strand of your hair or a big- sized bus, all of them have a three dimensional geometry. And it is necessary to learn their properties.

Module-2: Vector Analysis

Instructor:Dr. Debasis Das

Lecture-20 hours

Product of three or more vectors,

Vector Calculus: Continuity and differentiability of vector-valued function of one variable, Space curve, Arc length, Tangent, Normal. Serret- Frenet's formulae. Integration of vector-valued function of one variable.

Vector-valued functions of two and three variables, Gradient of scalar function, Gradient vector as normal to a surface, Divergence and Curl, their properties.

Evaluation of line integral of the type

Evaluation of surface integrals of the type

Evaluation of volume integrals of the type

Green's theorem in the plane. Gauss and Stokes' theorems (Proof not required), Green's first and second identities.

Course outcome:

√ **Vector calculus motivates the study of vector differentiation and integration in two and three dimensional spaces.**

✔ **It is widely accepted as a prerequisite in various fields of science and engineering.**

✓ **It offers important tools for understanding functions (both real & complex) non-Euclidean geometry and topology.**

Paper-BMTMSEHT305

Title: Logic and Sets

Instructor:Shishir kumar Murmu

Lecture-20 hours

Syllabus:

Introduction, propositions, truth table, negation, conjunction and disjunction.Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations and the laws of set theory and Venn diagrams.Examples of finite and infinite sets.Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set. Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation. Partial ordering relations, n- arry relations.

Course outcome:

√ Properly use the vocabulary and symbolic notation of higher mathematics in definitions, theorems, and problems.

√ Analyze the logical structure of statements symbolically, including the use of logical connectives, predicates, and quantifiers.proper Construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic. Solve problems and write proofs using the concepts of set theory, including the methods of Venn diagrams and truth tables.

SEMESTER-IV

Paper-BMTMCCHT401

Title: Dynamics of Particle

Instructor: Dr. Debasis Das

Lecture:50 hours

Syllabus:

Kinematics

1. Expressions for velocity & acceleration for

(i) Motion in a straight line;

(ii) Motion in a plane;

(a) Cartesian co-ordinates, (b) polar co-ordinates, (c) tangential and normal direction, (d) referred to rotating axes in the plane.

(iii) Motion in three dimension in rectangular Cartesian co-ordinates.

Kinetics

2. Basic kinematic quantities: Momentum and Angular momentum of a moving particle, Potential energy and Kinetic energy of a particle, Principles of conservation (i) of linear momentum, (ii) of angular momentum, (iii) of energy of a particle, Work and Power and simple examples on their applications.

3. Newton's laws of motion, Equation of motion of a particle moving under the action of given external forces.

(a) Motion of a particle in a straight line under the action of forces μxn, n = 0, ± 1, n = -2 (μ>0 or < 0) with physical interpretation,

(b) simple harmonic motion and elementary problems,

(c) the S.H.M. of a particle attached to one end of an elastic string, the other end being fixed,

(d) harmonic oscillator, effect of a disturbing force, linearly damped harmonic motion and Forced oscillation with or without damping,

(f) Vertical motion under gravity when resistance varies as some integral power of velocity, terminal velocity.

4. Impulse of force, Impulsive forces, change of momentum under impulsive forces, Examples, Collision of two smooth elastic bodies, Newton's experimental law of impact, Direct and oblique impacts of (i) Sphere on a fixed horizontal plane, (ii) Two smooth spheres, Energy loss.

5. Motion in two dimensions:

(a) Velocity and acceleration of a particle moving on a plane in Cartesian and polar coordinates, Motion of a particle moving on a plane referred to a set of rotating rectangular axes, Angular velocity and acceleration, Circular motion, Tangential and normal accelerations.

(b) Trajectories in a medium with the

(i) Motion of a projectile under gravity with air resistance neglected;

(ii) Motion of a projectile under gravity with air resistance proportional to velocity, square of the velocity;

(iii) Motion of a simple pendulum;

(c) Central forces and central Orbits: Motion under a central force, basic properties and differential equation of the path under given forces and velocity of projection, Apses, Time to describe a given arc of an orbit, Law of force when the center of force and the central orbit are known. Special study of the following problems:

To find the central force for the following orbits –

(i) A central conic with the force directed towards the focus;

(ii) Equiangular spiral under a force to the pole;

(iii) Circular orbit under a force towards a point on the circumference.

To determine the nature of the orbit and of motion for different velocity of projection under a force per unit mass equal to –

(i) μ / (dist)2 towards a fixed point ;

(ii) under a repulsive force μ / (dist)2 away from a fixed point .

(d) Circular orbit under any law of force μ f (r) with the centre of the circle as the centre of force, Question of stability of a circular orbit under a force μ f (r) towards the center. Particular case of μ f (r) =1/rn.

(e) Kepler's laws of planetary motion from the equation of motion of a central orbit under inverse square law, Modification of Kepler's third law from consideration of motion of a system of two particles under mutual attractions according to Newton's law of gravitational attraction, Escape velocity.

(f) Constrained Motion: Motion of a particle along a smooth curve, Examples of motion under gravity along a smooth vertical circular curve.

Course outcome: After completion of the the students will be able to…

√ The students will be able to organize their knowledge about various concepts such as force, motion, work, energy, impulse, and momentum, among others. Newton's 2nd Law of motion and its integration over time and displacement are also part of the curriculum.

√ Understand the kinematics of particles in Cartesian

√ Display understanding and knowledge of the free body diagram.

Paper-BMTMCCHT402

Title: Partial Differential Equation, Laplace Transform & Tensor Analysis

Instructor:pintu samui

Syllabus:

Module-1: Partial Differential Equation [Lecture:20 hours]

Partial Differential Equations – Basic concepts and Definitions. Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First- order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Solution by Lagrange's and Charpit's method.

Course outcome:

√ Learning first order partial differential equations, its geometrical representation and solving using various methods

√ Solving second order partial differential equations - linear, non-linear, homogeneous and non-homogeneous,

√ Various examples and its solutions are explored using different methods and techniques

Module-2: Laplace Transform

Instructor: Pintu samui

[Lecture-10 hours]

Definition and properties of Laplace transforms, Sufficient conditions for the existence of Laplace Transform, Laplace Transform of some elementary functions, Laplace Transforms of the derivatives, Initial and final value theorems, Convolution theorems, Inverse of Laplace Transform, Application to Ordinary differential equations

Course outcome: After successfully this course, students will be able to..

√ Find the Laplace transform of a function and Inverse Laplace transform of a function using definition.

√ Learn the Laplace transform for ordinary derivatives and partial derivatives of different orders.

√ Use the Method of Laplace transforms to solve ordinary differential equation.

Unit-3: Tensor Analysis

Instructor: pintu samui

[Lecture-20 hours]

Tensor as a generalized concept of a vector in E3.Generalization of idea to an ndimensional Euclidean space (En), Definition of an n-dimensional space, Transformation of Co-ordinates.

Summation Convention, Kronecker delta, Invariant, Contravariant and Covariant vectors, Contravariant and Covariant tensors, Mixed tensors. Algebra of tensors, Symmetric and Skew- symmetric tensors, Contraction, Outer and inner products of tensors, Quotient Law (Statement only).

Fundamental metric tensor of Riemannian space, Reciprocal metric tensor. A magnitude of a vector, angle between two vectors, Christoffel symbols, Covariant differentiation of vectors and tensors of rank 1 and 2. The identities gij,k= gij, k = 0 and δ ij , k = 0.

Course outcome: After studying this course the student will be able to

√ demonstrate knowledge of concepts and theorems in tensor algebra, tensor analysis and the formalism

√ understand coordinate systems and their transformation laws, concepts of tensors and their types, Quotient law.

√ differ between tensor quantities and scalar or vector quantities.

√ understand Contraction and transvection of tensors, Metric tensor and its associated tensor, Christoffel symbols and their coordinate transformation law.

Paper-BMTMCCHT403

Title: Real Analysis-III

Instructor: Shishir kumar Murmu

Lecture:50 hours

Syllabus:

Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two Definitions.

Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.

Intermediate Value theorem for Integrals.Fundamental theorem of Integral Calculus.

Improper integrals. Convergence of Beta and Gamma functions.

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions.

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

Fourier series: Definition of Fourier coefficients and series, ReimannLebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition.

Examples of Fourier expansions and summation results for series.

Power series, radius of convergence.

Differentiation and integration of power series; Abel’s Theorem; Weierstrass Approximation Theorem.

Course outcome: After completion of this course the students will be able to..

√ Riemann-Stieltje's integration and their properties provide mathematical ability and problem solving skills, Concept of sequence and series of functions leads to distinguish between pointwise convergence and uniform convergence

√ Notion of continuity and differentiability of functions of several variables will provide a problem solving skills to solve certain examples.

√ Understand Integrability and theorems on integrability. Recognize the difference between point wise and uniform convergence of a sequence of function.

√ Study improper integration using Riemann integration and concept of power series, their application.

.√ understand about Fourier srries and their application.

Paper-BMTMSEHT405

Title: Graph Theory

Instructor: shishir kumar Murmu

Lecture:20 hours

Syllabus:

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs.

Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems

Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

Travelling salesman’s problem, shortest path, Tree and their properties, spanning tree, Dijkstra’s algorithm, Warshall algorithm.

Course outcome:

√ This course enables the student to know and learn graph theory in detail .

√ It covers major topics like connectivity, Directed Graphs, representation of graph by matrix,tree, Dijkstra's algorithm etc..

SEMESTER-V

Paper-BMTMCCHT501

Title: Algebra-III

Instructor: Shishir kumar murmu

Syllabus:

Module-1: Abstract Algebra

[Lecture-20 hours]

External direct product of a finite number of groups, normal subgroups, quotient groups, Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms.First, Second and Third isomorphism theorems, Automorphism.

Ideal, ideal generated by a subset of a ring, quotient rings, operations on ideals, prime, maximal and primary ideals, quotient ring.

Ring homomorphism, isomorphism, 1st, 2nd and 3rd isomorphism theorems, Every integral domain can be extended to a field.

Course outcome:

√ This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics.

√ The focus of the course will be the study of certain structures called groups, rings, fields and some related structures.

√ In particular to study in details the normal groups, ideals ,ring and group homomrphism,isomophim .This course helps to gain skill in problem solving and critical thinking.

Unit-2: Linear Algebra

Instructor: Pintu samui

[Lecture-30 hours]

Introduction to linear transformations, algebra of linear transformation.null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation. Inverse of a matrix, characterizations of invertible matrices. Subspaces of Rn, dimension of subspaces of Rn, rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Characteristic equation, statement of Caley-Hamilton theorem and its application, eigen values, eigen vectors, similar matrices, diagonalization of matrices of order 2 and 3, Real Quadratic Form involving three variables, Reduction to Normal Form (Statements of relevant theorems and applications).

Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator.

Course outcome:

√Introduction to vector space and subspace and it's application.

√ Use computational techniques and algebraic skills essential for the study of systems of Linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, Orthogonality and Diagonalization. (Computational and Algebraic Skills).

Paper-BMTMCCHT502

Title: Metric Spaces & Complex Analysis

Instructor: Shishir kumar murmu

Syllabus:

Module-1: Metric Spaces

[Lecture-30 hours]

Metric, examples of standard metric spaces including Euclidean and Discrete metrics; open ball, closed ball, open sets; metric topology; closed sets, limit points and their fundamental properties; interior, closure and boundary of subsets and their interrelation; denseness; separable and second countable metric spaces and their relationship.

Continuity: Definition of continuous functions, algebra of real/complex valued continuous functions, distance between a point and a subset, distance between two subsets, Homeomorphism (definitions with simple examples)

Connectedness: Connected subsets of the real line R, open connected subsets in R2, components; components of open sets in R and R2; Structure of open set in R, continuity and connectedness; Intermediate value theorem.

Sequence and completeness: Sequence, subsequence and their convergence; Cauchy sequence, Cauchy's General Principle of convergence, Cauchy's Limit Theorems. completeness, completeness of Rn; Cantor's theorem concerning completeness, Definition of completion of a metric space, construction of the real as the completion of the incomplete metric space of the rational with usual distance (proof not required). Continuity preserves convergence. Compactness.

Course outcome:

√ Able to understand the Euclidean distance function on R n and appreciate its properties.

√ Explain the definition of continuity for functions from R n to R m and determine whether a given function from R n to Rm is continuous

√ Explain the geometric meaning of each of the metric space

√Distinguish between open and closed balls in a metric space

√ Define convergence for sequences in a metric space and Determine whether a given sequence in a metric space converges.

√ concept of connectedness, Compactness, complete metric space.

Module-2: Complex Analysis

Instructor: Shishir kumar murmu [Lecture-20 hours]

Introduction of complex number as ordered pair of real numbers, geometric interpretation, metric structure of the complex plane **C**, regions in **C.** Stereographic projection and extended complex plane **C**∞ and circles in **C**∞ .

Limit, Continuity and differentiability of a complex function, sufficient condition for differentiability of a complex function, Analytic functions and Cauchy-Riemann equation, harmonic functions, Conjugate harmonic functions, Relation between analytic function and harmonic function.

Power series, radius of convergence, sum function and its analytic behavoiur within the circle of convergence, Cauchy-Hadamard theorem.

Transformation (mapping), Concept of Conformal mapping, Bilinear (Mobius) transformation and its geometrical meaning, fixed points and circle preserving character of Mobius transformation.

Course outcome:

√ Compute sums, products, quotients, conjugate, modulus, and argument of complex numbers. Define and analyze limits and continuity for complex functions as well as consequences of continuity.

√Conceive the concepts of analytic functions and will be familiar with the elementary complex functions and their properties Determine whether a given function is differentiable, and if so find its derivative,application of the power series expansion of analytic functions.

√ concept of conformal mapping, Mobous transformation ans it's application.

Paper-BMTMDSHT1

Title: Linear Programming

Instructor: pintu samui

Lecture:50 hours

Syllabus:

General introduction to optimization problem, Definition of L.P.P., Mathematical formulation of the problem, Canonical & Standard form of L.P.P.

Basic solutions, feasible, basic feasible & optimal solutions, Reduction of a feasible solution to basic feasible solution.

Hyperplanes and Hyperspheres, Convex sets and their properties, convex functions, Extreme points, Convex feasible region, Convex polyhedron, Polytope, Graphical solution of L. P.P.

Fundamental theorems of L.P.P., Replacement of a basis vector, Improved basic feasible solutions, Unbounded solution, Condition of optimality, Simplex method, Simplex algorithm, Artificial variable technique (Big M method, Two phase method), Inversion of a matrix by Simplex method. Degeneracy in L.P.P. and itsresolution.

Duality in L.P.P.: Concept of duality, Fundamental properties of duality, Fundamental theorem of duality, Duality & Simplex method, Dual simplex method and algorithm.

Transportation Problem (T.P.): Matrix form of T.P., the transportation table, Initial basic feasible solutions (different methods like North West corner, Row minima, Column minima, Matrix minima & Vogel's Approximation method), Loops in T.P. table and their properties, Optimal solutions, Degeneracy in T.P., Unbalanced T.P.

Assignment Problem, Mathematical justification for optimal criterion, optimal solution by Hungarian Method, Travelling Salesman Problem.

Theory of Games : Introduction, Two person zero-sum games, Minimax and Maximinprinciples, Minimax and Saddle point theorems, Mixed Strategies games without saddle points, Minimax (Maximin) criterion, The rules of Dominance, Solution methods of games without Saddle point; Algebraic method, Matrix method, Graphical method and Linear Programming method.

Course outcome: After studying this course the student will be able to

1: formulate some real life problems into Linear programming problem.

2: use the simplex method to find an optimal vector for the standard linear programming problem and the corresponding dual problem.

3: prove the optimality condition for feasible vectors for Linear programming problem and Dual Linear programming problem.

4: find optimal solution of transportation problem and assignment problem

Paper-BMTMDSHT2

Title: Mechanics-I

Instructor: Dr. Debasis Das

Lecture:50 hours

Syllabus:

Foundations of Classical Dynamics

Inertial frames, Newton's laws of motion, Galilean transformation, Form-invariance of Newton's laws of motion under Galilean transformation, Fundamental forces in classical physics (gravitation), Electric and Magnetic forces, action-at-a-distance. Body forces; contact forces: Friction, Viscosity.

System of particles

Fundamental concepts, centre of mass, momentum, angular momentum, kinetic energy, work done by a field of force, conservative system of forces – potential and potential energy, internal potential energy, total energy.

The following important results to be deduced in connection with the motion of system of particles:

(i) Centre of mass moves as if the total external force were acting on the entire mass of the system concentrated at the centre of mass (examples of exploding shell, jet and rocket propulsion).

(ii) The total angular momentum of the system about a point is the angular momentum of the system concentrated at the centre of mass, plus the angular momentum for motion about the center.

(iii) Similar theorem as in (ii) for kinetic energy.

Conservation laws: conservation of linear momentum, angular momentum and total energy for conservative system of forces.

An idea of constraints that may limit the motion of the system, definition of rigid bodies, D'Alembert's principle, principle of virtual work for equilibrium of a connected system.

Rigid Body

Moments and products of inertia (in three-dimensional rectangular co-ordinates), Inertia matrix, Principal values and principal axes of inertia matrix. Principal moments and principal axes of inertia for (i) a rod, (ii) a rectangular plate, (iii) a circular plate, (iv) an elliptic plate, (v) a sphere, (vi) a right circular cone, (vii) a rectangular parallelepiped and (viii) a circular cylinder.

Equation of motion of a rigid body about a fixed axis, Expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis, Compound pendulum, Interchangeability of the points of a suspension and centre of oscillation, Minimum time of oscillation.

Equations of motion of a rigid body moving in two-dimension, Expression for kinetic energy and angular momentum about the origin of rigid body moving in two dimensions. Necessary and sufficient condition for pure rolling, Two-dimensional motion of a solid of revolution moving on a rough horizontal plane, the following examples of the twodimensional motion of a rigid body to be studied:

(i) Motion of a uniform heavy sphere (solid and hollow) along a perfectly rough inclined plane;

(ii) Motion of a uniform heavy circular cylinder (solid and hollow) along a perfectly rough inclined plane:

(iii) Motion of a rod when released from a vertical position with one end resting upon a perfectly rough table or smooth table.

(iv) Motion of a uniform heavy solid sphere along an imperfectly rough inclined plane; (v) Motion of a uniform circular disc, projected with its plane vertical along an imperfectly rough horizontal plane with a velocity of translation and angular velocity about the centre.

Course outcome: The students will be able to -

1.Understand properties of system of paticle, Newtons law of motion, laws of Galilian transformation, Viscosity etc.

1: Understand D'Alembert's Principle and its simple applications. Able to construct General equation of motion of a rigid body under fixed force, no force and impulsive force.

2: Describe the concept of Motion of a rigid body in two dimensions, Rolling and sliding friction, rolling and sliding of uniform rod and uniform sphere.

3: Able to Describe Motion in three dimensions with reference to Euler's dynamical and geometrical Motion under impulsive forces.

Paper-BMTMDSHT3

Title: Theory of Equations

Instructor:Shishir kumar murmu

Lecture:50 hours

Syllabus:

Module 1:
General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.
Course outcome: After completion of this course the students will be able to understand about properties polynomials, Descarte's rule and it's application.

Module 2:
Symmetric functions. Applications of symmetric function of the roots. Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.
Course outcome: On completion of this course the students will be able to-
. undurstand symmetric function , reciprocal, binomial equation, cubic biquadraic equation and their application.

Module 3:
Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.
Courses outcome:
.They understand about roots of symmetric function, application of Newton's theorem and limit of roots.

Module 4:
Separation of the roots of equations, Strums theorem. Applications of Strum's theorem, Conditions for reality of the roots of an equation. Solution of numerical equations.

Course outcome:

.After completion of this course they know about Strums theorem,their application and solution of numerical equations.

SEMESTER-VI

Paper-BMTMCCHT601 Title:

Numerical Methods & Computer Programming

Syllabus:

Module-1: Numerical Methods

Instructor:Pintu samui

[Lecture-30 hours]

Algorithms.Convergence. Errors: Relative, Absolute. Round off. Truncation.

Transcendental and Polynomial equations: Bisection method, Secant method, Regulafalsi method, fixed point iteration, Newton-Raphson method. Geometrical interpretation, convergency conditions, Rate of convergence of these methods.

System of linear algebraic equations: Gaussian Elimination, Gauss Seidel method and their convergence analysis.

Interpolation: Lagrange and Newton's methods. Error bounds.Finite difference operators.

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Composite Trapezoidal rule, Composite Simpson's 1/3rd rule.

Ordinary Differential Equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Course outcome:

✓Solve an algebraic or transcendental equation using an appropriate numerical method.

√ Solve a differential equation using an approximate numerical method Evaluate a derivative at a value using an appropriate numerical method.

√Perform an error analysis for a given numerical method

✓ Prove results for numerical root finding methods

✓Calculate a definite integral using an appropriate numerical method

✓ Code a numerical method in a modern computer language.

Midule-2: Computer Programming

Instructor: pintu samui

[Lectire-20 hours] Introduction to computer

Computer Languages:Machine language, Assembly language, computer-high level languages, Compiler, Interpreter, Operating system, Source programs and objects programs.

Boolean algebra and its application to simple switching circuits.

Binary number system, Conversions and arithmetic operation, Representation for Integers and Real numbers, Fixed and floating point.

Introduction to C programming: Basic structures, Character set, Keywords, Identifiers, Constants, Variable-type declaration

Operators: Arithmetic, Relational, Logical, assignment, Increment, decrement, Conditional. Operator precedence and associativity, Arithmetic expression,

Statement: Input and Output, Define, Assignment, User define, Decision making (branching and looping) – Simple and nested IF, IF – ELSE, LADDER, SWITCH, GOTO, DO, WHILE – DO, FOR, BREAK AND CONTINUE Statements. Arrays- one and two dimensions, user defined functions.

Statistical and other simple programming

(a) To find mean, median, mode, standard deviation

(b) Ascending, descending ordering of numbers

(c) Finite sum of a series

(d) Fibonacci numbers

(e) Checking of prime numbers

(f) Factorial of a number

(g) Addition and multiplication of two matrices

(h) Matrix Inversion

Course outcome:After completion of this course they understand about theoretical knowledge of C programming.

Paper-BMTMCCHT602

Title: Computer Aided Numerical Practical (P)

Instructor: Pintu samui and Dr. Debasis Dey

Syllabus:

List of Problems for C Programming

1. Finding a real Root of an equation by

(a) Fixed point iteration and **(b)** Newton-Rapson's method.

2. Interpolation (Taking at least six points) by

(a) Lagrange's formula and **(b)** Newton's Forward & Backward Difference Formula.

3. Integration by

(a) Trapezoidal rule

(b) Simpson's 1/3rdrule (taking at least 10 sub-intervals)

4. Solution of a 1storder ordinary differential equation by

(a) Modified Euler's Method

(b) Fourth-order R. K. Method, taking at least four steps.

Course outcome:

***They apply C programming practically in depatmental lab and solve real life problems, they use it for advanced programming language.**

Paper-BMTMDSHT4

Title: Probability and Statistics

Syllabus:

Module-1: Probability

Instructor:Shishir kumar murmu

[Lecture-30 hours]

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.Central Limit theorem for independent and identically distributed random variables with finite variance.

Course outcome:

1. basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables.

2. How to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions.

3. How to calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables, Chebyshev's inequality, central limit theorem.

6. How to translate real-world problems into probabilily methods.

Module-2: Statistics

Instructor:Shishir kumar murmi

[Lecture-20 hours]

Moments and measures of Skewness and Kurtosis.

Bivariate frequency distribution, Scatter diagram, Correlation co-efficients, regression lines and their properties.

Concept of statistical population and random sample, Sampling distribution of sample mean and related $\chi 2$ and t distribution.

Estimation – Unbiasedness and minimum variance, consistency and efficiency, method of maximum likelihood, interval estimation for mean or variance of normal populations.

Testing of hypothesis (based on z, t and $\chi 2$ distributions).

Course outcome:

***Define Moments Skewness and Kurtosis. Fit a straight line.**

***Calculate the correlation coefficient for the given data. Compute Rank correlation.**

*** Define Probability, Conditional probability. Derive Baye's theorem, unbiasedness, learn about method of maximum likehood, testing hypothesis, populatons.**

Paper-BMTMDSHT5

Title: Mechanics-II

Syllabus:

Module-1: Statics

Instructor: Dr. Deadis Das

[Lecture- 20 hours]

Forces in three dimensions: Forces, concurrent forces, Parallel forces, Moment of a force, Couple, Resultant of a force and a couple (Fundamental concept only), Reduction of forces in three-dimensions, Pointsot's central axis, conditions of equilibrium.

Virtual work: Principle of Virtual work, Deduction of the conditions of equilibrium of a particle under coplanar forces from the principle of virtual work, Simple examples of finding tension or thrust in a two-dimensional structure in equilibrium by the principle of virtual work.

Stable and unstable equilibrium, Coordinates of a body and of a system of bodies, Field of forces, Conservative field, Potential energy of a system, Dirichlet's Energy test of stability, stability of a heavy body resting on a fixed body with smooth surfaces- simple examples.

General equations of equilibrium of a uniform heavy inextensible string under the action of given coplanar forces, common catenary, catenary of uniform strength.

Course outcome:

***Concept of force in three dimension, virtual work and their properties, also they know about stable and unstable equilibrium and cartenary**

Unit-2: Elements of Continuum Mechanics & Hydrostatics

Instructor: Dr. Debasis Das

[Lecture- 30 hours]

Deformable body, Idea of a continuum (continuous medium), Surface forces or contact forces, Stress at point in a continuous medium, stress vector, components of stress (normal stress and shear stress) in rectangular Cartesian co-ordinate system; stress matrix, Definition of ideal fluid and viscous fluid.

Pressure (pressure at a point in a fluid in equilibrium is same in every direction), Incompressible and compressible fluid, Homogeneous and non-homogeneous fluids.

Equilibrium of fluids in a given field of force; pressure gradient, Equipressure surfaces, equilibrium of a mass of liquid rotating uniformly like a rigid body about an axis, Simple applications.

Pressure in a heavy homogeneous liquid. Thrust on plane surfaces, center of pressure, effect of increasing the depth without rotation, Centre of pressure of a triangular & rectangular area and of a circular area immersed in any manner in a heavy homogeneous liquid, Simple problems.

Thrust on curved surfaces: Archemedes' principle, Equilibrium of freely floating bodies under constraints. (Consideration of stability not required).

Equation of state of a 'perfect gas', Isothermal and adiabatic processes in an isothermal atmosphere, Pressure and temperature in atmosphere in convective equilibrium.

Course outcome: Upon successful completion of this course the students will be able to:

*** Understand the various properties of fluids and their influence on fluid motion and analyse a variety of problems in fluid statics and dynamics and concept of deformable baody,stress and stair.**

*** Calculate the forces that act on submerged planes and curves.**

***Identify and analyse various types of fluid pressure, thurst on curved surface.**

Paper-BMTMDSHT6

Title: Point Set Topology

Syllabus:

Module 1:
Instructor:Shishir kumar murmu
Lecture:25 hours

Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantor’s Theorem. Cardinal Numbers and Cardinal Arithmetic. Continuum Hypothesis, Zorns Lemma, Axiom of Choice.

Well-Ordered Sets, Hausdorff’s Maximal Principle. Ordinal Numbers.

Course outcome:

*** Observation of differences between**
Countable and Uncountable Sets, application of Cantor's theorem, concept of Hausdorff's maximal principal.

***Ability to learn/understand any topic related to topology.**

Module 2:
Instructor:Shishir kumar murmu
Lecture:25 hours

Topological spaces, Basis and Subbasis for a topology, subspace Topology, Interior Points, Limit Points, Derived Set, Boundary of a set, Closed Sets, Closure and Interior of a set. Continuous Functions, Open maps, Closed maps and Homeomorphisms. Product Topology, Quotient Topology, Metric Topology, Baire Category Theorem. Unit 3 Connected and Path Connected Spaces, Connected Sets in R, Components and Path Components, Local Connectedness. Compact Spaces, Compact Sets in R. Compactness in Metric Spaces. Totally Bounded Spaces, Ascoli-Arzela Theorem, The Lebesgue Number Lemma. Local Compactness.

Course outcome: Upon successful completion of the program the students will be aware of:-

*** The definitions of standard terms in topology.**

***How to read and write proofs in topology with a variety of examples and counter examples.**

***Some important concepts like continuity, compactness, connectedness, projection mapping etc Count ability, separation axioms and convergence in topological spaces. Using new ideas in mathematics and also help them in communicating the subject with other subjects.**

END

Botany (Hons.) syllabus, lesson plan and course outcome

Semester – I
CC – 1 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC101
Course Title - Phycology and Microbiology
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Introduction to microbial world Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). (7 lectures)
Unit 2: Viruses Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T4-phage), lytic and lysogenic cycle; RNA virus (TMV). (7 lectures)
Unit 3: Bacteria Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; vegetative and Reproductive structure - asexual and recombination (conjugation, transformation and transduction). (7 lectures)
Unit 4: Algae General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P.
Iyengar). Role of algae in the environment, agriculture, biotechnology and industry. (11 lectures)
Unit 5: Cyanophyta and Xanthophyta Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and Vaucheria. (8 lectures)
Unit 6: Chlorophyta and Charophyta General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas*, *Volvox*, *Oedogonium*, *Chara*. Evolutionary significance of Prochloron. (8 lectures)
Unit 7: Phaeophyta and Rhodophyta Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Ectocarpus, Fucus and Polysiphonia. (12 lectures)

Practical

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Study od bacteria from curd and root nodule.

Phycology
Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpu*s and *Polysiphonia*, through electron micrographs, temporary preparations and permanent slides.

Course outcome:
After the completion of the course the students will be able to:

1. Develop understanding about the classification and diversity of Bacteria, viruses, Algae and their economic importance.
2. Develop conceptual skill about identifying microbes and algae.
3. Gain knowledge about developing commercial enterprise of microbial products.
4. Understand the structure and lifecycles of certain selected Algae.

Semester – I
CC – 2 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC102
Course Title - Biomolecules and Cell Biology
Course Instructor – Dr. Avishek Dey

Syllabus:
Unit 1: Biomolecules (20 lectures) Types and significance of chemical bonds; Structure and properties of water; pH and buffers. 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; Triacyl glycerols structure, functions and properties; Phosphoglycerides. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.
Unit 2: Bioenergenetics (4 lectures) Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.
Unit 3: Enzymes (6 lectures) 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 theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.
Unit4: The cell (4 lectures) Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin ofeukaryotic cell (Endosymbiotic theory).
Unit 5: Cell wall and plasma membrane (4 lectures) 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.Exracellular matrix
Unit 6: Cell organelles (16 lectures) 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;
Semiautonomous 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 7: Cell division (6 lectures) Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases
.
Practical
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. Measurement of cell size by the technique of micrometry.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
5. Study of cell and its organelles with the help of electron micrographs.
6. Cytochemical staining of : DNA - Aceto orcein and cell wall in the epidermal peel of onion.
7. Study the phenomenon of plasmolysis and deplasmolysis.
8. Study different stages of mitosis and meiosis.

Course outcome:
After the completion of the course the students will be able to:

1. Develop comprehensive understanding about the cellular architecture, communication systems and divisional types.

2. Understand details about bio-molecules, enzymes and bioenergetics.

3. Gain knowledge about developing practical skills in cell biology and biochemistry.

Semester – II
CC – 3 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC201
Course Title - Mycology and Phytopathology
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Introduction to true fungi (6 lectures) General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.
Unit 2: Chytridiomycota and Zygomycota (5 lecture) Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to Synchytrium, Rhizopus .
Unit 3: Ascomycota (10 lectures) General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces*, *Penicillium*, *Neurospora* and *Peziza*.
Unit 4: Basidiomycota (8 lectures) General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat Puccinia (Physiological

Spec5alization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation (Oyster).
Unit 5 Oomycota (4 lectures) General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora*.
Unit 6 Symbiotic associations (4 lectures) Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza,Endomycorrhiza and their significance.
Unit 7: Applied Mycology (9 Lectures) Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Agriculture (Biofertilizers); Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.
Unit 8: Phytopathology (14 lectures)Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Practical
1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus and Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
7. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
8. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Course outcome:

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

1. Develop understanding about the classification and diversity of Fungi, Lichens and their economic importance.

2. Develop conceptual skill about identifying fungi, fungal pathogens, and lichens.

3. Understand the structure and lifecycles of certain selected Fungi.

Semester – II
CC – 4 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC202
Course Title - Archegoniate and Palaeobotany
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Introduction (4 lectures) Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Unit 2: Bryophytes (6 lectures) General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

Unit 3: Type Studies- Bryophytes (12 lectures) Classification (up to order), morphology, anatomy and reproduction of *Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria*; Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros and Polytrichum* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 4: Pteridophytes (6 lectures) General characteristics; Classification; Early land plants *(Cooksonia and Rhynia*).

Unit 5: Type Studies- Pteridophytes (10 lectures) Classification (up to family), morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included).Apogamy, and apospory, heterospory andseed habit, telome theory, stelar evolution; Ecological and economic importance.

Unit 6: Gymnosperms (16 lectures) General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

Unit 7: Palaeobotany (6 Lectures) Plant life through ages, Geological time table, Fossils - definition, types, process of fossilization, factors for fossilization, Importances.

Practical

1. *Riccia* – Morphology of thallus.
2. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionof thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. *Anthocero*s- Morphology of thallus, dissection of sporophyte (to show stomata, spores,pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. *Pellia*, Porella- Permanent slides.
5. *Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).
6. *Polytrichum*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

7. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
8. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
9. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).
13. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
14. Study of fossil genera - *Rhynia, Cooksonia and Lepidodendron* through photographs.
14. Botanical excursion.

Course outcome:

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

1. Develop critical understanding on morphology, anatomy, reproduction, affinities and evolutionary significance of Bryophytes, Pteridophytes and Gymnosperms.

2. Understand the process of plant evolution and their transition to land habitat.

Semester – III
CC – 5 [Credit – 4 (L)+2(P)]
Course Code – 301
Course Title - Anatomy of Angiosperms
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Introduction and scope of Plant Anatomy (4 Lectures) Applications in systematics and pharmacognosy.

Unit 2: Structure and Development of Plant Body (6 Lectures) Internal organization of plant body: The three tissue systems, types of cells and tissues.Root stem transition.
Unit 2: Tissues (12 Lectures) Classification of tissues; Simple and complex tissues (no phylogeny); 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 (15 Lectures) Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, 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, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.
Unit 4: Vascular Cambium and Wood (15 Lectures) Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Anomalous secondary growth in *Bignonia, Boerhaavia, Aristolochia and Dracaena*. 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 (8 Lectures) Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular
and nonglandular, two examples of each), stomata (classification). Mechanical tissue.

Practical

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. Xylem: Tracheary elements-tracheids, xylem fibres.
5. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
6. Root: monocot, dicot, secondary growth.
7. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
8. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
9. Secretory tissues: cavities, lithocysts and laticifers.

Course outcome:

After the completion of the course the students will be able to develop a concept and knowledge on anatomical details of angiosperm.

Semester – III
CC – 6 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC302
Course Title - Economic Botany
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Origin of Cultivated Plants (6 lectures) 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 (6 lectures) Wheat and Rice (origin, morphology, cultivation, management, processing & uses).

Unit 3: Legumes (6 lectures) Origin, morphology cultivation, management and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: Sources of sugars and starches (4 lectures) Morphology and processing of sugarcane, cultivation, management, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: Spices (6 lectures) Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

Unit 6: Beverages (4 lectures) Tea, Coffee (morphology, processing & uses)

Unit 7: Sources of oils and fats (10 lectures) General description, classification, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, comparison with fatty oils & their uses.

Unit 8: Natural Rubber (3 lectures) Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants (8 lectures) Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis; Tobacco (Morphology, processing, uses and health hazards).

Unit 10: Timber plants (3 Lectures) General account with special reference to teak and pine.

Unit 11: Fibers (4 lectures) Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practical

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), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Sources of oils and fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.

10. Tobacco: specimen and products of Tobacco.
11. Woods: Tectona, Pinus: Specimen, Section of young stem.
12. 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 on transverse section of stem and fiber).

Course outcome:

After the completion of the course the students will be able to:
1. Identify the major economically important plants and their role in civilization.
2. Use evidenced-based comparative knowledge and the propagation of plants with respect to environmental conditions.

Semester – III
CC – 7 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC303
Course Title - Genetics
Course Instructor – Dr. Avishek Dey

Syllabus:
Unit 1: Mendelian genetics and its extension (16 lectures)
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, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.
Unit 2: Extrachromosomal Inheritance (6 lectures) Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.
Unit 3: Linkage, crossing over and chromosome mapping (12 lectures) Linkage and crossing over-Cytological and molecular basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.
Unit 4: Variation in chromosome number and structure (8 lectures) Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy
Unit 5: Gene mutations (6 lectures) 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 repair mechanisms.
Unit 6: Fine structure of gene (6 lectures) Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.
Unit 7. Population and Evolutionary Genetics (6 lectures) Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.
Practical
1. Meiosis through temporary squash preparation with special reference to *Allium sp*.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Idea about pretreatment, fixation, staining and smear preparation.
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. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Course outcome:

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

1. Interpret the Mendelian principles of Genetics, Non-Mendelian inheritance, Linkage and Crossing over, cytoplasmic inheritance and sex-linked inheritance.

2. Acquire knowledge on Population and Evolutionary Genetics.

Semester – III
SEC – 1 [Credit – 2 (L)]
Course Code – BBOTSEHT305
Course Title - Biofertilizers
Course Instructor – Dr. Avishek Dey

Syllabus:
Unit 1:General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
(4 lectures)
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. (8 lectures)
Unit 3:Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.(4 lectures)
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.
(8 lectures)
Unit 5:Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (6 lectures)

Course outcome:

After the completion of the course the students will be able to understand the different types and importance of biofertilizers in nursery and gardening as well as in agriculture for a sustainable future.

Semester – IV
CC – 8[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC401
Course Title – Molecular Biology
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Nucleic acids : Carriers of genetic information (4 lectures) Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Unit 2. The Structures of DNA and RNA / Genetic Material (10 lectures) 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 renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes.RNA Structure. Organelle DNA -- mitochondria and chloroplast DNA.The Nucleosome. Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 2:The replication of DNA (10 lectures) Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

Unit 3: Central dogma and genetic code (2 lectures) Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit 4: Transcription (18 lectures) Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in E.coli. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit 5: Processing and modification of RNA (8 lectures) Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.

Unit 6: Translation (8 lectures)
Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases;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.

Practical

1. Preparation of LB medium and raising E.Coli.
2. Isolation of genomic DNA from E.Coli.
3. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication

and semi-discontinuous replication).
4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
5. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
6. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Course outcome:

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

1. Understand the mechanism and concepts of life process at molecular level through central dogma concept.

2. Gain knowledge on nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.

3. Know about Processing and modification of RNA and translation process, function and regulation of expression.

Semester – IV
CC – 9[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC402
Course Title – Plant Ecology and Phytogeography
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Introduction (4 lectures) Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.
Unit 2: Soil (8 lectures) Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.
Unit 3: Water (4 lectures) Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.
Unit 4: Light, temperature, wind and fire (6 lectures) Variations; adaptations of plants to their variation.
Unit 5: Ecosystems (4 lectures) Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.
Unit 6: Population ecology (4 lectures) Characteristics and Dynamics .Ecological Speciation
Unit 7: Plant communities (8 lectures) Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes,

types; climax concepts.
Unit 5: Biotic interactions (2 lectures) Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.
Unit 9: Functional aspects of ecosystem (8 lectures) Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.
Unit 10: Phytogeography (12 lectures) Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.
Practical
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 of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. (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).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Course outcome:

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

1. Develop knowledge on the cognitive development and get the latest exposure in the domain of plant sciences.

2. Develop a knowhow for the development of the proper description of the different environmental issues.

3. Internalization of the concept of conservation and evolution through the channel of the spirit

of enquiry.

Semester – IV
CC – 10[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC403
Course Title – Plant Systematics
Course Instructors – Dr. Avishek Dey and Keya Sarkar

Syllabus:
Unit 1: Significance of Plant systematics (12 lectures) 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; Keys:Single access and Multi-access.
Unit 2: Taxonomic hierarchy (6 lectures) Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
Unit 3: Botanical nomenclature (10 lectures) Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.
Unit 4: Systems of classification (12 lectures) Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.
Unit 5: Biometrics, numerical taxonomy and cladistics (10 lectures) Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).
Unit 6: Phylogeny of Angiosperms (12 lectures) Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram only).
Practical
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):
Malvaceae - *Sida / Abutilon*.
Acanthaceae - *Ruellia/Barleria*
Fabaceae - *Tephrosia/Crotalaria*
Verbenaceae - *Lantana/Vitex*
Asteraceae - *Vernonia/Ageratum, Eclipta/Tridax*
Solanaceae - *Solanum /Nicotiana*
Lamiaceae - *Leucas/Ocimum*
Euphorbiaceae - *Euphorbia / Jatropha*
Liliaceae - *Lilium/Allium*
Poaceae - *Triticum/Andropogon*
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).

Course outcome:

After the completion of the course the students will be able to learn about systematic beauty of the angiosperms especially diversity of angiosperms along with its identification.

Semester – IV
SEC – 2 [Credit – 2 (L)]
Course Code – BBOTSEHT405
Course Title - Herbal Technology
Course Instructor – Dr. Avishek Dey

Syllabus:

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. (6 Lectures)

Unit 2:Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.(6 Lectures)

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). (6 Lectures)

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) (8 Lectures)

Unit 5:Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) (4 Lectures)

Course outcome:

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

1. Gain knowledge about different herbal and medicinal plants of India
2. Know about the phytochemistry and active principles of these plants and utilize them to make commercially available drugs.
3. Develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.

Semester – V
CC –11[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC501
Course Title – Reproductive Biology of Angiosperms
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Introduction (4 lectures) 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.
Unit 2: Reproductive development (6 lectures) Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.
Unit 3: Anther and pollen biology (10 lectures) Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.
Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.
Unit 4: Ovule (10 lectures) 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 4: Pollination and fertilization (6 lectures) Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
Unit 5: Self incompatibility (10 lectures) Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); 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 6: Embryo, Endosperm and Seed (10 lectures) 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. Seed structure, importance and dispersal mechanisms
Units 7: Polyembryony and apomixis (6 lectures) Introduction; Classification; Causes and applications.
Practical
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.
3. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in differentmedia 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: Study of different types..
8. Embryogenesis: Study of development of dicot embryo through permanent slides.

Course outcome:

1. Students will have the pleasure of the cognitive development and get the latest exposure in the domain of the reproductive biology plant sciences.

2. Skill development of for the proper description of the different plant reproduction issues
3. Internalization of the concept of plants reproductive behavioural pattern through the channel of the spirit of enquiry.

Semester – V
CC –12[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC502
Course Title – Plant Physiology
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Plant-water relations (10 lectures) 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.

Unit 2: Mineral nutrition (8 lectures) 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 3: Nutrient Uptake (8 lectures) 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.

Unit 4: Translocation in the phloem (8 lectures) Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 5: Plant growth regulators (14 lectures) Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Unit 6: Physiology of flowering (6 lectures) Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7: Phytochrome , crytochromes and phototropins (6 lectures) Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practical

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 study the phenomenon of seed germination (effect of light).
6. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/Avena coleptile bioassay (demonstration).

Course Outcome:
After the completion of the course the students will be able to:

1. Gain knowledge on the role of physiological processes for plant growth and development.

2. Learn symptoms of mineral deficiency in crops and their management.

3. Assimilate knowledge about Biochemical constitution of plant diversity.

Semester – V
DSE – 1 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSHC1
Course Title – Industrial and Environmental Microbiology
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Scope of microbes in industry and environment (6 lectures)
Unit 2: Bioreactors/Fermenters and fermentation processes (12 lectures) Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale 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 3: Microbial production of industrial products (12 lectures) 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 4: Microbial enzymes of industrial interest and enzyme immobilization (8 lectures) Microorganisms for industrial applicationsand 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 5: Microbes and quality of environment.(6 lectures) Distribution of microbes in air; Isolation of microorganisms from soil, air and water.
Unit 6: Microbial flora of water. (8 lectures) 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 7: Microbes in agriculture and remediation of contaminated soils. (8 lectures) Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.
Practical
1.Principles and functioning of instruments in microbiology laboratory
2.Hands on sterilization techniques and preparation of culture media.

Course Outcome:

1. Studying industrial microbiology to exploit microorganisms for a specific product or use as commercial level.
2. Students will learn about bioreactors/fermenters and fermentation processes.

Semester – V
DSE – 3 [Credit – 5 (L)+1(Tu)]
Course Code – BBOTDSHT3
Course Title – Plant Breeding
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Plant Breeding (2 lectures) Introduction and objectives. Modes of reproduction in crop plants.
Unit 2: Methods of crop improvement (20 lectures) Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
Unit 3: Quantitative inheritance (4 lectures) Concept, mechanism with examples of inheritance.Monogenic vs polygenic Inheritance.
Unit 4:Heterosis (4 lectures) Theories and Applications.
Unit 5: Crop improvement and breeding (10 lectures) Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Project / Dissertation / Seminar / Review work and Viva-voce (20 lectures)

Course Outcome:
To develop conceptual skill about the plant breeding and method of crop improvement.

Semester – VI
CC –13[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC601
Course Title – Plant Metabolism
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Concept of metabolism (6 lectures) Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).
Unit 2: Carbon assimilation (14 lectures) Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.
Unit 3: Carbohydrate metabolism (2 lectures) Synthesis and catabolism of sucrose and starch.
Unit 4: Carbon Oxidation (10 lectures) 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 5: ATP-Synthesis (8 lectures) Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.
Unit 6: Lipid metabolism (8 lectures) Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.
Unit 7: Nitrogen metabolism (8 lectures) Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes);Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.
Unit 8: Mechanisms of signal transduction (4 lectures) Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.
Practical
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.
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.

Course Outcome:

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

1. Understand basic functions and intermediary metabolism in a plant body.

2. Gain knowledge on the role of physiological and metabolic processes for plant growth and development.

Semester – VI
CC –14[Credit – 4 (L)+2(P)]
Course Code – BBOTCCHC602
Course Title – Plant Biotechnology
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Plant Tissue Culture (16 lectures) 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 (12 lectures) Restriction 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 (10 lectures) Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCRmediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR
Unit 4: Methods of gene transfer (8 lectures) Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics–selectable marker and reporter genes (Luciferase, GUS, GFP).
Unit 5: Applications of Biotechnology (14 lectures) Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines;
Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.
Practical
1. (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, Flavr Savr tomato through photographs.

Course Outcome:

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

1. Have knowledge and skill in plant tissue culture, plant molecular biology and transgenic.
2. Understand the basic tools and techniques used in Plant tissue culture.

Semester – VI
DSE – 5 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSHC5
Course Title – Analytical Techniques in Plant Sciences
Course Instructor – Dr. Avishek Dey

Syllabus:
Unit 1: Imaging and related techniques (15 lectures) 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 (8 lectures) Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.
Unit 3: Radioisotopes (4 lectures) Use in biological research, auto-radiography, pulse chase experiment.
Unit 4: Spectrophotometry (4 lectures) Principle and its application in biological research.
Unit 5: Chromatography (8 lectures) Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
Unit 6: Characterization of proteins and nucleic acids (6 lectures) Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE
Unit 7:Biostatistics (15 lectures) 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; Chi-square test for goodness of fit.
Practical
1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
7. Preparation of permanent slides (double staining).

Course Outcome:

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

1. Understand instruments, techniques, lab etiquettes and good lab practices necessary for working in a laboratory.

2. Develop skill in different microscopic techniques.

3. Gain knowledge on applications of radiolabelling techniques, spectroscopy and chromatographic techniques in analysis biomolecules.

4. Have comprehensive concept on analytical techniques used for DNA, RNA and proteins.

Semester – VI
DSE – 6 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSHC6
Course Title – Stress Biology
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Defining plant stress (2 lectures) Acclimation and adaptation.

Unit 2: Environmental factors (20 lectures) Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit 3: Stress sensing mechanisms in plants (20 lectures) Calcium modulation, Phospholipid signaling

Unit 4: Developmental and physiological mechanisms that protect plants against environmental stress (12 lectures) Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.

Unit 5: Reactive oxygen species–Production and scavenging mechanisms. (6 lectures)

Practical

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.

2. Superoxide activity in seedlings in the absence and presence of salt stress.

3. Viability testing of seeds affects heat stress through TTC method.

4. Estimation of superoxide anions.

5. Demonstration of photograph of zymographic analysis of catalase.

Course Outcome:

1. Skill development of for the proper description of the plant health & disease consequences.
2. Internalization of the concept of plant defence mechanisms.

Botany (Program) syllabus, lesson plan and course outcome

Semester – I
CC – 1 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCRC101
Course Title - Biodiversity (Microbes, Algae, Fungi and Archegoniate)
Course Instructors – Dr. Avishek Dey and Keya Sarkar

Syllabus:

Unit 1: Microbes (10 Lectures) Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 Lectures) General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.

Unit 3: Fungi (12 Lectures) Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia,
Agaricus (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: Introduction to Archegoniate (2 Lectures) Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes (10 Lectures) General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 6: Pteridophytes (8 Lectures) General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical
importance of Pteridophytes.

Unit 7: Gymnosperms (6 Lectures) General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. (Developmental details not to be included). Ecological and economical importance.

Practical

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: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, 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. 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, 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).
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).

Course Outcome:

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

1. Develop understanding about the classification and diversity of Bacteria, viruses, Algae, Fungi & Lichens & their economic importance.

2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.

3. Gain knowledge about developing commercial enterprise of microbial products.

4. Understand the structure and lifecycles of certain selected Algae and Fungi.

5. Develop critical understanding on morphology, anatomy, reproduction, affinities and evolutionary significance of Bryophytes, Pteridophytes and Gymnosperms.

6. Understand the process of plant evolution and their transition to land habitat.

Semester – II
CC – 2 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCRC201
Course Title - Plant Ecology and Taxonomy
Course Instructors – Dr. Avishek Dey and Keya Sarkar

Syllabus:

Unit 1: Introduction (2 Lectures)

Unit 2: Ecological factors (10 Lectures) Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 3: Plant communities (6 Lectures) Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 4: Ecosystem (8 Lectures) Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Phytogeography (4 Lectures) Principle biogeographical zones; Endemism

Unit 6 Introduction to plant taxonomy (2 Lectures) Identification, Classification, Nomenclature.

Unit 7 Identification (4 Lectures) Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access.

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 Lectures)

Unit 9 Taxonomic hierarchy (2 Lectures) Ranks, categories and taxonomic groups

Unit 10 Botanical nomenclature (6 Lectures) Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 Classification (6 Lectures) Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 Biometrics, numerical taxonomy and cladistics (4 Lectures) Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences)

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Practical

1. Determination of pH, and analysis of two soil / water samples for carbonates, chlorides, nitrates, sulphates, organic matter by rapid kit 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 (four each). (b)Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. 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):Malvaceae - *Sida / Abutilon*;

Asteraceae - *Vernonia / Ageratum, Eclipta / Tridax*;
Solanaceae -*Solanum nigrum, Withania*; Lamiaceae - *Leucas, Ocimum*; Liliaceae - *Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted with record book).

Course outcome:

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

1. Develop knowledge on the cognitive development and get the latest exposure in the domain of plant sciences.

2. Develop a knowhow for the development of the proper description of the different environmental issues.

3. Internalization of the concept of conservation and evolution through the channel of the spirit of enquiry.
4. To learn about systematic beauty of the angiosperms especially diversity of angiosperms along with its identification.

Semester – III
CC – 3 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCRC301
Course Title - Plant Anatomy and Embryology
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Meristematic and permanent tissues (8 Lectures) Root and shoot apical meristems; Simple and complex tissues.
Unit 2: Organs (4 Lectures) Structure of dicot and monocot root stem and leaf.
Unit 3: Secondary Growth (8 Lectures) Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).
U nit 4: Adaptive and protective systems (8 Lectures) Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.
Unit 5: Structural organization of flower (8 Lectures) Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.
Unit 6: Pollination and fertilization (8 Lectures) Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.
Unit 7: Embryo and endosperm (8 Lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryoendosperm relationship.
Unit 8: Apomixis and polyembryony (8 Lectures) Definition, types and practical applications.

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous / campylotropous.
9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Course outcome:

After the completion of the course the students will be able to develop concept and knowledge on anatomical details and embryology of angiosperm.

Semester – III
SEC – 1 [Credit – 2 (L)]
Course Code – BBOTSERT304
Course Title - Biofertilizers
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1:General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. (4 lectures)

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. (8 lectures)

Unit 3:Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.(4 lectures)

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. (8 lectures)

Unit 5:Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (6 lectures)

Course outcome:

After the completion of the course the students will be able to understand the different types and importance of biofertilizers in nursery and gardening as well as in agriculture for a sustainable future.

Semester – IV
CC – 4 [Credit – 4 (L)+2(P)]
Course Code – BBOTCCRC401
Course Title - Plant Physiology and Metabolism
Course Instructor – Dr. Avishek Dey

Syllabus:
U nit 1: Plant-water relations (8 Lectures) Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.
U nit 2: Mineral nutrition (8 Lectures) Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.
Unit 3: Translocation in phloem (6 Lectures) Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.
Unit 4: Photosynthesis (12 Lectures) Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.
Unit 5: Respiration (6 Lectures) Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.
Unit 6: Enzymes (4 Lectures) Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.
Unit 7: Nitrogen metabolism (4 Lectures) Biological nitrogen fixation; Nitrate and ammonia assimilation.
Unit 8: Plant growth regulators (6 Lectures) Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.
Unit 9: Plant response to light and temperature (6 Lectures) Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Practical
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 a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH 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.

Demonstration experiments (any four)
1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Course Outcome:
After the completion of the course the students will be able to:

1. Understand basic functions and intermediary metabolism in a plant body.

2. Gain knowledge on the role of physiological and metabolic processes for plant growth and development.

3. Learn symptoms of mineral deficiency in crops and their management.

Semester – IV
SEC – 2 [Credit – 2 (L)]
Course Code – BBOTSERT404
Course Title - Herbal Technology
Course Instructor – Dr. Avishek Dey

Syllabus:
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. (6 Lectures)
Unit 2:Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.(6 Lectures)
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). (6 Lectures)
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) (8 Lectures)
Unit 5:Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) (4 Lectures)

Course outcome:

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

1. Gain knowledge about different herbal and medicinal plants of India
2. Know about the phytochemistry and active principles of these plants and utilize them to make commercially available drugs.
3. Develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.

Semester – V
DSE-1 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSRC1
Course Title - Economic Botany and Biotechnology
Course Instructors – Dr. Avishek Dey and Keya Srkar

Syllabus:

Unit 1: Origin of Cultivated Plants (4 Lectures) Concept of centres of origin, their importance with reference to Vavilov's work
Unit 2: Cereals (4 Lectures) Wheat -Origin, morphology, uses
Unit 3: Legumes (6 Lectures) General account with special reference to Gram and soybean
Unit 4: Spices (6 Lectures) General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)
Unit 5: Beverages (4 Lectures) Tea (morphology, processing, uses)
Unit 6: Oils and Fats (4 Lectures) General description with special reference to groundnut
Unit 7: Fibre Yielding Plants (4 Lectures) General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)
Unit 8: Introduction to biotechnology (2 lecture)
Unit 9: Plant tissue culture (8 Lectures) Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications
Unit 10: Recombinant DNA Techniques (18 Lectures) Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Course Outcome:

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

1. Have knowledge & skill in plant tissue culture, plant molecular biology and transgenic.
2. Understand the basic tools and techniques used in Plant tissue culture.
3. Identify the major economically important plants and their role in civilization.
4. Use evidenced-based comparative knowledge and the propagation of plants with respect to environmental conditions.

Semester – V
DSE-2 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSRC2
Course Title - Cell and Molecular Biology
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Techniques in Biology (8 Lectures) Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.
Unit 2: Cell as a unit of Life (2 Lectures) The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.
Unit 3: Cell Organelles (20 Lectures) Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplastDNA. ER, Golgi body & Lysosomes: Structures and roles. Peroxisomes and Glyoxisomes:Structures, composition, functions in animals and plants and biogenesis. Nucleus:Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).
Unit 4: Cell Membrane and Cell Wall (6 Lectures) The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.
Unit 5: Cell Cycle (6 Lectures) Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.
Unit 6: Genetic material (6 Lectures) DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ǿ (theta) mode of replication, replication of linear, ds- DNA, replicating the 5′end of linear chromosome including replication enzymes.
Unit 7: Transcription (Prokaryotes and Eukaryotes) (6 Lectures) Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.
Unit 8: Regulation of gene expression (6 Lectures) Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and

electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study the effect of temperature, organic solvent on semi permeable membrane.
6. Demonstration of dialysis of starch and simple sugar.
7. Study of plasmolysis and deplasmolysis on Rhoeo leaf.
8. Measure the cell size (either length or breadth/diameter) by micrometry.
9. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
10. Study DNA packaging by micrographs.
11. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Course Outcome:

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

1. Understanding the mechanism and concepts of life process at molecular level through central dogma concept.

2. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.

3. Know about Processing and modification of RNA and translation process, function and regulation of expression.

Semester – V
SEC-3 [Credit – 2 (L)]
Course Code – BBOTSERT504
Course Title - Etnobotany
Course Instructor – Keya Sarkar

Syllabus:

Unit 1: Ethnobotany Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. (6 Lectures)
Unit 2: Methodology of Ethnobotanical studies a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. (6 Lectures)
Unit 3: Role of ethnobotany in modern Medicine Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo.* d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina*, *Trichopus zeylanicus*,
Artemisia,*Withania.* Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). (10 Lectures)

Unit 4: Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (8 Lectures)

Course Outcome:

After the completion of the course the students will be able to learn about various medicinal plants, active principles and their therapeutic uses.

Semester – VI
DSE-3 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSRC3
Course Title - Genetics and Plant Breeding
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Mendelian genetics and its extension (8 lectures)
Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy.

Unit 2: Extrachromosomal Inheritance (6 lectures) Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail.
Unit 3: Linkage, crossing over (6 lectures) Linkage and crossing over-Cytological and molecular basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence.

Unit 4: Variation in chromosome number and structure (8 lectures) Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy.
Unit 5: Gene mutations (4 lectures) Types of mutations; Molecular basis of mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents).
Unit 6. Population Genetics (4 lectures) Basic idea, Hardy-Weinberg Law.

Unit 7. Plant Breeding (8 lectures) Introduction and objectives; Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods; Hybridization: Procedure, advantages and limitations.

Unit 8: Crop improvement and breeding (6 lectures) Role of mutations; Polyploidy; role of biotechnology in crop improvement.
Practical
1. Idea about pretreatment, fixation, staining and smear preparation.

2. Mitosis through temporary squash preparation with special reference to root of *Allium sp*.
3. Mendalian and Non-Mendalian inheritance through seed ratios.

Course Outcome:

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

1. Interpret the Mendel's principles; acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.

2. Develop conceptual skill about the plant breeding and method of crop improvement.

Semester – VI
DSE-4 [Credit – 4 (L)+2(P)]
Course Code – BBOTDSRC4
Course Title - Analytical Techniques in Plant Sciences
Course Instructor – Dr. Avishek Dey

Syllabus:

Unit 1: Principles of microscopy (8 lectures); Light microscopy; Fluorescence microscopy; Confocal microscopy; Transmission and Scanning electron microscopy Unit 2: Centrifugation (6 lectures): Principle and application of differential and density gradient centrifugation.
Unit 3: Spectroscopy (4 lectures) Principle and its application in biological research (UV-Vis and IR).
Unit 4: Chromatography (6 lectures) Principle and types.
Unit 5: Characterization of proteins and nucleic acids (4 lectures) using Gel electrophoresis
Unit 6:Biostatistics (5 lectures) Arithmetic mean, mode, median; standard deviation.

Practical

1. Photographs of different analytical instruments used in Plant sciences.

2. Observation of double stained permanent slides of plant samples using light microscopy.

3. Photographs of different Blotting techniques.
4. Separation of amino acid through TLC.

Course Outcome:

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

1. Understand instruments, techniques, lab etiquettes and good lab practices necessary for working in a laboratory.

2. Develop skill in different microscopic techniques.

3. Gain knowledge on applications of radiolabelling techniques, spectroscopy and chromatographic techniques in analysis biomolecules.

4. Have comprehensive concept on analytical techniques used for DNA, RNA and proteins.

Semester – VI
SEC-3 [Credit – 2 (L)]
Course Code – BBOTSERT604
Course Title - Nursery and Gardening
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. (4 Lectures)
Unit 2: Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification. (6 Lectures)
Unit 3:Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house. (6Lectures)
Unit 4: Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.
(8 Lectures)
Unit 5: Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic,tomatoes, and carrots - Storage and marketing procedures. (6 Lectures)

Course Outcome:
To develop in depth knowledge about nursery and gardening. Gain knowledge about developing commercial enterprise of nursery.

Botany (Generic Elective) syllabus, lesson plan and course outcome

Semester – I
GE [Credit – 4 (L)+2(P)]
Course Code – BBOTGEHC6
Course Title - Plant Ecology and Taxonomy
Course Instructor – Keya Sarkar

Syllabus:
Unit 1: Introduction (2 Lectures)
Unit 2: Ecological factors (10 Lectures) Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.
Unit 3: Plant communities (6 Lectures) Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 4: Ecosystem (8 Lectures) Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous
Unit 5: Phytogeography (4 Lectures) Principle biogeographical zones; Endemism
Unit 6 Introduction to plant taxonomy (2 Lectures) Identification, Classification, Nomenclature.
Unit 7 Identification (4 Lectures) Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access.
Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 Lectures)
Unit 9 Taxonomic hierarchy (2 Lectures) Ranks, categories and taxonomic groups
Unit 10 Botanical nomenclature (6 Lectures) Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.
Unit 11 Classification (6 Lectures) Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).
Unit 12 Biometrics, numerical taxonomy and cladistics (4 Lectures) Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms,
cladograms (definitions and differences)
.
Practical

1. Determination of pH, and analysis of two soil / water samples for carbonates, chlorides, nitrates, sulphates, organic matter by rapid kit 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 (four each). (b)Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. 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):Malvaceae - *Sida / Abutilon*; Asteraceae - *Vernonia / Ageratum, Eclipta / Tridax*;
Solanaceae -*Solanum nigrum, Withania*; Lamiaceae - *Leucas, Ocimum*; Liliaceae - *Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted with record book).

Course outcome:

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

1. Develop knowledge on the cognitive development and get the latest exposure in the domain of plant sciences.

2. Develop a knowhow for the development of the proper description of the different environmental issues.

3. Internalization of the concept of conservation and evolution through the channel of the spirit of enquiry.

4. To learn about systematic beauty of the angiosperms especially diversity of angiosperms along with its identification.

Semester – II
GE [Credit – 4 (L)+2(P)]
Course Code – BBOTGEHC6A
Course Title - Plant Physiology and Metabolism
Course Instructor – Dr. Avishek Dey

Syllabus:

U nit 1: Plant-water relations (8 Lectures) Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

U nit 2: Mineral nutrition (8 Lectures) Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem (6 Lectures) Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis (12 Lectures) Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 5: Respiration (6 Lectures) Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes (4 Lectures) Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 Lectures) Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 Lectures) Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9: Plant response to light and temperature (6 Lectures) Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Practical

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 a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 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.

Demonstration experiments (any four)
1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Course Outcome:
After the completion of the course the students will be able to:

1. Understand basic functions and intermediary metabolism in a plant body.

2. Gain knowledge on the role of physiological and metabolic processes for plant growth and development.

3. Learn symptoms of mineral deficiency in crops and their management.

FULL SYLLABUS WITH COURSE OUTCOME, Dept. of ZOOLOGY, Ramananda centenary college, Purulia.

Course Code	Course Title	Course Type	Course outcomes
BZOOCCHC101	**Non-chordates I: Protista to Pseudocoelomates**	**CC-1**	1. Development of clear concept on different invertebrate forms and their physiology. 2. Describing general taxonomic rules of non-chordate classification. 3. Classifying Protista up to phylum using examples from parasitic adaptation.
BZOOCCHC102	**Perspectives in Ecology**	**CC-2**	1. Learning the basic biological principles and processes to understand ecology and environment and their proper functioning. 2. Understanding distribution of fauna in different realms and their mutual interaction. 3. Studying interaction between biotic and abiotic factors. Conducting a local excursion to obtain and record various data and their subsequent analysis to holistically understand Ecology in silico. 4. Developing idea on numerous protected zones in wildlife, different conservation strategies and WPA
BZOOCCHC201	**Non-Chordates II: Coelomates**	**CC-3**	Correlating the theoretical knowledge with practical curricula to develop a holistic idea on Invertebrate Zoology
BZOOCCHC202	**Cell Biology**	**CC-4**	1. Identification & knowledge gathering on cellular & subcellular levels of organisation. 2. Correlating the theoretical knowledge with practical curricula to develop a holistic idea on cell biology.
BZOOCCHC301	**Diversity of Chordata**	**CC-5**	1. Development of clear concept on different vertebrate forms and their physiology. 2. Describing general taxonomic rules of chordate classification.
BZOOCCHC302	**Animal Physiology: Controlling & Coordinating Systems**	**CC-6**	1. Learning principles and concepts of basic physiological processes to relate the various levels of organization and interaction amongst them to ensure proper functionality of an individual. 2. Developing physiological and biochemical understanding through scientific enquiry into the nature of mechanical, physical, and biochemical functions of humans, their organs, and the cells of which they are composed. 3. Understanding interactions and interdependence of physiological and biochemical processes.
BZOOCCHC303	**Fundamentals of Biochemistry**	**CC-7**	1. Learning the practical knowledges to analyse different biochemical samples and assess the presence of macro and/or micro molecules therein. 2. Development of bio-chemical background in various life sustaining processes.

FULL SYLLABUS WITH COURSE OUTCOME, Dept. of ZOOLOGY, Ramananda centenary college, Purulia.

BZOOCCHC401	**Comparative Anatomy of Vertebrates**	**CC-8**	1. Body structures of different species of animals in order to understand the adaptive changes they have undergone in the course of evolution from common ancestors. 2. Comparative anatomy is an important tool that helps determine evolutionary relationships between organisms.
BZOOCCHC402	**Animal Physiology: Life Sustaining Systems**	**CC-9**	1. Learning principles and concepts of basic physiological processes to relate the various levels of organization and interaction amongst them to ensure proper functionality of an individual. 2. Determine if an animal has sustained an injury. Understand the physical capabilities or limitations of particular species.
BZOOCCHC403	**Immunology**	**CC-10**	1. Learning the fundamental basis of how organisms react to biological foreign agents. 2. Understanding different types of immunity. 3. Studying interactions of antigens, antibodies, complements and other immune components. 4. Understanding of immune mechanisms in disease control, vaccination, process of immune interactions. 5. Understanding the basis and mechanism of various parasite mediated and Physiological diseases.
BZOOCCHC501	**Molecular Biology**	**CC-11**	1. Developing knowledge of underlying molecular mechanisms of various genetic and cellular phenomena. 2. Structure and function of macromolecules, the importance of proteins to all living organisms, and molecular genetics.
BZOOCCHC502	**Principles of Genetics**	**CC-12**	1. This course focuses on transmission and molecular genetics. Topics include chromosome structure and replication, genetic linkage and mapping, regulation of gene expression in prokaryotes and eukaryotes, epigenetics, genetic mutation, genetics of cancer, and the principles of genetic engineering. 2. Gathering knowledge on different genetic mechanisms.
BZOOCCHC601	**Developmental Biology**	**CC-13**	1. Aims to understand how an organism develops—how a single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks. 2. Development of clear concept on different vertebrate forms and their physiology. 3. Gathering knowledge on different developmental processes & genetic mechanisms 4. Correlating the theoretical knowledge with practical curricula to develop a holistic idea on Vertebrate Zoology by considering their skeletal systems.
BZOOCCHC602	**Evolutionary Biology**	**CC-14**	1. Evolutionary biology seeks to explain the diversity of life: the variety of organisms

			and their characteristics, and their changes over time. 2. Learning the theoretical skills to taxonomic assessment of different animals correlating their evolutionary background as well as behavioral pattern. 3. Gaining knowledge regarding the various theories of evolution, evolutionary process such as variation, speciation, natural selection, origin of primates and man. 4. Learning basic principles of animal taxonomy, systematic, classification, speciation etc.
BZOOSEHT305	**Aquarium Fish Keeping**	**SEC-1**	1.The main emphasis in ornamental plant breeding is to improve variety traits, novel colour, form, size, number of flowers, flower vase life, repeat blooming, disease resistance, nutrient uptake capacity and growth habit. 2. Increase in the income of the Ornapreneurs and fish farmers through different activities in this sector. To create employment opportunity to the rural & urban population. To augment ornamental fisheries traders & export earnings.
BZOOSEHT405	**Sericulture**	**SEC-2**	1. Gain skill with hands on training on mulberry cultivation and carry forward to field, 3. Gain skill with hands on training on silkworm egg production and support grainage activity, 4. Acquire knowledge and develop skill in silkworm rearing and support silkworm farming. 2. It is used in clothing, upholsteries, surgical sutures, beddings, parachutes, etc. Sericulture is the cultivation of silkworms for harvesting silk. This article will look closer at the impact of sericulture on economy, environment, and society. 3. Sericulture provides gainful employment, economic development and improvement in the quality of life to the people in rural area and therefore it plays an important role in anti poverty programme and prevents migration of rural people to urban area in search of employment.
BZOODSHC1	**Animal Biotechnology**	**DSE-1**	1. The objective of this course is to familiarize the techniques involved animal biotechnology. The course aims to provide theory and practical sessions of biotechnology as part of Professionalization. 2. There is a wide array of scope for veterinary biotechnologists in numerous sectors such as research institutes, defense organizations, biotechnology companies, food-processing plants. Apart from research, they can opt for a teaching profession in different universities.
BZOODSHC2	**Fish and Fisheries**	**DSE-2**	1. A student studying Fisheries resource management is also taught biology, anatomy, taxonomy, physiology along with a fisheries environment which includes oceanography,

			limnology, ecology, biodiversity. 2. The management of fisheries, the protection of species, and the preservation of the aquatic environment all depend on an in-depth study of fish variety, distribution, habitat requirements, and life cycles. 3. It is a multidisciplinary subject that encompasses the biological study of breeding, habits and life of different species of fish.
BZOODSHC3	**Wild Life Conservation and Management**	**DSE-3**	1. Students will be able to identify species, characteristics, habitat requirements and life cycles of birds, fish and/or mammalian wildlife species. Students will be able to apply knowledge to solve problems related to wildlife conservation and management. 2. Natural resources are components of the environment that are vital to humans somehow. The term conservation of natural resources refers to the sustainable use and management of natural resources such as animals, water, air, and earth deposits. 3. Learning the basic biological principles and processes to understand ecology and environment and their proper functioning. 4. Understanding distribution of fauna in different realms and their mutual interaction. 5. Studying interaction between biotic and abiotic factors. 6. Developing idea on numerous protected zones in wildlife, different conservation.
BZOODSHC4	**Parasitology**	**DSE-4**	1. Developing idea on parasites and parasitic diseases, including the distribution, biochemistry, physiology, molecular biology, ecology, evolution and clinical aspects of parasites, including the host response to these agents. 2. Identify, describe and contrast unicellular parasites and parasitic worms. Describe specific human and non-human parasitic diseases. Prepare and observe live parasitic specimens and test students' own seropositivity for a particular parasitic infection.
BZOODSHC5	**Animal Behaviour and Chronobiology**	**DSE-5**	1. The objective of this course is to gain insight into animal behavior, we are in a stronger position to understand vexing conservation problems, such as how to save endangered species, assess environmental quality, design nature preserves, and evaluate the importance of human-related threats to survival in otherwise fit animals.
BZOODSHC6	**Bio statistics and Bio informatics**	**DSE-6**	1. Learning the theoretical skills to establish any biological phenomena by statistically assessing the experimental data. 2. The objective of this course is to data analysis and statistical reasoning applied practically to medicine and public health. It is a fundamental discipline at the core of modern health data science, and underpins most key public health research disciplines such as epidemiology and health services research.

			3. Bioinformatics combines computer programming, big data, and biology to help scientists understand and identify patterns in biological data. It is particularly useful in studying genomes and DNA sequencing, as it allows scientists to organize large amounts of data.

FULL SYLLABUS WITH COURSE OUTCOME, Dept. of ZOOLOGY, Ramananda centenary college, Purulia.

Course Code	Course Title	Course Type	Allotted
BZOOCCHC101	**Non-chordates I: Protista to Pseudocoelomates**	**CC-1**	R.M
BZOOCCHC102	**Perspectives in Ecology**	**CC-2**	M.KS.
BZOOCCHC201	**Non-Chordates II: Coelomates**	**CC-3**	R.M
BZOOCCHC202	**Cell Biology**	**CC-4**	M.KS.
BZOOCCHC301	**Diversity of Chordata**	**CC-5**	R.M
BZOOCCHC302	**Animal Physiology: Controlling & Coordinating Systems**	**CC-6**	M.KS.
BZOOCCHC303	**Fundamentals of Biochemistry**	**CC-7**	M.KS.
BZOOCCHC401	**Comparative Anatomy of Vertebrates**	**CC-8**	R.M
BZOOCCHC402	**Animal Physiology: Life Sustaining Systems**	**CC-9**	M.KS.
BZOOCCHC403	**Immunology**	**CC-10**	M.KS.
BZOOCCHC501	**Molecular Biology**	**CC-11**	M.KS.
BZOOCCHC502	**Principles of Genetics**	**CC-12**	M.KS.
BZOOCCHC601	**Developmental Biology**	**CC-13**	M.KS.
BZOOCCHC602	**Evolutionary Biology**	**CC-14**	R.M
BZOOSEHT305	**Aquarium Fish Keeping**	**SEC-1**	M.KS.
BZOOSEHT405	**Sericulture**	**SEC-2**	R.M
BZOODSHC1	**Animal Biotechnology**	**DSE-1**	M.KS.
BZOODSHC2	**Fish and Fisheries**	**DSE-2**	M.KS.
BZOODSHC3	**Wild Life Conservation and Management**	**DSE-3**	R.M
BZOODSHC4	**Parasitology**	**DSE-4**	R.M
BZOODSHC5	**Animal Behaviour and Chronobiology**	**DSE-5**	R.M
BZOODSHC6	**Bio statistics and Bio informatics**	**DSE-6**	M.KS.

M.KS.: Dr. MANAB KUMAR SAHA, **R.M:** Mr. RAMANATH MAHATO

SIDHO-KANHO-BIRSHA UNIVERSITY

Purulia, West Bengal, India

CURRICULUM

Under Choice Based Credit System (w.e.f session 2017-2018)

BACHELOR OF SCIENCE(BSC)
HONOURS
IN
ZOOLOGY

BACHELOR OF SCIENCE(BSC) HONOURS IN ZOOLOGY

NOTE: ** referes the **Course Code** of the selected course from the pool of choices

First Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCHC101	1.1 Core T1 – Non-chordates I: Protista to Pseudocoelomates	CC-1	4-2-0	6
BZOOCCHC102	Core T2 – Perspectives in Ecology	CC-2	4-2-0	6
**103	**One from pool of Generic Electives**	GE-1		6
BAECCEST104	Environmental Studies	AECC-1	2-2-0	4
			Total	***22***

Second Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCHC201	Non-Chordates II: Coelomates	CC-3	4-2-0	6
BZOOCCHC202	Cell Biology	CC-4	4-2-0	6
**203	**One from pool of Generic Electives**	GE-2		6
**204	**One from pool of AECC-MIL (ENGLISH / MIL)**	AECC-2	2-0-0	2
			Total	***20***

Third Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCHC301	Diversity of Chordata	CC-5	4-2-0	6
BZOOCCHC302	Animal Physiology: Controlling & Coordinating Systems	CC-6	4-2-0	6
BZOOCCHC303	Fundamentals of Biochemistry	CC-7	4-2-0	6
**304	**One from pool of Generic Electives**	GE-3		6
BZOOSEHT305	Aquarium Fish Keeping	SEC-1	2-0-0	2
			Total	***26***

Fourth Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCHC401	Comparative Anatomy of Vertebrates	CC-8	4-2-0	6
BZOOCCHC402	Animal Physiology: Life Sustaining Systems	CC-9	4-2-0	6

BZOOCCHC403	Immunology	CC-10	4-2-0	6
**404	**One from pool of Generic Electives**	GE-4		6
BZOOSEHT405	Sericulture	SEC-2	2-0-0	2
			Total	***26***

Fifth Semester

Course Code	Course Title	Course Type	(L-P-Tu)	Credit
BZOOCCHC501	Molecular Biology	CC-11	4-2-0	6
BZOOCCHC502	Principles of Genetics	CC-12	4-2-0	6
**503	**One from pool of Discipline Specific Electives**	DSE-1		6
**504	**One from pool of Discipline Specific Electives**	DSE-2		6
			Total	***24***

Sixth Semester

Course Code	Course Title	Course Type	(L-P-Tu)	Credit
BZOOCCHC601	Developmental Biology	CC-13	4-2-0	6
BZOOCCHC602	Evolutionary Biology	CC-14	4-2-0	6
**603	**One from pool of Discipline Specific Electives**	DSE-3		6
**604	**One from pool of Discipline Specific Electives**	DSE-4		6
			Total	***24***

SIDHO-KANHO-BIRSHA UNIVERSITY
Curriculum

BACHELOR OF SCIENCE(BSC) HONOURS IN ZOOLOGY (Continued)

List of Discipline Specific Electives

Available in Semester	DSE Ref Code	DSE Course Code (**)	Course Title	(L-P-Tu)	Credit
V	BZOODSHC1	BZOODSHC	Animal Biotechnology	4-2-0	6

V	BZOODSHC2	BZOODSHC	Fish and Fisheries	4-2-0	6
V	BZOODSHC3	BZOODSHC	Wild Life Conservation and Management	4-2-0	6
VI	BZOODSHC4	BZOODSHC	Parasitology	4-2-0	6
VI	BZOODSHC5	BZOODSHC	Animal Behaviour and Chronobiology	4-2-0	6
VI	BZOODSHC6	BZOODSHC	Bio statistics and Bio informatics	4-2-0	6

SIDHO-KANHO-BIRSHA UNIVERSITY
Curriculum

BACHELOR OF SCIENCE(BSC) HONOURS IN ZOOLOGY (Continued)

List of AECC-MIL Courses

AECC-MIL Course Code (**)	Course Title	Offered By Department	(L-P-Tu)	Credit
BAECCLET	EnglishCommunication	ENGLISH	2-0-0	2
BAECCLBT	BANGLA BHASAR BHASIK SANGJOG বাংলা ভাষার ভাষিক যোগ সংযোগ	BENGALI	2-0-0	2
BAECCLHT	Hindi bhasa aur sampreshan AECC (MIL) : हिन्दी भाषा और सम्प्रेषण	HINDI	2-0-0	2

Title:
1.1 Core T1 – Non-chordates I: Protista to Pseudocoelomates

Syllabus:

1.1 Core T1 – Non-chordates I: Protista to Pseudocoelomates

Non-Chordates I: Protists to Pseudocoelomates 4 Credits

Unit 1: Basics of Animal Classification

1. Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types
2. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Carl Woese)

Unit 2: Protista and Metazoa

1. Protozoa
    1. General characteristics and Classification up to phylum (according to Levine et. al., 1981) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*.
    2. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
2. Metazoa
    1. Evolution of symmetry and segmentation of Metazoa

Unit 3: Porifera
General characteristics and Classification up to classes; Canal system and spicules in sponges

Unit 4: Cnidaria

1. General characteristics and Classification up to classes
2. Metagenesis in *Obelia*
3. Polymorphism in Cnidaria
4. Corals and coral reef diversity, function & conservation

Unit 5: Ctenophora
General characteristics

Unit 6: Platyhelminthes

1. General characteristics and Classification up to classes
2. Life cycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium*

Unit 7: Nematoda

1. General characteristics and Classification up to classes
2. Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*
3. Parasitic adaptations in helminthes

Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.

1.1 Core P1 – Non-Chordates I Lab
Non-Chordates I: Protists to Pseudocoelomates
2 credits
List of Practical
Identification of Amoeba, Euglena, Entamoeba, Opalina, Paramecium, Plasmodium vivax and Plasmodium falciparum (from the prepared slides)
Identification of Sycon, Neptune's Cup, Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora
Identification and significance of adult Fasciola hepatica, Taenia solium and Ascaris lumbricoides
Staining/mounting of any protozoa/helminth from gut of cockroach

Reading References:

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Invertebrates by Brusca&Brusca. Second edition, 2002.

Title:
Core T2 – Perspectives in Ecology
Syllabus:
Unit 1: Introduction to Ecology
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.

Unit 2: Population
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion.
Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors
Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.

Unit 3: Community
Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession with one example

Unit 4: Ecosystem
Types of ecosystem with an 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: Applied Ecology
Wildlife Conservation (in-situ and ex-situ conservation).Management strategies for tiger conservation; Wild life protection act (1972)

List of Practical

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-Wiener 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 CO2
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/Sea coast

Reading References:

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
► Ecology: Theories & Application (2001). 4th Edition by Peter Stilling.
► Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer associates

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Title: Fundamentals of Environmental Studies
Syllabus:
Unit 1: Basics of Environmental Studies (05 lectures)
Definition, Nature, Scope and Importance; Components of environment: Environmental education

Unit 2: Natural Resources: Renewable and Nonrenewable Resources (10 lectures)
Nature and natural resources their conservation and associated problems:

- Forest resources: Uses, types and importance, Joint Forest Management & Tribal population, Deforestation and its effects
- Water resources: Distribution of water on Earth; Use, over exploitation of surface and ground water; Dams: Benefits and problems; Flood and Drought
- Mineral resources: Mineral resources in India; Use and exploitation, Social impacts of mining
- Food resources: World food problems and food insecurities.
- Energy resources: Renewable and Nonrenewable energy sources; Use of alternate energy sources - Case studies
- Land resources: Land as a resource; Land degradation, landslides, soil erosion, desertification
- Use of resources for sustainable development

Unit 3: Ecology and Ecosystems (08 lectures)
Concept of ecology, Population ecology, Community ecology

- Concept of an ecosystem, different types of ecosystem
- Food chains, food weds and ecological succession
- Energy flow in the ecosystem and energy flow models

Unit 4: Biodiversity and its conservation (08 lectures)

- Biodiversity: Levels of biological diversity
- Values of biodiversity

- Hot-Spots of biodiversity, Mega-biodiversity countries
- Threat to biodiversity
- Threatened and endemic species of India
- Conservation of biodiversity (*In- situ* and *Ex-situ)*
- Ecosystem services: Ecological, Economical, Social, Ethical, Aesthetical and Informational values

Unit 5: Environmental Pollution and Management (08 lectures)

(a) Nature, Causes, Effects and Control measures of –

(i) Air pollution (ii) Water pollution (iii) Soil pollution (iv) Noise pollution

v) Nuclear hazards

(b) Fireworks Pollution: Definition, Composition/Ingredients, effects, monitoring strategies

- Solid waste management: Causes, effects and disposal methods; Management of biomedical and municipal solid wastes
- Disaster management: Floods, Earthquake, Cyclone and Landslides

Unit 6: Environmental Policies and Practices (10 lectures)

- Constitutional Provisions for protecting environment- Articles 48(A), 51 A (g)
- Environmental Laws: The Environment (Protection) Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act 1974; Forest (Conservation) Act, 1980
- The wildlife Protection Act, 1972
- Climate change, Global warming, ENSO, Acid rain, Ozone layer depletion; Montreal and Kyoto Protocols

Unit 7: Human Communities and Environment (06 lectures)

- Human population growth; Impacts on environment
- Population explosion – Family Welfare Programme
- Environment and human health: Concept of health and disease; Common communicable and Non- communicable diseases; Public awareness
- Environment movements in India: Chipko Movements, Silent Valley Movement, Movements in Karnataka

Unit 8: Field Work Report/Project Report/Term paper (based on any one of the following topics and to be evaluated by internal teachers only) (05 lectures)

- Environmental assets - River/Forest/Grassland/Hill/Mountain *etc*.
- Environmental pollution - Urban/Rural/Industrial/Agricultural
- Study of common Plants/Insect /Birds/Wild life *etc*.
- Study of simple ecosystems: Pond/River/Hill slope *etc*.
- Municipal solid waste management and handling.

Title: Non-Chordates II: Coelomates

Syllabus:

Unit 1: Introduction

Evolution of coelom and metamerism

Unit 2: Annelida
General characteristics and Classification up to classes Excretion in Annelida through nephridia. Metamerism in Annelida.

Unit 3:Arthropoda
1. General characteristics and Classification up to classes. Vision in Insecta.
2. Respiration in Arthropoda (Gills in prawn and trachea in cockroach)
3. Metamorphosis in Lepidopteran Insects.
4. Social life in termite

Unit 4: Onychophora
General characteristics and Evolutionary significance

Unit 5: Mollusca
1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda
3. Feeding and respiration in *Pila* sp

Unit 6: Echinodermata
1. General characteristics and Classification up to classes
2. Water-vascular system in Asteroidea
3. Larval forms in Echinodermata
4. Affinities with Chordates

Unit 7: Hemichordata
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates

Note: Classification to be followed from Rupert and Barnes, 1994, 6th Edition.
List of Practical

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

*Periplaneta**

1. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Reading References:

1. and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition

► The Invertebrates: A New Synthesis, III Edition, Blackwell Science

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Title: Cell Biology

Syllabus:

Unit 1: Overview of Cells

Basic structure of Prokaryotic and Eukaryotic cells, Viruses, Viroid, Prion and Mycoplasma

Unit 2: Plasma Membrane

1. Ultra structure and composition of Plasma membrane: Fluid mosaic model
2. Transport across membrane: Active and Passive transport, Facilitated transport
3. Cell junctions: Tight junctions, Gap junctions, Desmosomes

Unit 3: Cytoplasmic organelles I

1. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes
2. Protein sorting and mechanisms of vesicular transport

Unit 4: Cytoplasmic organelles II

1. Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis
2. Peroxisomes: Structure and Functions

Unit 5: Nucleus

1. Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus
2. Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)

Unit 6: Cell Division

Type, structure and functions of cytoskeleton, Centrosome: Structure and Functions, Accessory proteins of microfilament & microtubule, Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC. Mitosis and Meiosis: Basic process and their significance

Unit 7: Cell Signaling

1. Cell signalling transduction pathways; Types of signaling molecules and receptors
2. GPCR and Role of second messenger (cAMP)
3. Extracellular matrix-Cell interactions
4. Apoptosis and Necrosis

List of Practical

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
    1. DNA by Feulgen reaction/ By Ethidium Bromide
    2. Cell viability study by Trypan Blue staining

Reading References:

Lewin's Cells – 3rd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
► Biology of Cancer by Robert. A. Weinberg. 2nd edition.
► 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.
► 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.

Title: Diversity of Chordata

Syllabus:

Unit 1: Introduction to Chordates

General characteristics and outline classification of Phylum Chordata

Unit 2: Protochordata

General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*. Chordate Features and Feeding in *Branchiostoma*

Unit 3: Origin of Chordata

1. Dipleurula concept and the Echinoderm theory of origin of chordates
2. Advanced features of vertebrates over Protochordata

Unit 4: Agnatha

General characteristics and classification of cyclostomes up to order

Unit 5: Pisces

1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
2. Accessory respiratory organ, migration and parental care in fishes
3. Swim bladder in fishes.

Unit 6: Amphibia

1. General characteristics and classification up to living Orders.

2. Metamorphosis and parental care in Amphibia

Unit 7: Reptilia

1. General characteristics and classification up to living Orders
1. Poison apparatus and Biting mechanism in Snake

Unit 8: Aves

1. General characteristics and classification up to Sub-Classes
2. Exoskeleton and migration in Birds
3. Principles and aerodynamics of flight

Unit 9: Mammals

1. General characters and classification up to living orders
2. Affinities of Prototheria
3. Exoskeleton derivatives of mammals
4. Adaptive radiation in mammals with reference to locomotor appendages
5. Echolocation in Chiropterans and Cetaceans

Unit 10: Zoogeography

Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Nelson (1994), for Amphibia to be followed from Duellman and Trueb (1986).

List of Practical

1. Protochordata

Balanoglossus, Herdmania, Branchiostoma

1. Agnatha

Petromyzon, Myxine

1. Fishes

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

1. Amphibia

Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton

1. Reptilia

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

1. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
2. Pecten from Fowl head
3. Dissection of brain and pituitary of Tilapia
4. Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

Title: Animal Physiology: Controlling & Coordinating Systems

Syllabus:

Unit 1: Tissues

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

Unit 2: Bone and Cartilage

Structure and types of bones and cartilages, Ossification

Unit 3: Nervous System

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and Neuromuscular junction; Reflex action and its types

Unit 4: Muscular system

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

Unit 5: Reproductive System

Histology of testis and ovary (mammalian), Physiology of Reproduction (mammalian)

Unit 6: Endocrine System

1. Histology and function of pituitary, thyroid, pancreas and adrenal
2. Classification of hormones; Mechanism of Hormone action
3. Signal transduction pathways for Steroidal and Non steroidal hormones
4. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system

5. Placental hormones

List of Practical

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)
3. Preparation of temporary mounts: Squamous epithelium.
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/Fish) tissues

Reading References:

Reference Books

► Histology: A Text and Atlas. Sixth Edition. Ross &Pawlina. Lippincott Williams & Wilkins.

► Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition. W.H.Freeman.

Title: Fundamentals of Biochemistry

Syllabus:

Unit 1: Carbohydrates

1. Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosachharides
2. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

Unit 2: Lipids

1. Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids.
2. Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis

Unit 3: Proteins

1. Amino acids

Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids

1. Proteins

Bonds stabilizing protein structure; Levels of organization
Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 4: Nucleic Acids

1. Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids
2. Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA
3. Basic concept of nucleotide metabolism

Unit 5: Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)

Unit 6: Oxidative Phosphorylation

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

List of Practical

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Quantitative estimation of Lowry Method
3. Demonstration of proteins separation by SDS-PAGE.
4. To study the enzymatic activity of Trypsin and Amylase.

5. Preparation of Normal. Molar and Standard solutions, Phosphate Buffers, Serial dilutions

Reading References:

Reference Books

► 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.

Title: Aquarium Fish Keeping

Syllabus:

Unit 1: Introduction to Aquarium Fish Keeping

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

Unit 4: Fish Transportation

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

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Title: Comparative Anatomy of Vertebrates

Syllabus:

Unit 1: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals

Unit 2: Skeletal System

Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.

Unit 3: Digestive System

Comparative anatomy of stomach; dentition in mammals

Unit 4: Respiratory System

Respiratory organs in fish, amphibian, birds and mammals

Unit 5: Circulatory System

General plan of circulation, Comparative account of heart and aortic arches

Unit 6: Urinogenital System

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System

Comparative account of brain, Cranial nerves in mammals

Unit 8: Sense Organs

Classification of receptors, Brief account of auditory receptors in vertebrate

List of Practical

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig
3. Demonstration of Carapace and plastron of turtle
4. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal
5. Dissection of Tilapia: Digestive system, Brain, pituitary, urinogenital system

Reading References:

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

Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons

Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt.

Title: Animal Physiology: Life Sustaining Systems

Syllabus:

Unit 1: Physiology of Digestion

Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids, Proteins and Nucleic Acids; Digestive enzymes

Unit 2: Physiology of Respiration

Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning

Unit 3: Physiology of Circulation

1. Components of Blood and their functions; Structure and functions of haemoglobin
2. Haemostasis; Blood clotting system, Fibrinolytic system
3. Haemopoiesis; Basic steps and its regulation

1. Blood groups; ABO and Rh factor

Unit 4: Physiology of Heart

1. Structure of mammalian heart, Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses
2. Cardiac Cycle and cardiac output
3. Blood pressure and its regulation

Unit 5: Thermoregulation & Osmoregulation

1. Physiological classification based on thermal biology.
2. Thermal biology of endotherms
3. Osmoregulation in aquatic vertebrates
4. Extrarenal osmoregulatory organs in vertebrates

Unit 6: Renal Physiology

Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance

List of Practical

1. Enumeration of red blood cells and white blood cells using haemocytometer
2. Estimation of haemoglobin using Sahli's haemoglobinometer
3. Preparation of haemin and haemochromogen crystals
4. Recording of blood pressure using a sphygmomanometer

Reading References:

Reference Books

► 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,
► Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and FrenchVander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

► Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

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Title: Immunology

Syllabus:

Unit 1: Overview of Immune System
Basic concepts of health and diseases, Historical perspective of Immunology, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).

Unit 3: Antigens
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit 4: Immunoglobulins
Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production

Unit 5: Major Histocompatibility Complex
Structure and functions of MHC molecules.
Structure of T cell Receptor and its signalling, T cell development & selection

Unit 6: Cytokines
Types, properties and functions of cytokines.

Unit 7: Complement System
Components and pathways of complement activation.

Unit 8: Hypersensitivity
Gell and Coombs' classification and brief description of various types of hypersensitivities.

Unit 9: Immunology of diseases
Dengue and Tuberculosis, Leprosy

Unit 10: Vaccines
Various types of vaccines. Active & passive immunization (Artificial and natural).

List of Practical

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. ABO blood group determination.
5. Demonstration of ELISA

The experiments can be performed depending upon usage of animals in UG courses.

Reading References:

Reference Books

► Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.

- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

Title: Sericulture

Syllabus:

Unit 1: Introduction

1. Sericulture: Definition, history and present status; Silk route
2. Types of silkworms, Distribution and Races
3. Exotic and indigenous races
4. Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

1. Life cycle of *Bombyx mori*
2. Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

1. Selection of mulberry variety and establishment of mulberry garden
2. Rearing house and rearing appliances.
3. Disinfectants: Formalin, bleaching powder, RKO
4. Silkworm rearing technology: Early age and Late age rearing
5. Types of mountages
6. Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

1. Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
2. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
3. Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture

1. Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture
2. Visit to various sericulture centres.

Title: Molecular Biology

Syllabus:

Unit 1: Nucleic Acids

Salient features of DNA and RNA Watson and Crick Model of DNA

Unit 2: DNA Replication

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres

Unit 3: Transcription

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

Unit 4: Translation

Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 6: Gene Regulation

Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

Unit 7: DNA Repair Mechanisms

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

Unit 8: Molecular Techniques

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing

List of Practical

1. Demonstration of polytene and lampbrush chromosome from photograph
2. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement)
3. Agarose gel electrophoresis for DNA

Reading References:

Reference Books

► Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman.
► Molecular BiologyOf The Gene by Watson. 7th Edition. Pearson.
► iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.

Title: Principles of Genetics

Syllabus:

Unit 1: Mendelian Genetics and its Extension

1. Principles of inheritance, Incomplete dominance and co-dominance, Epistasis Multiple alleles, Lethal alleles, Pleiotropy,
2. Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence

Unit 3: Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

Unit 4: Sex Determination

1. Mechanisms of sex determination in *Drosophila*
2. Sex determination in mammals
3. Dosage compensation in *Drosophila* & Human

Unit 5: Extra-chromosomal Inheritance

1. Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamyadomonas,*
2. Kappa particle in *Paramoecium*
3. Shell spiralling in snail

Unit 6: Recombination in Bacteria and Viruses

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 7: Transposable Genetic Elements

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, LINE, SINE, Alu elements in humans

List of Practical

1. Chi-square analyses
2. Linkage maps based on conjugation
3. Identification of chromosomal aberration in Drosophila and man from photograph
4. Pedigree analysis of some human inherited traits

Reading References:

Reference Books

► Developmental biology by Scott.F.Gilbert, 9th edition.

► 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.

Title: Developmental Biology

Syllabus:
Unit 1: Introduction
Basic concepts: Phases of Development, Cell cell interaction, Differentiation and growth, Differential gene expression

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
Development of brain and Eye in Vertebrate
Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

Unit 5: Implications of Developmental Biology
Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis
List of Practical
1. Study of whole mounts 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)
2. Study of the developmental stages and life cycle of Drosophila from stock culture
3. Study of different sections of placenta (photomicropgraph/ slides)
4. Project report on Drosophila culture/chick embryo development

Reading References:
Reference Books

► Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
► Slack JMW , Essential Developmental Biology

Title: Evolutionary Biology

Syllabus:
Unit 1

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

Unit 2
Historical review of Evolutionary concepts, Lamarkism, Darwinism and Neo Darwinism

Unit 3
1. Geological time scale, Fossil records of Hominids (from *Australopithecus* to *Homo sapiens*), evolution of horse
2. Neutral theory of molecular evolution, Molecular clock

Unit 4
Sources of variations: Heritable variations and their role in evolution

Unit 5
1. Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority).
2. Genetic Drift mechanism (founder's effect, bottleneck phenomenon)
3. Role of Migration and Mutation in changing allele frequencies.

Unit 6
Species concept, Isolating mechanisms, modes of speciation
Adaptive radiation/macroevolution (exemplified by Galapagos finches)

Unit 7
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

Unit 8
1. Origin and Evolution of Man, Unique Hominin characteristics contrasted with primate characteristic
2. Molecular analysis of human origin

Unit 9
Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Convergent & Divergent evolution.

List of Practical
1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis

4. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Reading References:

Reference Books

► Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
► Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
► Genetics: A Molecular Approach. 3rd edition. Peter.J.Russell.

BACHELOR OF SCIENCE(BSC) HONOURS IN ZOOLOGY (Continued)

List of Discipline Specific Electives

Title: Animal Biotechnology

Syllabus:

Unit 1: Introduction

Concept and scope of Biotechnology. Organization of prokaryotic and eukaryotic genome, Concept of genomics

Unit 2: Molecular Techniques in Gene manipulation

1. 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. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization
2. Southern, Northern and Western blotting
3. DNA sequencing: Sanger method
4. Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms

1.Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.

2.Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.

Unit 4: Culture Techniques and Applications

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

List of Practical

1. Genomic DNA isolation from E. coli/Blood genomic
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
    1. Southern Blotting
    2. Northern Blotting
    3. Western Blotting
    4. DNA Sequencing (Sanger's Method)
    5. PCR
    6. DNA fingerprinting
7. Project report on animal cell culture

Reading References:

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 Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.

► Weaver. Molecular Biology of Gene. 5th edition.

Primrose & Twyman. Principles of Gene Manipulation and Genomics. 7th edition.

Title: Fish and Fisheries

Syllabus:

Unit 1: Introduction and Classification

1. General description of fish
2. Feeding habit, habitat and manner of reproduction
3. Classification of fish (up to Subclasses)

Unit 2: Morphology and Physiology

Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence

Unit 3: Fisheries

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

Unit 4: Aquaculture

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

Unit 5: Fish in research
Transgenic fish, Sex reversal

Note: Classification to be followed from: Nelson (2004)
List of Practical

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, Conductivity, Turbidity, Alkalinity, Salinity
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
7. Project Report on a visit to any fish farm/ pisciculture unit.

Reading References:
Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
► D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor.The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
► C.B.L. Srivastava, Fish Biology, Narendra Publishing House
► J.R. Norman, A history of Fishes, Hill and Wang Publishers
► S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

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Title: Wild Life Conservation and Management

Syllabus:
Unit 1: Introduction to Wild Life
Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

Unit 2: Evaluation and management of wild life
Habitat analysis, Physical parameters: Topography, Geology, Soil and water Biological Parameters: food, cover, forage, browse and cover estimation Standard evaluation procedures: remote sensing and GIS.

Unit 3: Management of habitats
Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity
Restoration of degraded habitats

Unit 4: Population estimation
Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores; Pug marks and census method.

Unit 5: Aims and objectives of wildlife conservation

Wildlife conservation in India – through ages; different approaches of wildlife conservation; modes of conservation; in-situ conservation and ex-situ conservation: necessity for wildlife conservation

Unit 6: Management planning of wild life in protected areas
Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbence.

Unit 7: Man and Wildlife
Causes and consequences of human-wildlife conflicts; mitigation of conflict – an overview; Management of excess population

Unit 8: Protected areas

National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.
List of Practical

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc.
4. Demonstration of different field techniques for flora and fauna
5. PCQ, ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)

Reading References:
Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
► Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
► Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
► Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
► Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

Title: Parasitology

Syllabus:
Unit 1: Introduction to Parasitology
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

Unit 2: Parasitic Protists
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*

Unit 3: Parasitic Platyhelminthes
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium, Taenia sajinata*

Unit 4: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti* and *Trichinella spiralis*, *Brugia malayi*; Nematode plant interaction; Gall formation

Unit 5: Parasitic Arthropods

Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*)

Unit 5: Parasite Vertebrates

Brief account of Cookicutter Shark, Hood Mocking bird, Vampire bat

List of Practicals

1. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*

through permanent slides/micro photographs

1. Study of adult and life stages of *Schistosoma haematobium, Taenia sajinata* through permanent slides/micro photographs
2. Study of adult and life stages of *Ancylostoma duodenale*, *Brugia malayi* and *Trichinella spiralis* through permanent slides/micro photographs
3. Immunopathology of Malaria and Filaria
4. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample
5. Study of *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
6. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
7. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product

Submission of a brief report on parasitic vertebrates

Reading References:

Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors

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 and Francis Group

Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS

Title: Animal Behaviour and Chronobiology

Syllabus:

Unit 1: Introduction to Animal Behaviour

Origin and history of Ethology, Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

Unit 2: Patterns of Behaviour

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

Unit 3: Social and Sexual Behaviour

Social Behaviour: Concept of Society; Communication and the senses

Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Parental care in fish and amphibian, Parent-offspring conflict.

Unit 4: Introduction to Chronobiology

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period Adaptive significance of biological clocks

Unit 5: Biological Rhythm

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

List of Practical

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

Reading References:

Animal Behaviour by Drickamar.

► John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.

► Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.

► Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA

► Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Title: Bio statistics and Bio informatics

Syllabus:

Unit 1: Concept of data and distribution

1. Definition of data.
2. Concept of qualitative, quantitative, discrete, continuous, nominal, ordinal, interval and ratio data.
3. Types of distribution: Normal, skewed, uniform, symmetric bimodal, non-symmetric bimodal, spread, spread with outlier.
4. Basic concept and types of Kurtosis.

Unit 2: Probability and its use in Biological Sciences

1. General concept of probability.
2. The sum rule and the product rule.
3. Usage of probability in Biological Sciences (Genetics mainly).

Unit 3: Analytical Methods

1. Correlation.
2. Regression.
3. t Test.

Unit 4: Bioinformatics

1. Basic concept of Bioinformatics: Goals, scope, application and limitations.
2. Biological databases: Primary, secondary, and specialised databases.
3. Pitfalls of biological databases.

List of practical:

1. Calculation of mean, median, mode, standard deviation, and standard error.
2. Construction of bar diagrams and pie diagrams using computer.
3. Submission of a project report on field generated data with application of at least one statistical tool (i.e. correlation, regression, t Test, mean, median, mode, standard deviation, and standard error)

Reading references:

1. Essential Bioinformatics by JinXiong, 1st Edition, 2006, Cambridge University press
2. Genetics: Analysis and Principles by Robert Brooker, 4th Edition, 2012, McGrow Hill
3. Biostatistics: A guide to design, analysis and discovery by Ronald Forthofer Eun Lee Mike Hernandez, 2nd Edition, 2006, Academic Press (Elsevier)

SIDHO-KANHO-BIRSHA UNIVERSITY

Purulia, West Bengal, India

CURRICULUM

Under Choice Based Credit System (w.e.f session 2017-2018)

BACHELOR OF SCIENCE(BSC)
PROGRAM COURSE
WITH
ZOOLOGY

NOTE: ** referes the **Course Code** of the selected course from the pool of choices

First Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCRC101	Non-Chordates I: Protists to Pseudocoelomates	CC-1 (Discipline A)	4-2-0	6
102	Discipline B	CC-1 (Discipline B)		6
103	Discipline C	CC-1 (Discipline C)		6
**104	**One from pool of AECC-MIL (ENGLISH / MIL)**	AECC-1	2-0-0	2
Total				***20***

Second Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCRC201	Non-Chordates II: Coelomates	CC-2 (Discipline A)	4-2-0	6
202	Discipline B	CC-2 (Discipline B)		6
203	Discipline C	CC-2 (Discipline C)		6
BAECCEST204	Environmental Studies	AECC-2	2-2-0	4
Total				***22***

Third Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCRC301	Diversity of Chordata	CC-3 (Discipline A)	4-2-0	6
302	Discipline B	CC-3 (Discipline B)		6
303	Discipline C	CC-3 (Discipline C)		6
BZOOSERT304	Aquarium Fish Keeping	SEC-1 (Discipline A)	2-0-0	2
Total				***20***

Fourth Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
BZOOCCRC401	Comparative Anatomy of Vertebrates	CC-4 (Discipline A)	4-2-0	6
402	Discipline B	CC-4 (Discipline B)		6
403	Discipline C	CC-4 (Discipline C)		6
BZOOSERT404	Sericulture	SEC-2 (Discipline A)	2-0-0	2
Total				***20***
Fifth Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
**501	**One from pool of Discipline Specific Electives of Zoology**	DSE-1 (Discipline A)		6
**502	**One from pool of Discipline Specific Electives of Discipline B**	DSE-1 (Discipline B)		6
**503	**One from pool of Discipline Specific Electives of Discipline C**	DSE-1 (Discipline C)		6
BZOOSERT504	Medical Diagnostic Techniques	SEC-3 (Discipline A)	2-0-0	2
Total				***20***

Sixth Semester				
Course Code	**Course Title**	**Course Type**	**(L-P-Tu)**	**Credit**
**601	**One from pool of Discipline Specific Electives of Zoology**	DSE-2 (Discipline A)		6
**602	**One from pool of Discipline Specific Electives of Discipline B**	DSE-2 (Discipline B)		6
**603	**One from pool of Discipline Specific Electives of Discipline C**	DSE-2 (Discipline C)		6
BZOOSERT604	Apiculture	SEC-4 (Discipline A)	2-0-0	2
Total				***20***

DSE Ref Code	**DSE Course Code (**)**	**Course Title**	**Offered By Department**	**(L-P-Tu)**	**Credit**
BZOODSRC1	BZOODSRC	Wild Life Conservation and Management	Zoology	4-2-0	6
BZOODSRC2	BZOODSRC	Fish and Fisheries	Zoology	4-2-0	6

GE Reference Code	**GE Course Code (**)**	**Course Title**	**Offered By Department**	**(L-P-Tu)**	**Credit**
BSNSGERT1	BSNSGERT	Basic Sanskrit प्राथमिकसंस्कृतम्	SANSKRIT	5-0-1	6
BHISGERT2	BHISGERT	Colonialism and Developments in the Environment: India	HISTORY	5-0-1	6
BENGGERT3	BENGGERT	Selections from English Prose and Poems	ENGLISH	5-0-1	6
BMUCGERT4	BMUCGERT	Preliminary knowledge of Music in practical field	MUSIC	5-0-1	6
BBNGGERT5	BBNGGERT	PRAK-ADHUNIK BANGLA SAHITYER NIRBACHITA PATH প্রাক-আধুনিক বাংলা সাহিত্যের নির্বাচিত পাঠ	BENGALI	5-0-1	6
BBOTGERC6	BBOTGERC	Plant Ecology and Taxonomy	BOTANY	4-2-0	6
BCEMGERC7	BCEMGERC	Atomic Structure, Chemical Periodicity, Acids And Bases, Redox Reactions, General Organic Chemistry & Aliphatic Hydrocarbons	CHEMISTRY	4-2-0	6
BEDCGERT8	BEDCGERT	Philosophical and Sociological Foundations of Education	EDUCATION	5-0-1	6
BECOGERT9	BECOGERT	Introductory Microeconomics	ECONOMICS	5-0-1	6
BMTMGERT10	BMTMGERT	Basics of Higher Mathematics	MATHEMATICS	5-0-1	6
BPHIGERT11	BPHIGERT	Ethics in the Public Domain	PHILOSOPHY	5-0-1	6
BPHSGERC12	BPHSGERC	Mechanics	PHYSICS	4-2-0	6
BPLSGERT13	BPLSGERT	Gandhi and Contemporary World I	POLITICAL SCIENCE	5-0-1	6
BGEOGERT14	BGEOGERT	GE 1 – Climate Change: Vulnerability and Adaptation	GEOGRAPHY	5-0-1	6
BSNTGERT15	BSNTGERT	Introduction of Santali Language Santali Parsi Reyak Uprum	SANTALI	5-0-1	6
BSOCGERT16	BSOCGERT	Indian Society: Images and Realities	SOCIOLOGY	5-0-1	6
BZOOGERC17	BZOOGERC	Animal Diversity	ZOOLOGY	4-2-0	6
BSTSGERT18	BSTSGERT	Probability and Statistics	STATISTICS	5-0-1	6
BHINGERT19	BHINGERT	Kala aur sahitya GEC-1 : कला और साहित्य	HINDI	5-0-1	6
BCOSGERC20	BCOSGERC	Computer Fundamentals	COMPUTER SCIENCE	4-2-0	6
BANTGERC21	BANTGERC	Health Science/Env. Science + Practical	ANTHROPOLOGY	4-2-0	6
BGELGERC22	BGELGERC	Essentials of Geology	GEOLOGY	4-2-0	6
BNUTGERT23	BNUTGERT	Nutritional Physiology and Nutrition and Human Life Cycle	NUTRITION	5-0-1	6
BMCBGERC24	BMCBGERC	INDUSTRIAL AND FOOD MICROBIOLOGY	MICROBIOLOGY	4-2-0	6
BPEDGERT25	BPEDGERT	Yoga Science	PHYSICAL EDUCATION	5-0-1	6
BENVGERT26	BENVGERT	Environment and Society	ENVIRONMENTAL SCIENCE	5-0-1	6

LCC-MIL Reference Code	LCC-MIL Course Code (**)	Course Title	Offered By Department	(L-P-Tu)	Credit
BBNGCCLT 103	BBNGCCLT	KABITA কবিতা	BENGALI	2-0-0	6
BBNGCCLT 303	BBNGCCLT	GALPO গল্প	BENGALI	2-0-0	6
BHINCCLT 103	BHINCCLT	Hindi wyakaran aur sampreshan CC-3(MIL): हिन्दी व्याकरण और सम्प्रेषण	HINDI	2-0-0	6
BHINCCLT 303	BHINCCLT	Hindi bhasha aur sampreshan CC-9(MIL) : हिन्दी भाषा और सम्प्रेषण	HINDI	2-0-0	6

AECC-MIL Course Code (**)	Course Title	Offered By Department	(L-P-Tu)	Credit
BAECCLET	EnglishCommunication	ENGLISH	2-0-0	2
BAECCLBT	BANGLA BHASAR BHASIK SANGJOG বাংলা ভাষার ভাষিক যোগ সংযোগ	BENGALI	2-0-0	2
BAECCLHT	Hindi bhasa aur sampreshan AECC (MIL) : हिन्दी भाषा और सम्प्रेषण	HINDI	2-0-0	2

Non-Chordates I: Protists to Pseudocoelomates

Unit 1: Basics of Animal Classification:

1. Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types
2. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Carl Woese)

Unit 2: Protista and Metazoa

1. Protozoa:
    1. General characteristics and Classification up to phylum (according to Levine et. al., 1981) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*.
    2. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
2. Metazoa:
    1. Evolution of symmetry and segmentation of Metazoa

Unit 3: Porifera

General characteristics and Classification up to classes; Canal system and spicules in sponges

Unit 4: Cnidaria

1. General characteristics and Classification up to classes
2. Metagenesis in *Obelia*
3. Polymorphism in Cnidaria
4. Corals and coral reef diversity, function & conservation

Unit 5: Ctenophora

General characteristics

Unit 6: Platyhelminthes

1. General characteristics and Classification up to classes
2. Life cycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium*

Unit 7: Nematoda

1. General characteristics and Classification up to classes
2. Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*
3. Parasitic adaptations in helminthes
4. Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.

List of Practical:

Identification of *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium vivax* and *Plasmodium falciparum* (from the prepared slides)

1. Identification of *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
2. Identification and significance of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*
3. Staining/mounting of any protozoa/helminth from gut of cockroach

Title:<u>Non-Chordates II: Coelomates</u>

Syllabus:Unit 1: Introduction:
Evolution of coelom and metamerism

Unit 2: Annelida
General characteristics and Classification up to classes Excretion in Annelida through nephridia. Metamerism in Annelida.

Unit 3:Arthropoda

1. General characteristics and Classification up to classes. Vision in Insecta.
2. Respiration in Arthropoda (Gills in prawn and trachea in cockroach)
3. Metamorphosis in Lepidopteran Insects.
4. Social life in termite

Unit 4: Onychophora
General characteristics and Evolutionary significance

Unit 5: Mollusca

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda
3. Feeding and respiration in *Pila* sp

Unit 6: Echinodermata

1. General characteristics and Classification up to classes
2. Water-vascular system in Asteroidea
3. Larval forms in Echinodermata
4. Affinities with Chordates

Unit 7: Hemichordata
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates
Note: Classification to be followed from Rupert and Barnes, 1994, 6th Edition

List of Practical:

Study of following specimens:

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

1. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
3. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta**

1. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Diversity of Chordata

Unit 1: Introduction to Chordates:
General characteristics and outline classification of Phylum Chordata
Unit 2: Protochordata
General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*. Chordate Features and Feeding in *Branchiostoma*
Unit 3: Origin of Chordata
1. Dipleurula concept and the Echinoderm theory of origin of chordates
2. Advanced features of vertebrates over Protochordata

Unit 4: Agnatha
General characteristics and classification of cyclostomes up to order
Unit 5: Pisces
1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
2. Accessory respiratory organ, migration and parental care in fishes
3. Swim bladder in fishes. Classification up to Sub-Classes

Unit 6: Amphibia
1. General characteristics and classification up to living Orders.
2. Metamorphosis and parental care in Amphibia

Unit 7: Reptilia
1. General characteristics and classification up to living Orders.
2. Poison apparatus and Biting mechanism in Snake

Unit 8: Aves
1. General characteristics and classification up to Sub-Classes
2. Exoskeleton and migration in Birds
3. Principles and aerodynamics of flight

Unit 9: Mammals
1. General characters and classification up to living orders
2. Affinities of Prototheria
3. Exoskeleton derivatives of mammals
4. Adaptive radiation in mammals with reference to locomotor appendages
5. Echolocation in Chiropterans and Cetaceans

Unit 10: Zoogeography
Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms
Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Nelson (1994), for Amphibia to be followed from Duellman and Trueb (1986).

List of Practical

Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*
Agnatha: *Petromyzon*, *Myxine*
Fishes: *Scoliodon*, *Sphyrna, Pristis, Torpedo*, *Chimaera, Mystus, Heteropneustes*, *Labeo, Exocoetus*, *Echeneis, Anguilla*, *Hippocampus*, *Tetrodon*/ *Diodon*, *Anabas*, Flat fish
Amphibia: *Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton*
Reptilia: *Chelone*, *Trionyx*, *Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*. Key for Identification of poisonous and non-poisonous snakes

1. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
2. Pecten from Fowl head
3. Dissection of brain and pituitary of Tilapia
4. Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

Title: Aquarium Fish Keeping

Unit 1: Introduction to Aquarium Fish Keeping

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

Unit 4: Fish Transportation

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

Title: Comparative Anatomy of Vertebrates

Unit 1: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals

Unit 2: Skeletal System

Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.

Unit 3: Digestive System

Comparative anatomy of stomach; dentition in mammals

Unit 4: Respiratory System

Respiratory organs in fish, amphibian, birds and mammals

Unit 5: Circulatory System

General plan of circulation, Comparative account of heart and aortic arches

Unit 6: Urinogenital System

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System

Comparative account of brain, Cranial nerves in mammals

Unit 8: Sense Organs

1. Classification of receptors, Brief account of auditory receptors in vertebrate**List of Practical**
2. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
3. Study of disarticulated skeleton of Toad, Pigeon and Guineapig
4. Demonstration of Carapace and plastron of turtle
5. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal
6. Dissection of Tilapia: Digestive system, Brain, Pituitary, Urinogenital system

Title: Sericulture

Unit 1: Introduction

1. Sericulture: Definition, history and present status; Silk route
2. Types of silkworms, Distribution and Races
3. Exotic and indigenous races
4. Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

1. Life cycle of *Bombyx mori*
2. Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

1. Selection of mulberry variety and establishment of mulberry garden
2. Rearing house and rearing appliances.
3. Disinfectants: Formalin, bleaching powder, RKO
4. Silkworm rearing technology: Early age and Late age rearing
5. Types of mountages
6. Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases
1. Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
2. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
3. Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture
1. Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture
2. Visit to various sericulture centres.

Title: Medical Diagnostic Techniques

Unit 1: Introduction to Medical Diagnostics and its Importance

Unit 2: Diagnostics Methods Used for Analysis of Blood

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 3: Diagnostic Methods Used for Urine Analysis

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4: Non-infectious Diseases

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

Unit 5: Infectious Diseases

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)

Unit 6: Clinical Biochemistry: LFT, Lipid profiling

Unit 7: Clinical Microbiology:Antibiotic Sensitivity Test

Unit 8: Tumours

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

Title:Apiculture

Unit 1: Biology of Bees:
1. History, Classification and Biology of Honey Bees
2. Social Organization of Bee Colony

Unit 2: Rearing of Bees
1. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
2. Bee Pasturage
3. Selection of Bee Species for Apiculture
4. Bee Keeping Equipment
5. Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies
1. Bee Diseases and Enemies
2. Control and Preventive measures

Unit 4: Bee Economy

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture

Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

<u>Syllabus, Lesson Plan and Course Outcome of English (Honours)</u>

<u>Semester I</u>

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT101 Course Title: Indian Classical Literature

Course Type: CC 1 Credit: 6

1. Kalidasa: *Abhijnana Shakuntalam*, tr. Chandra Rajan, in *Kalidasa: The Loom of Time* (New Delhi: Penguin, 1989). 118 pgs [18 class hours]

2. Vyasa: (i) 'The Dicing' [7 class hours] and (ii) 'The Sequel to Dicing' [5 class hours] (from Book II 'The Book of the Assembly Hall'), (iii) 'The Temptation of Karna' [6 class hours] (from Book V 'The Book of Effort') in *The Mahabharata:* tr. and ed.J.A.B. van Buitenen (Chicago: Brill, 1975) pp. 106–69.

3. Sudraka: *Mrcchakatika*, tr. M.M. Ramachandra Kale (New Delhi: Motilal Banarasidass, 1962). [17 class hours]

4. Ilango Adigal: The Book of Banci, in Cilappatikaram: The Tale of an Anklet, Tr R. Parthasarathi (Delhi: Penguin, 2004) Book 3 [17 class hrs]

Course Code: BENGCCHT102 Course Title: European Classical Literature

Course Type: CC 2 Credit: 6

1. Homer: *The Iliad (Book I & IX),* tr. E.V. Rieu (Harmondsworth: Penguin, 1985).[17 class hours]

2. Sophocles: *Oedipus the King*, tr. Robert Fagles in *Sophocles: The Three Theban Plays* (Harmondsworth: Penguin, 1984). [17 class hours]

3. Aristotle: *Poetics (Chapter I, VI & XIV)*, translated with an introduction and notes by Malcolm Heath, (London: Penguin, 1996)chaps 1, 6 and 14. (18 class hours)

4. Ovid: *Selections from Metamorphoses*

(i) 'Bacchus', (Book III), [9 class hours]

(ii) 'Pyramus and Thisbe'(Book IV), [5 class hours]

(iii) 'Philomela' (Book VI), [5 class hours]

tr. Mary M. Innes (Harmondsworth: Penguin, 1975).

- **Course Outcome:**

1. Students will acquire a literary orientation as they study classical literatures of two different continents.
2. Making a comparative study on the classical literatures of India and Europe.
3. Understanding literature as a global phenomenon.
4. To acquire language skills with a sense of literature.
5. Learn the methods of critical thinking.

Semester II

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT201 Course Title: Indian Writing in English

Course Type: CC 3 Credit: 6

Syllabus:

1. R.K. Narayan: *The Guide* [17 class hours]

2. Anita Desai: *In Custody* [17 class hours]

3. H.L.V. Derozio: 'The Orphan Girl' [2 class hours]

Kamala Das: 'Introduction' [4 class hours]

Jayanta Mahatatra: 'Hunger' [4 class hours]

Nissim Ezekiel: 'The Night of the Scorpion' [4 class hours]

Robin S. Ngangom: 'A Poem for Mother' [4 class hours]

4. Mulk Raj Anand: 'Lullaby' [4 class hours]

Khushwant Singh: 'The Mulberry Tree' [4 class hours]

Salman Rushdie: 'The Commonwealth Literature Does Not Exist' [5 class hours]

Arundhati Roy: 'The Cost of Living' [5 class hours]

Course Code: BENGCCHT202 Course Title: British Poetry and Drama: 14th to 17th Centuries

Course Type: CC 4 Credit: 6

Syllabus:

1. Geoffrey Chaucer: *The Wife of Bath's Prologue from The Canterbury Tales.* Tr. (into Modern English) Nevill Coghill (Penguin Classics) [4 class hours]

Edmund Spenser: from *Amoretti:* Sonnet LXXV 'One day I wrote her name...' [2 class hours]

John Donne: 'The Sun Rising' [4 class hours]

Andrew Marvell: ‘To His Coy Mistress’ [3 class hours]

2. Christopher Marlowe: *Edward the Second* [20 class hours]

3. William Shakespeare: *Macbeth* [20 class hours]

4. William Shakespeare: *As You Like It* [17 class hours]

- **Course Outcome:**

To learn about the cultural texts of various regions of India, to grow a critical perception on the social and cultural issues of India. To understand the genesis of drama in England and the growth of English poetry and the impact of renaissance on English life. To acquire knowledge about the development of English stage in the pre-Shakespearean and Shakespearean era.

Semester III

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT301 Course Title: American Literature

Course Type: CC 5 Credit: 6

Syllabus:

1. Eugene O'Neill: *Hairy Ape* [18 class hours]

2. Earnest Hemingway: *Old Man and the Sea* [18 class hours]

3. Edgar Allan Poe: 'The Purloined Letter' [8 class hours]

William Faulkner: 'Dry September' [8 class hours]

4. Anne Bradstreet: 'The Prologue' [5 class hours]

Walt Whitman: 'O Captain, My Captain' [4 class hours],

'Passage to India' (lines 1–68) [5 class hours]

Robert Frost: 'Road not taken' [4 class hours]

Course Code: BENGCCHT302 Course Title: Popular Literature
Course Type: CC 6 Credit: 6

Syllabus:

1. Lewis Carrol: *Through the Looking Glass* [18 class hours]

2. Agatha Christie: *The Murder of Roger Ackroyd* [18 class hours]

3. Jerome K Jerome: *Three Men in a Boat* [17 class hours]

4. Durgabai Vyam and Subhash Vyam: *Bhimayana: Experiences of Untouchability* OR, Autobiographical Notes on Ambedkar (For the Visually Challenged students) [17 class hours]

Course Code: BENGCCHT303 Course Title: British Poetry and Drama: 17th and 18th Centuries
Course Type: CC 7 Credit: 6

Syllabus

1. John Milton: *Paradise Lost: Book 1*[20 class hours]

2. Oliver Goldsmith: *She Stoops to Conquer* [18 class hours]

3. Aphra Behn: *The Rover* [18 class hours]

4. Alexander Pope: *The Rape of the Lock (Canto 1 & 2)* [14 class hours]

- **Course Outcome:**

To understand the salient features of epic poem, mock epic and women's drama. Learning about the comics and graphic art form, to enhance an inquisitive mindset through a reading of detective fiction.

Semester IV

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT401 Course Title: British Poetry and Drama: 17th and 18th Centuries
Course Type: CC 8 Credit: 6

Syllabus:

1. John Milton: *Paradise Lost: Book 1*[20 class hours]

2. Oliver Goldsmith: *She Stoops to Conquer* [18 class hours]

3. Aphra Behn: *The Rover* [18 class hours]

4. Alexander Pope: *The Rape of the Lock (Canto 1 & 2)* [14 class hours]

Course Code: BENGCCHT402 Course Title: British British Literature: 18th Century
Course Type: CC 9 Credit: 6

Syllabus:

1. Richard Steele: 'The Art of Story Telling' [7 class hours]

Joseph Addison: 'Mischiefs of Party Spirit' [7 class hours]

2. Jonathan Swift: *Gulliver's Travels* (Books I and II) [22 class hours]

3. William Collins: 'Ode to Evening' [6 class hours]

Thomas Gray: 'Elegy Written in a Country Churchyard' [6 class hours]

4. Horace Walpole: *The Castle of Otranto*. [22 class hours]

Course Code: BENGCCHT403 Course Title: British Literature: 19th Century
Course Type: CC 10 Credit: 6

Syllabus:

1. Jane Austen: *Pride and Prejudice* [18 class hours]

2. Charles Dickens: *Hard Times* [18 class hours]

3. Thomas Hardy: *The Return of the Native* [18 class hours]

4. Alfred Tennyson: ‘Ulysses’ [6 class hours]

Robert Browning: ‘My Last Duchess’ [7 class hours]

Matthew Arnold: ‘Dover Beach’ [3 class hours]

- **Course Outcome:**

Discussions on these texts will help the learners to observe the social and political changes taking place in the society, to diagnose the impact of scientific discoveries in the literary texts of the age. To recognize the social changes caused by Industrial revolution as reflected in literary productions.

Semester V

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT501 Course Title: Women's Writing

Course Type: CC 11 Credit: 6

Syllabus:

1. Emily Dickinson: 'I cannot live with you',

'Because I could not stop for death'. [3+3 class hours]

Sylvia Plath: 'Lady Lazarus' [3 class hours]

Eunice De Souza: 'Advice to Women', 'Bequest' [3+3 class hours]

2. Harriet Beecher Stowe: *Uncle Tom's Cabin* [18 class hours]

3. Katherine Mansfield: 'Honeymoon' [7 class hours]

Jhumpa Lahiri: 'Interpreter of Maladies' [7 class hours]

Mahashweta Devi: 'The Hunt', tr. Gayatri Chakravorty Spivak (Seagull, 2002) [7 class hours]

4. Virginia Woolf: 'Shakespeare's Sisters', Profession for Woman'. [6+5 class hours]

Rassundari Debi: Excerpts from *Amar Jiban* in Susie Tharu and K. Lalita, eds. *Women's writing in India*, vol. 1 (New Delhi: OUP, 1989) pp. 191–2. [5 class hours]

Course Code: BENGCCHT502 Course Title: British Literature: The Early 20th Century
Course Type: CC 12 Credit: 6

Syllabus:

1. G B Shaw: *Arms and the Man* [18 class hours]

2. D.H. Lawrence: 'Odour of Chrysanthemums' [7 class hours]

Somerset Maugham: 'The Lotus Eater' [7 class hours]

3. James Joyce: *A Portrait of an Artist as a Young Man*. [20 class hours]

4. W.B. Yeats: 'The Second Coming', 'Sailing to Byzantium' [4+4 class hours]

T.S. Eliot: ‘The Love Song of J. Alfred Prufrock’, ‘The Hollow Men’ [5+5 class hours]

Course Code: BENGCCHT503 Course Title: History of English Literature (OE to 1798) Course Type: DSE-1 Credit: 6

Syllabus:

1. OE to 1550 [17 class hours]

2. 1550 to 1625 [18 class hours]

3. 1625 to 1700 [17 class hours]

4. 1700 to 1798 [18 class hours]

Course Code: BENGCCHT504 Course Title: Literary Criticism

Course Type: DSE-2 Credit: 6

Syllabus:

1. Sir Philip Sidney: *An Apology for Poetry*

2. Wordsworth: Preface to *Lyrical Ballads* (1802) [8 class hours]

Coleridge: *Biographia Literaria* (Chapters XIII & XIV) [9 class hours]

3. Virginia Woolf: ‘Modern Fiction’ [9 class hours]

T.S. Eliot: ‘Tradition and Individual Talent’ (1919) [9 class hours]

4. I.A. Richards: *Principles of Literary Criticism* (Chapters 1 & 2). [17 class hours]

Course Code: BENGCCHT504 Course Title: Modern Indian Writing in English Translation

Course Type: DSE-2 Credit: 6

Syllabus:

1. Tagore: ‘Hungry Stone’ [4 class hours]

IsmatChugtai: ‘The Quilt’, in *Lifting the Veil: Selected Writings of Ismat Chugtai,* tr. M. Assaduddin (New Delhi: Penguin Books, 2009). [4 class hours]

2. G.M. Muktibodh: ‘The Void’, (tr. VinayDharwadker) and ‘So Very Far’, (tr. Tr. Vishnu Khare and Adil Jussawala), in *The Oxford Anthology of Modern Indian Poetry*, ed. Vinay Dharwadker and A.K. Ramanujam (New Delhi: OUP, 2000). [3+3 class hours]

Amrita Pritam ‘I Say UntoWaris Shah’, (tr. N.S. Tasneem) in *Modern Indian Literature: An Anthology, Plays and Prose, Surveys and Poems*, ed. K.M. George, vol. 3 (Delhi: SahityaAkademi, 1992). [3 class hours]

3. Vijay Tendulkar: *Silence! The Court is in Session*. [19 class hours]

4. Nabarun Bhattacharya: *Harbart* [20 class hours]

- **Course Outcome:**

Students will have profuse knowledge on literary texts produced by women in different ages. It will also help them to understand gender and racial issues. Discussion on modern poetry and modern drama will enhance the understanding on modern society and the changes and critical issues of such society. The critical texts may help to cultivate their critical insight in understanding literary texts.

Semester VI

Course Instructors: Arpita Ghosh, Sanjib Kumar Kar, Hriday Roy

Course Code: BENGCCHT601 Course Title: Modern European Drama

Course Type: CC 13 Credit: 6

Syllabus:

1. Henrik Ibsen: *Ghosts,* Tr. Peter Watts (Penguin Classics) [17 class hours]

2. Anton Chekhov: *The Cherry Orchard,* Tr. Peter Carson (Penguin) [17 Class Hours]

3. Bertolt Brecht: *Mother Courage and her Children,* Tr. John Willett (Bloomsberry) [18 class hours]

4. Eugene Ionesco: *Rhinoceros,* Tr. Derrek Prouse (Penguin) [18 class hours]

Course Code: BENGCCHT602 Course Title: Postcolonial Literatures

Course Type: CC 14 Credit: 6

Syllabus:

1. Chinua Achebe: *Things Fall Apart* [18 class hours]

2. V. S. Naipaul: *Mystic Masseur* [18 class hours]

3. Bessie Head: 'The Collector of Treasures' [6 class hours]

Ama Ata Aidoo: 'The Girl who can' [6 class hours]

Grace Ogot: 'The Green Leaves' [6 class hours]

4. Pablo Neruda: 'Tonight I can Write.' Tr. W.S. Merwin in *Twenty Love Poems and a Song of Despair* by Pablo Neruda (Penguin Classics) [4 class hours]

Derek Walcott: 'A Far Cry from Africa' [4 class hours]

David Malouf: 'Wild Lemons' [4 class hours]

Mamang Dai: ‘The Voice of the Mountain’ [4 class hours]

Course Code: BENGCCHT603 Course Title: History of English Literature (1798 to present)

Course Type: DSE-3 Credit: 6

Syllabus:

1. Romantic age [17 class hours]
2. Victorian age [17 class hours]
3. Modern age [18 class hours]
4. Post 1950s [18 class hours]

Course Code: BENGCCHT604 Course Title: Science Fiction and Detective Literature
Course Type: DSE-4 Credit: 6

Syllabus:

1. Mary Shelley: *Frankenstein* [18 class hours]

2. H.G. Wells: *The Invisible Man* [17 class hours]

3. Arthur Conan Doyle: *A Study in Scarlet* [18 class hours]

4. G.K. Chesterton: *The Blue Cross* [17 class hours]

Course Code: BENGCCHT604 Course Title: English Language and Literary Types

Course Type: DSE-4 Credit: 6

Syllabus:
1. Philology
2. Phonetics & Prosody
3. Rhetoric
4. Literary types and Literary terms

- **Course Outcome:**

Learners will acquire a sound knowledge on the history of English literature beginning from the Romantic age to the Post 50s. Discussions on Modern European Drama will help the students to gather ideas on European stage and to enhance their understanding on Brechtian theatre and its impact on the upcoming dramatists. Postcolonial literature will broaden their understanding on various aspects of postcolonialism and inert-cultural relationships. To make comparative study on different cultures and literatures. To acquire better skill of pronunciation, of writing rhythmic poetry and to use various rhetorics in composing literary texts.

Bengali Syllabus, lesson Plan and Course outcome

Dept. of Bengali

Ramananda Centenary College

<u>Semester- 1</u>

Title: PRAK-ADHUNIK BANGLA SAHITYA প্রাক্-আধুনিক বাংলা সাহিত্য

Course Code: BBNGCCHT101

Syllabus:

১) চর্যাগীতি (নির্বাচিত পদঃ ১, ৫, ৮, ১৪, ২২) [১৫ ক্লাস] RP

২) শ্রীকৃষ্ণকীর্তন, বড়ু চন্ডীদাস (নির্বাচিত খন্ড - তাম্বুল খন্ড, নৌকা খন্ড) [১৫ ক্লাস] KPS

৩) শ্রীকৃষ্ণবিজয়, মালাধর বসু (নির্বাচিত স্কন্ধ - একাদশ) RSP [১০ ক্লাস]

৪) শিবসঙ্কীর্তন, রামেশ্বর ভট্টাচার্য [২৫ ক্লাস] DM

Course Outcome: প্রাচীন ও মধ্যযুগের সাহিত্য সম্পর্কে সম্যক ধারণা লাভ।

Title: ADHUNIK BANGLA SAHITYA আধুনিক বাংলা সাহিত্য

Course Code: BBNGCCHT102

Syllabus:

১) পদ্মিনী উপাখ্যান, রঙ্গলাল বন্দ্যোপাধ্যায় (সৈন্য-সেনাপতি ও অন্যান্য ক্ষত্রিয় রাজাদের যুদ্ধে উৎসাহ দেবার জন্য ভীমসিংহের আহ্বান পর্যন্ত) [২০ ক্লাস] RP

২) আলালের ঘরে দুলাল, টেকচাঁদ ঠাকুর [১৫ ক্লাস] KPS

৩) গল্পগুচ্ছ, রবীন্দ্রনাথ ঠাকুর (নির্বাচিত গল্প- পোস্টমাস্টার, শাস্তি, একরাত্রি, মেঘ ও রৌদ্র, নিশীথের [১৫ ক্লাস] RSP

৪) নীলদর্পণ, দীনবন্ধু মিত্র [২০ ক্লাস] DM

Course Outcome: উনিশ শতকের সাহিত্য, সমাজ ও রাজনীতি সম্পর্কে সম্যক ধারণা লাভ।

<u>Semester- 2</u>

Title: CHHANDA O ALANKAR ছন্দ ও অলঙ্কার

Course Code: BBNGCCHT201

Syllabus:

১) ছন্দ প্রসঙ্গে সংজ্ঞা ও স্বরূপ - ধ্বনি ও বর্ণ , অক্ষর (দল), মাত্রা (কলা), শ্বাসাঘাত (প্রস্বর), ছেদ (অর্থ সাপেক্ষ বিরাম), যতি, পর্ব, পর্বাঙ্গ, অতিপর্ব, চরণ (পঙক্তি), মিল। [১৭ ক্লাস] RP

২) ছন্দ নিরূপণ- অক্ষরবৃত্ত, মাত্রাবৃত্ত, স্বরবৃত্ত,সনেট ও গদ্য ছন্দ। [১৭ ক্লাস] RP

৩) অলঙ্কার প্রসঙ্গে সংজ্ঞা ও স্বরূপ - অনুপ্রাস, যমক, শ্লেষ, বক্রোক্তি, উপমা, রূপক, উৎপ্রেক্ষা, অপহ্নুতি, সন্দেহ, নিশ্চয়, ভ্রান্তিমান, ব্যতিরেক, সমাসোক্তি, অতিশয়োক্তি, বিষম, অসঙ্গতি, ব্যাজস্তুতি, বিরোধাভাস, দৃষ্টান্ত । (১৭ ক্লাস) KPS

৪) অলঙ্কার নিরূপণ।   [১৭ ক্লাস] KPS

Course Outcome: বাংলা কবিতায় ছন্দ ও অলঙ্কারের প্রয়োগ ও ব্যবহার সম্পর্কে সম্যক ধারনা লাভ।

Title: BHASATATTWA ভাষাতত্ত্ব

Course Code: BBNGCCHT202

Syllabus:

১) বাংলা ভাষার উৎস ও বিবর্তন [৭ ক্লাস] RSP
২) বাংলা ধ্বনি পরিবর্তনের সূত্র, বিচার ও বিশ্লেষণ [৭ ক্লাস]RSP
৩) বাগযন্ত্রের গঠন ও কার্যাবলী [৭ ক্লাস] DM
স্বরধবনি ও ব্যঞ্জনধ্বনিগুলির সংজ্ঞা, স্বরূপ ও শ্রেণীকরণ [৭ ক্লাস]
আন্তর্জাতিক ধ্বনিমূলক বর্ণমালা [৭ ক্লাস]
৪) বাংলা ক্রিয়াপদের রূপবৈচিত্র [৭ ক্লাস] DM
বাংলা উপভাষা ও আঞ্চলিক উপভাষা [৭ ক্লাস]
শব্দার্থ তত্ত্ব [৭ ক্লাস]
শব্দভাণ্ডার [৭ ক্লাস]

Course Outcome: বাংলা ভাষার উৎস বিবর্তন, ধ্বনিতত্ত্ব, শব্দতত্ত্ব ও ক্রিয়াপদ সম্পর্কে সম্যক ধারণা লাভ।

<u>Semester-3</u>

Title: MADHYAYUGER KABITA O KABYA মধ্যযুগের কবিতা ও কাব্য

Course Code: BBNGCCHT301

Syllabus:

১) বৈষ্ণব পদাবলি (তত্ত্ব ও প্রসঙ্গসহ আলোচনা) -নির্বাচিত পদ ক)আজু হাম কি পেখঁলু নবদ্বীপচন্দ খ) ঘরের বাহিরে দণ্ডে শতবার গ) কন্টকগাড়ি কমলসম পদতল ঘ) এ সখি, হামারি দুখের নাহি অর ঙ) তাতল সৈক্ত বারিবিন্দুসম। [১৫ ক্লাস] RP
২) শাক্ত পদাবলি - নির্বাচিত পদ ক) গিরি, এবার আমার উমা এলে, আর পাঠাব না খ) আমি কি হেরিলাম নিশি-স্বপনে গ) কাল স্বপনে শংকরী-মুখ হেরি আনন্দ আমার ঘ) ওরে নবমী-নিশি, না হইও রে অবসান ঙ) যেয়ো না রজনী আজি লয়ে তারাদলে চ) মা আমায় ঘুরাবে কত। [১৫ ক্লাস] KPS
৩) চৈতন্য ভাগবত (আদি খন্ড), বৃন্দাবন দাস [২০ ক্লাস] RSP
৪) চন্ডীমঙ্গল (আখেটিক খন্ড), মুকুন্দ চক্রবর্তী [২০ ক্লাস] DM

Course Outcome: মধ্যযুগের সাহিত্য সমাজ ও দর্শন সম্পর্কে সম্যক ধারণা লাভ।

Title: ADHUNIK KABYA-KABITA আধুনিক কাব্য-কবিতা

Course Code: BBNGCCHT302

Syllabus:

১) বীরাঙ্গনা কাব্য, মাইকেল মধুসূদন দত্ত [১৭ ক্লাস] RP
(শকুন্তলা, তারা, শূর্পণখা, কেকয়ী, জনা পত্রিকা)
২) বৃত্রসংহার, হেমচন্দ্র বন্দ্যোপাধ্যায় (নির্বাচিত সর্গ - ১, ১০, ১১, ২২, ২৩, ২৪)। [১৭ ক্লাস] KPS
৩) উনিশ শতকের গীতিকবিতা- নির্বাচিত কবিতা ক) পুরুলিয়া, মাইকেল মধুসূদন দত্ত খ) সুরবালা, বিহারীলাল চক্রবর্তী গ) বঙ্কিম বিদায়, গোবিন্দচন্দ্র দাস ঘ) বেলাশেষে, মানকুমারী বসু ঙ) মানববন্দনা, অক্ষয়কুমার বড়াল [১৭ ক্লাস] RSP
৪) বিশ শতকের কবিতা ক) বোধ, জীবনানন্দ দাশ খ) আমার কৈফিয়ৎ, নজরুল ইসলাম গ) বন্দীর বন্দনা, বুদ্ধদেব বসু ঘ) কাস্তে, দীনেশ দাস ঙ) ফুল ফুটুক না ফুটুক, সুভাষ মুখোপাধ্যায় চ) কলকাতার যীশু, নীরেন্দ্রনাথ চক্রবর্তী ছ) জন্মভূমিকেই, শামসুর রাহমান জ) বাবরের প্রার্থনা, শঙ্খ ঘোষ। [১৯ ক্লাস] DM

Course Outcome: উনিশ শতকের কবিতায় সমাজ, ধর্ম ও জাতীয়তাবোধ সম্পর্কে সম্যক ধারণা লাভ।

Title: ENGREJI SAHITYER ITIHAS ইংরেজি সাহিত্যের ইতিহাস

Course Code: BBNGCCHT303

Syllabus:

১) জিওফ্রে চসার [৫ ক্লাস] RSP
২) শেক্সপিয়ার [১০ ক্লাস] RSP
৩) মিল্টন, ওয়ার্ডসওয়ার্থ, কোলরিজ, শেলী, কীটস, এলিয়ট, ইয়েটস [৩৫ ক্লাস] RSP
৪) স্কট, ডিকেন্স, চার্লস ল্যাম্ব [১৫ ক্লাস] RSP

Course Outcome: ইংরেজি সাহিত্যের ইতিহাস ও বাংলা সাহিত্যে তার প্রভাব সম্পর্কে সম্যক ধারণা লাভ।

Title: ANUBAD O PROOF SANGSODHAN অনুবাদ ও প্রূফ সংশোধন

Course Code: BBNGSEHT305

Syllabus:

১) অনুবাদ - বাংলা থেকে ইংরেজি KPS
২) অনুবাদ - ইংরেজি থেকে বাংলা KPS
৩) প্রূফ সংশোধন - সংশোধন প্রক্রিয়া DM
৪) প্রূফ সংশোধন - সংশোধিত শুদ্ধরূপ DM

Course Outcome: অনুবাদ ও প্রুফ সংশোধনের মধ্য দিয়ে কর্মমুখী শিক্ষার প্রতি আগ্রহী করে তোলা।

Semester- 4

Title: SANSKRITA SAHITYER ITIHAS সংস্কৃত সাহিত্যের ইতিহাস

Course Code: BBNGCCHT401

Syllabus:

১) রামায়ন-মহাভারত [১৫ ক্লাস] DM
২) কালিদাস [১৫ ক্লাস] DM
৩) শূদ্রক [১৫ ক্লাস] RSP
৪) ভাস, বানভট্ট, জয়দেব [২৫ ক্লাস] RSP

Course Outcome: সংস্কৃত সাহিত্যের ইতিহাস ও বাংলা সাহিত্যে তার প্রভাব সম্পর্কে ধারণা লাভ।

Title: KABYATATTWA O SAHITYER RUPRITI কাব্যতত্ত্ব ও সাহিত্যের রূপরীতি

Course Code: BBNGCCHT402
Syllabus:
১) কাব্য জিজ্ঞাসা, অতুলচন্দ্র গুপ্ত
ধ্বনি ও রস [১৭ ক্লাস] RSP
২) ক্লাসিসিজম ও রোমান্টিসিজম [১৭ ক্লাস] KPS
৩) ট্রাজেডি , কমেডি, ফার্স [১৭ ক্লাস] KPS
৪) এপিক, লিরিক, (ওড, এলিজি, সনেট), ব্যালাড [১৯ ক্লাস] KPS

Course Outcome: সাহিত্যে নন্দনতত্ত্ব ও সাহিত্যে নানাবিধ আন্দোলন সম্পর্কে সম্যক ধারণা তৈরি করা।

Title: BANGLA UPANYAS O CHHOTOGALPO বাংলা উপন্যাস ও ছোটগল্প

Course Code: BBNGCCHT403

Syllabus:

১) রাজসিংহ, বঙ্কিমচন্দ্র চট্টোপাধ্যায় [১৫ ক্লাস] RP
২) চার অধ্যায়, রবীন্দ্রনাথ ঠাকুর [১৫ ক্লাস]KPS
৩) কবি, তারাশঙ্কর বন্দ্যোপাধ্যায় [১৫ ক্লাস]RSP
৪) ছোটগল্প - [২৫ ক্লাস] DM
অভাগীর স্বর্গ, শরৎচন্দ্র চট্টোপাধ্যায়
মহানগর, প্রেমেন্দ্র মিত্র
লম্বকর্ণ, পরশুরাম
প্রাগৈতিহাসিক, মানিক বন্দ্যোপাধ্যায়
চতুর্থ পানিপথের যুদ্ধ, সুবোধ ঘোষ
রস, নরেন্দ্রনাথ মিত্র

টোপ, নারায়ণ গঙ্গোপাধ্যায়
আদাব, সমরেশ বসু

Course Outcome: বাংলা কথাসাহিত্যের ক্রমবিকাশ ও বিবর্তন সম্পর্কে অবহিত করে তোলা।

Title: AMANTRAN PATRA, PRATISTHANIK CHITHI O PRABANDHA RACHANA আমনন্ত্রণ পত্র, প্রাতিষ্ঠানিক চিঠি ও প্রতিবেদন - প্রবন্ধ রচনা

Course Code: BBNGSEHT405

Syllabus:

১) আমন্ত্রণ পত্র রচনা KPS
২) প্রাতিষ্ঠানিক চিঠি রচনা KPS
৩) প্রতিবেদন রচনা, বিজ্ঞাপন রচনা KPS
৪) প্রবন্ধ রচনা DM

Course Outcome: চিঠি, প্রতিবেদন ও প্রবন্ধ রচনার মধ্য দিয়ে কর্মমুখী শিক্ষার প্রতি আগ্রহী করে

Semester-5

Title: BANGLA NATAK বাংলা নাটক

Course Code: BBNGCCHT501

Syllabus:

১) একেই কি বলে সভ্যতা? মাইকেল মধুসূদন দত্ত [১৪ ক্লাস] RP
২) চন্দ্রগুপ্ত, দ্বিজেন্দ্রলাল রায় [১৮ ক্লাস] KPS
৩) ডাকঘর, রবীন্দ্রনাথ ঠাকুর [১৮ ক্লাস] RSP
৪) চাঁদবণিকের পালা, শম্ভু মিত্র [২০ ক্লাস] DM

Course Outcome: বাংলা নাটকের উদ্ভব, গঠন ও বিবর্তন সম্পর্কে সম্যক ধারণা লাভ।

Title: PRABANDHA O SAHITYA - SANSKRITI BISHAYAK PRABANDHA RACHANA প্রবন্ধ ও সাহিত্য-সংস্কৃত বিষয়ক প্রবন্ধ রচনা

Course Code: BBNGCCHT502
Syllabus:

১) লোকশিক্ষা, বঙ্কিমচন্দ্র চট্টোপাধ্যায় [১৫ ক্লাস] RP
২) আমাদের ভাষা সংকট, প্রমথ চৌধুরী [১৫ ক্লাস] KPS
৩) বাংলার ব্রত, অবনীন্দ্রনাথ ঠাকুর [১৫ ক্লাস] RSP
৪) সাহিত্য-সংস্কৃতি বিষয়ক একটি প্রবন্ধ রচনা [১৫ ক্লাস] DM

Course Outcome: প্রবন্ধ পাঠের মধ্য দিয়ে যুক্তিবাদী ও মূল্যবোধ সম্পর্কে ধারণা তৈরি করা।

Course Code: BBNGDSHT1

Title:

BANGLA SAHITYER ITIHAS : ASTADASH SATABDI PARJANTA বাংলা সাহিত্যের ইতিহাস (অষ্টাদশ শতাব্দী পর্যন্ত

Syllabus:

১) বাংলা সাহিত্যের ইতিহাস : RP

যুগ বিভাগ – কাল ও নিদর্শন।

২) আদি মধ্যযুগ – KPS

তুর্কি আক্রমনের প্রভাব, মঙ্গলকাব্যের উদ্ভব, লক্ষণ ও বৈশিষ্ট্য, মনসামঙ্গল- বিজয়গুপ্ত, অনুবাদ সাহিত্য-কৃত্তিবাস ও তাঁর রামায়ণ, বৈষ্ণব পদাবলী সাহিত্য – বিদ্যাপতি ও চন্ডীদাস।

৩) অন্ত মধ্যযুগ RSP

বিশেষ গুরুত্ব –শ্রীচৈতন্য ও বাংলা সাহিত্য

চৈতন্য জীবনী কাব্য

বৈষ্ণব পদাবলী সাহিত্য-জ্ঞানদাস, গোবিন্দদাস

বৃন্দাবনের ষড়গোস্বামী

আনুবাদ সাহিত্য – কাশীরাম দাস ও তাঁর মহাভারত

মনসামঙ্গল কাব্য ও কবি (কেতকাদাস)

চন্ডীমঙ্গল কাব্য ও কবি (মুকুন্দ চক্রবর্তী)

ধর্মমঙ্গল কাব্য ও কবি (ঘনরাম)

কালিকামঙ্গল বা বিদ্যাসুন্দর কাব্য ও কবি

নাথ সাহিত্য, সপ্তদশ শতাব্দীর মুসলমান কবি ও কাব্য

শিবায়ন ও শাক্ত পদাবলী

ভারতচন্দ্র রায়গুনাকর ও তাঁর অন্নদামঙ্গল

৪) প্রাক্ আধুনিক পর্ব(১৭৬০-১৮০০) DM

বিশেষ গুরুত্ব – মহারাষ্ট্র পুরাণ, বাউল গান (লালন ফকির, ফকির পাঞ্জশাহ, কাঙাল হরিনাথ, গগন হরকরা, হাছন রাজা)

কবিগান ও কবিওয়ালা (গোঁজলা গুঁই, রাম বসু, হরু ঠাকুর, নিতাই বৈরাগী, ভোলা ময়রা, এ্যান্টনী ফিরিঙ্গি)

পাঁচালি – দাশরথি রায়

Course Outcome: বাংলা সাহিত্যের ইতিহাস ও যুগবিভাজন সম্পর্কে সম্যক ধারণা লাভ।

Course Code: BBNGDSHT2

Title: BANGLA SAHITYER ITIHASE SAMAJ-DHARMA-SANSKRITI বাংলা সাহিত্যের ইতিহাসে সমাজ-ধর্ম-সংস্কৃতি

Syllabus:

১) বঙ্গভাষা ও সাহিত্য, দীনেশচন্দ্র সেন – হিন্দু ও বৌদ্ধ যুগ ।RP

২) রামতনু লাহিড়ী ও তৎকালীন বঙ্গসমাজ, শিবনাথ শাস্ত্রী (প্রেক্ষিত – নবজাগরণ, ধর্ম, সমাজ ও সংস্কৃতি, জাতীয়তা), ৪, ৫, ৮ ও ৯ পরিচ্ছেদ।KPS

৩) জাতি, সংস্কৃতি ও সাহিত্য, সুনীতিকুমার চট্টোপাধ্যায় (জাতি, সংস্কৃতি ও সাহিত্য)।RSP

৪) মুসলিম-মানস ও বাংলা সাহিত্য, আনিসুজ্জামান – মধ্যযুগের অনুবৃত্তি ও আধুনিকতার সূচনা।DM

Course Outcome: উনিশ ও বিশ শতকের সমাজ ধর্ম ও রাজনীতি সম্পর্কে ধারনা তৈরি করা।

Course Code: BBNGDSHT3

Title:BANGLA SAMALOCHNA SAHITYA বাংলা সমালোচনা সাহিত্য

Syllabus:

১) বিবিধ প্রবন্ধ, বঙ্কিমচন্দ্র চট্টোপাধ্যায় – বিদ্যাপতি ও জয়দেব, শকুন্তলা-মিরান্দা-দেসদিমোনা, বাংলার নব্য লেখকদিগের প্রতি নিবেদন।RP

২) সাহিত্যচর্চা, বুদ্ধদেব বসু-মাইকেল, বাংলা শিশু সাহিত্য, রবীন্দ্রনাথ ও উত্তরসাধক।KPS

৩) কবিতার কথা, জীবনানন্দ দাশ – ১ম, ২য় ও ৪র্থ প্রবন্ধ।RSP

৪) আধুনিকতা ও রবীন্দ্রনাথ, আবু সয়ীদ আইয়ুব- অমঙ্গলবোধ ও আধুনিক কবিতা, শ্রেয়োনীতি ও সাহিত্যনীতি, কবিতার ভাষা।DM

Course Outcome: বাংলা সাহিত্যের কবিতা ও সাহিত্য চর্চা সম্পর্কে সমালোচনা মূলক মনোভাব তৈরি করা।

Semester-6

Title: RABINDRA SAHITYA রবীন্দ্র সাহিত্য

Course Code: BBNGCCHT601

Syllabus:

১) সঞ্চয়িতা- নির্ঝরের স্বপ্নভঙ্গ, মেঘদূত, নিরুদ্দেশ যাত্রা, বলাকা, আভিসার, আফ্রিকা, একগাঁয়ে, আমি, ঐকতান, সাধারণ মেয়ে [৩০ ক্লাস] KPS
২) ছিন্নপত্র - পত্রসংখ্যা ১০, ১৮, ৩০, ৬৭, ১০৮ [১২ ক্লাস] KPS
৩) প্রাচীন সাহিত্য - মেঘদূত, কাব্যের উপেক্ষিতা, শকুন্তলা, রামায়ণ [১৪ ক্লাস] RSP
৪) সাহিত্য- সাহিত্যের তাৎপর্য , সাহিত্যের সামগ্রী, সাহিত্যের বিচার, কাব্য -- স্পষ্ট-অস্পষ্ট [১৪ ক্লাস] KPS

Course Outcome: রবীন্দ্র সাহিত্য সম্পর্কে সম্যক ধারণা লাভ।

Title: SIMANTA BANGLAR LOKSAHITYA সীমান্ত বাংলার লোকসাহিত্য
Course Code: BBNGCCHT602
Syllabus:
সীমান্ত বাংলার লোকসংস্কৃতি - সংজ্ঞা, স্বরূপ ও বৈশিষ্ট্য
১) ঝুমুর [১৫ ক্লাস] RSP
২) টুসু [১৫ ক্লাস] RSP
৩) ভাদু [১৫ ক্লাস] RSP
৪) ছো [১৫ ক্লাস] RSP

Course Outcome: সীমান্ত বাংলার সাহিত্য ও সংস্কৃতি সম্পর্কে সম্যক ধারণা লাভ।

Course Code: BBNGCCHT604

Title: BANGLA SAHITYER ITIHAS-UNISH SHATAK O BISH SHATAKER PRATHAMARDHA বাংলা সাহিত্যের ইতিহাস (উনিশ শতক ও বিশ শতকের প্রথমার্ধ

Syllabus:

১) উনিশ শতকের প্রথমার্ধ : RP

বিশেষ গুরুত্ব – বাংলা গদ্যের বিকাশ (শ্রীরামপুর মিশন, ফোর্ট উইলিয়ম কলেজ, রামমোহন রায়)

সাময়িক পত্র –দিগ্‌দর্শন থেকে তত্ত্ববোধিনী

ঈশ্বরচন্দ্র গুপ্ত

নকশা – প্রমথনাথ শর্মা

২) উনিশ শতকের দ্বিতীয়ার্ধ – KPS

গদ্য ভাষা ও সাহিত্য –বিদ্যাসাগর, কালীপ্রসন্ন সিংহ ও বঙ্কিমচন্দ্র চট্টোপাধ্যায়

মহাকাব্যের ধারা – মাইকেল মধুসূদন দত্ত, হেমচন্দ্র বন্দ্যোপাধ্যায়, নবীনচন্দ্র সেন

আখ্যানকাব্য – দ্বিজেন্দ্রনাথ ঠাকুর, ইন্দ্রনাথ বন্দ্যোপাধ্যায়

গীতিকাব্য-বিহারীলাল চক্রবর্তী, অক্ষয় কুমার বড়াল

মহিলা গীতিকবি – গিরিন্দ্রমোহিনী দাসী, কামিনী রায়, মানকুমারী বসু

প্রহসন ও নাটক –মধুসূদন দত্ত, দীনবন্ধু মিত্র, গিরিশচন্দ্র ঘোষ

উপন্যাস – উদ্ভব ও বিকাশ (প্যারীচাঁদ মিত্র বা টেকচাঁদ ঠাকুর, ভূদেব মুখোপাধ্যায়, বঙ্কিমচন্দ্র চট্টোপাধ্যায়, রমেশচন্দ্র দত্ত)

সাময়িক পত্রিকা – মাসিক পত্রিকা, বঙ্গদর্শন, ভারতী, হিতবাদী, সাহিত্য, সাধনা

৩) রবীন্দ্রনাথ ঠাকুর – কাব্য-কবিতা, উপন্যাস, ছোটগল্প, নাটক ও প্রবন্ধ RSP

৪) বিশ শতকের প্রথমার্ধ – DM

বিশেষ গুরুত্ব-রবীন্দ্রনাথ ঠাকুর, (কাব্য, উপন্যাস, নাটক, প্রবন্ধ)

রবীন্দ্রানুসারী কবিসমাজ (করুণানিধান বন্দ্যোপাধ্যায়, যতীন্দ্রমোহন বাগচী, কুমুদরঞ্জন মল্লিক)

রবীন্দ্রানুরাগী কবি (সত্যেন্দ্রনাথ দত্ত)

রবীন্দ্র সমসাময়িক কবি (যতীন্দ্রনাথ সেনগুপ্ত , মোহিতলাল মজুমদার, কাজি নজরুল ইসলাম)

রবীন্দ্রোত্তরণ প্রয়াসী কবি (বুদ্ধদেব বসু, প্রেমেন্দ্র মিত্র)

রবীন্দ্রোত্তরণপ্রয়াসী কবি – জীবনানন্দ দাশ, সুধীন্দ্রনাথ দত্ত, অমিয় চক্রবর্তী, বিষ্ণু দে সমর সেন

কথাসাহিত্য-শরৎচন্দ্র চট্টোপাধ্যায়, তারাশঙ্কর-মানিক ও বিভূতিভূষণ বন্দ্যোপাধ্যায়

নাটক- ক্ষীরোদপ্রসাদ বিদ্যাবিনোদ, দ্বিজেন্দ্রলাল, মন্মথ রায়, বিজন ভট্টাচার্য

সাময়িক পত্রিকা – প্রবাসী, সবুজপত্র, কল্লোল, বিচিত্রা, কবিতা

Course Outcome: আধুনিক যুগের সাহিত্য, সমাজ, রাজনীতি ও দর্শন সম্পর্কে অবহিত করা।

Course Code: BBNGCCHT605
Title: ব্যবহারিক বাংলা ব্যাকরণ
Syllabus:

১) পদপ্রকরণ : বিশেষ্য, বিশেষণ, সর্বনাম, অব্যয়, কারক-বিভক্তি, অনুসর্গ, উপসর্গ ও সমাস DM

২) শব্দ প্রকরণ : DM

- শব্দের ব্যুৎপত্তিগত শ্রেণি বিভাগ – প্রত্যয় নিষ্পন্ন ও অনুষঙ্গ নিষ্পন্ন
- শব্দের অর্থগত শ্রেণি বিভাগ - যৌগিক শব্দ, রূঢ় শব্দ, যোগরূঢ় শব্দ
- বিশিষ্টার্থক শব্দ ও শব্দের বিশেষ অর্থে প্রয়োগ – বাচ্যার্থ, লক্ষ্যার্থ ও ব্যাঙ্গার্থ

৩) বাক্য প্রকরণ – DM

- বাক্যের শ্রেণি বিভাগ ; বাক্যের রূপান্তর (গঠনগত ও অর্থগত)
- বাক্যের অন্বয়ের বৈচিত্র্য সূচক শব্দাবলি (বিশেষ্য, বিশেষণ, সর্বনাম, অব্যয় ও ক্রিয়া-বিশেষণ-এর অতিরিক্ত)
- বাচ্য

৪) অশুদ্ধি সংশোধন – বর্ণগত, পদগঠনগত ও বাক্যগত DM

Course Outcome: বাংলা ব্যাকরণের নানাবিধ দিক সম্পর্কে ধারণা লাভ।

Course Code: BBNGCCHT606

Title: BANGLA SAHITYE PRACHYA O PASCHATYA PRAVAB বাংলা সাহিত্যে প্রাচ্য ও পাশ্চাত্য প্রভাব

Syllabus:

১) মাইকেল মধুসূদন দত্ত ও জীবনানন্দ দাশের কাব্য-কবিতায় পাশ্চাত্য প্রভাব RP

২) বঙ্কিমচন্দ্র চট্টোপাধ্যায়ের উপন্যাসে পাশ্চাত্য প্রভাব KPS

৩) রবীন্দ্র কাব্যে কালিদাসের প্রভাব RSP

৪) বাংলা নাটকে শেক্সপীয়রের প্রভাব DM

Course Outcome: বাংলা সাহিত্যের সঙ্গে প্রাচ্য ও পাশ্চাত্য সাহিত্যের সম্পর্ক মূল্যায়ন করা।

Note: RP: Ranjit Pramanik, RSP: Ram Sankar Pradhan, DM: Debabrata Mondal, KSP: Kalilash Pati Saha

SIDHO-KANHO-BIRSHA UNIVERSITY, PURULIA

RAMANANDA CENTENARY COLLEGE

LAULARA, PURULIA

SYLLABUS, LESSON PLAN AND COURSE OUTCOME FOR B.A (HONOURS)

IN

EDUCATION

Under Choice Based Credit System (CBCS)

Effective from the Academic Session 2017-2018

RAMANANDA CENTENARY COLLEGE

SIDHO-KANHO-BIRSHA UNIVERSITY

Purulia-723151, West Bengal

B.A. HONOURS COURSE STRUCTURE

Semester	Core Course (14)	Discipline Specific Elective (4)	Generic Elective (4)	Skill Enhancement Course (2)	Ability Enhancement Course (2)
I	CC1 CC2		GE1		Environmental Science
II	CC3 CC4		GE2		English/MIL
III	CC5 CC6 CC7		GE3	SEC1	
IV	CC8 CC9 CC10		GE4	SEC2	
V	CC11 CC12	DSE1 DSE2			
VI	CC13 CC14	DSE3 DSE4			

Core Subjects Syllabus

CC01 – Philosophical Foundation of Education

CC02 – Education in Pre-Independence India

CC03 – Psychological Foundation of Education

CC04 – Education in Post-independence India

CC05 – Sociological Foundation of Education

CC06 – Education for Quality Living

CC07 – Curriculum Studies

CC08 – Educational Technology

CC09 – Pedagogy

CC10 – Comparative Education

CC11 – Educational Administration

CC12 – Research Methodology in Education

CC13 – Statistics in Education

CC14 – Education and Mental Health

Department Specific Electives Subjects

(Any four courses for the Education Honours students, two each for Semesters V & VI)

DSE1 – Measurement and Evaluation in Education

DSE2 – Contemporary Issues in Education

DSE3 – Life Skill Education

DSE4 – Contributions of Great Educators

DSE5 – Teacher Education

Skill Enhancement Subjects

(Two courses to be studied by Education Honours students or BA Regular students who can opt Education as one of the two Disciplines)

Any one: SEC1A or SEC1B

SEC1A– Educational Guidance and Counselling

SEC1B– Computer Application in Education

Any one: SEC2A or SEC2B

SEC2A – Education to Include the Excluded

SEC2B– Yoga Education

Generic Elective Subjects (for other courses)

(For UG Honours students other than Education)

GE1– Philosophical Sociological Foundations of Education

GE2– Psychology of Learning and Development

GE3– Development of Education in India

GE4– Pedagogy

Ability Enhancement Course

AEL1-

AEE1-

Detailed Syllabus

CC1 – Philosophical Foundation of Education [Credit: 5+1]

60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. State and analyze the Meaning, Nature and Scope of Education.
2. Know the Areas of Focus, Recommendations and impact of International Commission on Education (1996).
3. Establish the relationship between Education and Philosophy.
4. Understand the various Factors of Education.
5. Understand Indian schools of philosophy.
6. Understand Western schools of philosophy
7. Understand the National values as enshrined in the Indian Constitution.

Course Contents:

Unit-I: Concept, Scope and Aim of Education

a) Meaning, Nature and Scope of Education.
b) Report of Delor's Commission (UNESCO, 1996)
c) Meaning and scope of educational Philosophy; Relation between education and philosophy.

Unit-II: Factors of Education:

a) Child: Meaning and characteristics of child centric education system.
b) Teacher: Qualities and duties of a good teacher. Teacher as a motivator, mentor, facilitator and problem solver.

c) Curriculum and School: Meaning and Types; Co-curricular activities; vision and functions of Schools.

Unit-III: Schools of Philosophy and National Values

a) Indian schools of Philosophy: Sankhya, Yoga, Buddhism; in terms of knowledge, reality as well as value, and their educational implications.
b) Western Schools of Philosophy: Idealism, Naturalism, Pragmatism: special reference to principles and their educational implications.
c) Inculcation of National Value as enshrined in the constitution of India: Democracy, Socialism and Secularism.

Suggested Books:

- Aggarwal, J. C. (2010). Psychological Philosophical and Sociological Foundations of Education (1st Edition). New Delhi: Shipra Publication.
- Brubacher, John.S.(1969). Modern philosophies of education. New York: McGraw Hill Co.
- Chatterjee. S. & Datta, D. (1948). An Introduction to Indian Philosophy. 3rd Edition. Calcutta: University Press.
- Dash, B.N. (1994) Foundation of Educational Thought and Practice, New Delhi: Kalyani Publishers
- Gupta, S. (2009) Education in Emerging India, Delhi: Shipra Publications.
- Hiriyanna, M. Outlines of Indian Philosophy, Delhi: Motilal Banarsidass Publishers Private Limited.
- Nayak, B. K. (2006) Foundation of Education, Cuttack, Kitab Mahal.
- Pathak, R. P. (2012). Philosophical and sociological principles of education. Delhi: Pearson.
- Radhakrishnan, S. Indian philosophy Vol. I and Vol. II.
- Safaya, R.N. & Shaida, B.D. (2010), Modern theory and principles of education. New Delhi: Dhanpati Publising Company Pvt. Ltd.
- Sharma, S. N. (1995). Philosophical and Sociological Foundations of Education, New Delhi: Kanishka Publishers Distributors.

- Taneja, V.R. (2000). Educational thought and practice, New Delhi: Sterling Publishers Pvt. Limited.

CC2 – Education in Pre-Independence India
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Understand the development of education in India during Ancient period and Medieval period.
2. Understand the development of education in 19th Century in India.
3. Understand the development of education in 20th Century in India.
4. Describe major recommendations of different policies and committee reports on education in Pre-Independence India.

Course Contents:

Unit-I: Education in Ancient and Medieval India

a) Brahmanic System of Education

Aims, curriculum, teacher and methods of teaching, Institutions, Women education and Evaluation system

b) Buddhistic System of Education

Aims, curriculum, teacher and methods of teaching, Institutions (Nalanda, Bikramsila), Women education and Evaluation system

c) Education in Medieval India

Aims, curriculum, teacher and methods of teaching, Institutions and Women education, Contribution of Firoz Shah Tughlak and Akbar

Unit-II: Education in 19th Century in India

a) Charter Act of 1813 and its educational significance
b) Bengal Renaissance- Concept, causes and its impact on education, contribution of Raja Rammohan Roy, Derozio and Vidyasagar in Education.

c) Wood's Despatch (1854) and Indian Education Commission (1882-83) and their impacts in education.

Unit-III: Education in 20th Century in India

a) Educational reformer- Lord Curzon
b) National education movement- Characteristics of National Education Movement; causes of National Education Movement; Different phases of National Education Movement.
c) Basic Education- Concept, characteristics, merits and demerits and Sadlar Commission or Calcutta University Commission (1917-19).

Suggested Books:

- Aggrawal, J.C.(2010) Landmarks in the history of modern Indian education. New Delhi: Vikash Publishing Pvt Ltd.
- Banerjee, J.P. (1994; Education in India Vol-I & II; Kolkata: Central Library.
- Das, K.K. (1993). Development of Education in India. New Delhi: Kalyani Publishers.
- Dash, B.N. (1911) Development of Education in India. New Delhi: Ajanta Prakashan.
- Mukherji, S.M., (1966). History of education in India. Vadodara: Acharya Book Depot.
- Naik, J.P. and Syed, N., (1974). A student's history of education in India. New Delhi: MacMillan.
- Purkait, B.R (1997); Milestone in Modern Indian Education; Kolkata: New Central Book Agency Pvt Ltd.
- Rawat, P.L.(1989). History of Indian education. New Delhi: Ram Prasad & Sons.

CC3 – Psychological Foundation of Education [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Discuss the Concept, Nature and Scope of Educational Psychology.
1. Explain the concepts and various stages of growth and development of child.
2. Describe the meaning and concept of learning, its theories and factors.
3. Explain the application of learning theories in classroom situation.
4. Discuss the concept and theories of intelligence and creativity.
5. Explain the concept and development of personality.

Course Contents:

Unit-I: Educational Psychology

a) Concept, Nature and Scope; Relation between Psychology and Educational Psychology.
b) Growth and Development: Stages and aspects of development in human life; Physical, Social, Emotional, Cognitive development during Infancy, Childhood and Adolescence period and respective educational programmes.
c) Piaget’s theory of Cognitive Development and Bandura’s Social Learning Theory.

Unit-II: Learning

a) Definition and characteristics of Learning; Factors influencing learning
b) Theories of learning: Classical and Operant conditioning, Trial and Error, Insightful Learning.
c) Memorization: Definition, factors, LTM, STM. Causes of Forgetting.

Unit-III: Intelligence, Creativity and Personality

a) Intelligence: Definition; Theories of Intelligence- Spearman, Guilford and Gardner; Measurement of Intelligence.
b) Creativity: Meaning, Nature, Factors and Development of Creativity.
c) Personality: Definition, types and importance in education.

Suggested Books:

- Chauhan, S.S. (1978). Advanced Educational Psychology. New Delhi: Vikas Publishing House Pvt. Ltd.
- Bhatnagar, S. (2002); Advanced Educational Psychology, Agra: Bhargava Book House.
- Hurlock, E. B. (1980). Developmental psychology: All span approach. New York: McGraw Hill Book.
- Mangal, S. K. (2009). Essentials of Educational Psychology, (1st Edition). Phi Learning Private Limited.
- Mangal, S. K. (2010). Advanced Educational Psychology (2nd Edition). Phi Learning Private Limited.
- Sindhu, I. S. (2012). Educational Psychology. Pearson India.
- Santrock, John W. (2011). Educational Psychology (4th Edition). Mcgraw Hill Education.

CC4 – Education in Post Independence India [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Understand the Preamble and various Articles on Education in Indian Constitution.
2. Know the RTE Act-2009.
3. Know the Development of Education under Five Years.
4. Describe major recommendations of different Education Commissions in Post Independent India.
5. Know the various National Policies and committees on Education in Post Independent India.

Course Contents:

Unit-I: Education and Constitution

a) Preamble and various Articles on Education in Indian Constitution.

b) RTE Act-2009.

c) Development of Education under Five Years Plan (Last two plans).

Unit-II: Education Commission in post Independent India

a) Radhakrishanan Commission or University Education Commission (1948-49).

b) Indian Education Commission (1964-66).

c) Asoke Mitra Commission (1991-92).

Unit-III: National Policies on Education

a) National Policy on Education (1968).

b) National Policy on Education (1986).

c) Programme of Action (POA)- 1992.

i) Ramamurti Committee (1990-91).

ii) Janardhan Reddy Committee (1992).

Suggested Books:

- Aggrawal, J.C.(2010) Landmarks in the history of modern Indian education. New Delhi: Vikash Publishing Pvt Ltd.
- Banerjee, J.P. (1994; Education in India Vol-I & II; Kolkata: Central Library.
- Das, K.K. (1993). Development of Education in India. New Delhi: Kalyani Publishers.
- Dash, B.N. (1911) Development of Education in India. New Delhi: Ajanta Prakashan.
- Mukherji, S.M., (1966). History of Education in India. Vadodara: Acharya Book Depot.
- Naik, J.P. and Syed, N., (1974). A student's history of education in India. New Delhi: MacMillan.
- Purkait, B.R (1997); Milestone in Modern Indian Education; Kolkata: New Central Book Agency Pvt Ltd.
- Rawat, P.L.(1989). History of Indian Education. New Delhi: Ram Prasad & Sons.

CC5 – Sociological Foundation of Education
[Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Know the Meaning, Nature and Scope of Educational Sociology.
2. Understand the relationship between Education and Sociology.
3. Know and understand the definition, characteristics, factors, constraints of Social Change.
4. Know and understand the interdependency between education and culture.
5. Know and understand various Social issues in Indian Scenario.
6. Acquire knowledge and understand the concept and role of Social Groups.
7. Know and understand the Meaning, Process and Factors of Socialization and the role of the family and school in Socialization.
8. Understand the role of different Social agencies in Education.

Course Contents:

Unit - I: Educational Sociology

a) Meaning, Nature and Scope of Educational sociology.

b) Relation between Education and Sociology.

c) Concept of Educational Sociology and Sociology of Education.

Unit-II: Social Change, Culture and Issues

a) Social change: definition, characteristics, factors, constraints and education as an instrument of social change.
b) Culture: Concept, role of education in culture, cultural lag.
c) Social issues: unemployment, poverty, education of socially and economically

backward classes, disadvantage section of Indian society (SC, ST and OBC).

Unit-III: Social Groups, Socialization and Social Agencies of Education

a) Social Groups: Primary, Secondary and Tertiary

b) Socialization: Meaning, process and factors of socialization, role of the family and school.

c) Social Agencies of Education: Family, School, State, Mass Media and Religion

Suggested Books:

- Aggrawal, J.C.(2013). Theory and principle of education. New Delh: Vikash Publishing House Pvt Ltd.
- Aggarwal, J. C. (2010). Psychological Philosophical and Sociological Foundations of Education (1st Edition). Shipra Publication, New Delhi.
- Bhat, Manzoor Ahmad (2014). Philosophical and Sociological Foundations of Education. APH.
- Chand, Jagdish (2010). Sociological Foundations of Education. Shipra Publication, New Delhi.
- Dash, B.N. (2011) Foundation of education, New Delhi; Kalyani Publishers.
- Mohanty, J. (1982) Indian Education in Emergency Society, New Delhi: Sterling Publishers.
- Mathur, S. S. (2000). A sociological Approach to Indian Education. Agra : Vinod Pustak Mandir.
- Pathak, R. P. (2009). Philosophical and Sociological Foundations of Education. Kanishka Publishers, New Delhi.
- Safaya, R.N. & Shaida, B.D. (2010), Modern theory and principles of education. New Delhi: Dhanpati Publishing Company Pvt. Ltd.
- Sharma, Anita (2011). Philosophical and Sociological Foundation of Education. New Delhi: Global Publication.
- Sharma, S. N. (1995). Philosophical and Sociological Foundations of Education. New Delhi: Kanishka Publishers Distributors.

- Sharma, Sita Ram (2003). Sociological Foundations of Education. New Delhi: Shri Sai Printographers Pub. & Print.

CC6 – Education for Quality Living [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Know the Concept of Value and Value Education.
2. Know the Nature and Scope of Value Education.
3. Understand the Role of Parents, Teachers and Society for fostering Values.
4. Know the various Approaches of Value Inculcation.
5. Know the Concept and Nature of Peace Education.
6. Know the Curriculum of Peace Education.
7. Know the role of Education in dissemination of peace and resolution of conflict.
8. Know the Concept and Aims of Sustainable Development.
9. Understand the Role of Education in Sustainable Development.
10. Know the difficulties in maintaining Sustainable Development.

Course Contents:

Unit- I: Value Education

a) Value and Value Education: Meaning, Definitions, Nature and Scope
b) Fostering Values: Role of parents, Teachers and Society
c) Approaches to inculcating values among children

Unit – II: Peace Education

a) Peace Education: Meaning and nature
b) Peace Education and Curriculum: Method of integration peace concept in education
c) Role of Education: Disseminations of peace and resolution of conflict

Unit –III: Education for Sustainable Development

a) Meaning, aims & objectives
b) Role of Education in Sustainable Development
c) Difficulties in maintaining sustainable development

Suggested Books:

- Aggarwal, J.C. (2010). *Education for Values, Environment and Human Rights.* New Delhi: Shipra Publications.
- Chadha, S. C. (2008). Education value & value education. Meerut: R.Lall Books Depot.
- Chand, J. (2007). Value Education. Delhi: Anshah publishing House.
- Chakrabarti, Mohit (2003); *Value Education: Changing Perspectives*. New Delhi: Kanishka Publishers.
- Diwahar, R. R., & Agarwal, M. (Ed). (1984). Peace education. New Delhi: Gandhi Marg.
- Fountain, S. (1999) Peace Education in UNICEF, Working Paper, Education Section, Programme Division, UNICEF, New York.
- Gupta, N.L. (2000). *Human Values in Education*. New Delhi: Concept Publishing Company.
- Morrison, M. L. (2003). Peace education. Australia: McFarland.
- Mahakud, L. & Behera, S.K. (2013) (Edit.) Value Education: Dimensions and Approaches, S.B. Enterprise, Kolkata.
- Mishra, L. (2009) Peace Education Framework For Teachers, New Delhi: APH Publishing Corporation.
- Passi, B. K., & Singh, P. (1999). Value education. Agra: Agra Psychological corporation.
- Ruhela, S.P. (ed.) (1986). *Human Values and Education*. New Delhi: Sterling Publishers Pvt. Ltd.
- Singh,Y. K. (2009). Value education. New Delhi: APH Publishing Corporation.
- Sharma, Y.K. and Katoch, K.S. (2007) Education for Values, Environment and Human Rights, New Delhi: Deep & Deep Publications Pvt. Ltd.
- Sharma, R. A. (2008). Human value of education. Meerut: R.Lall Books Depot.

- Shukla, R. P. (2004). Value education and human rights. New Delhi: Sarup and sons.
- Salomon, G., & Nevo, B. (2002). Peace Education: The concept, principles, and practices around the world. London: Lawrence Erlbaum Associates.

CC7 – Curriculum Studies [Credit: 5+1]

60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Define Curriculum.
2. Know the Nature and Functions of Curriculum.
3. Describe the various Principles of Curriculum Construction.
4. Explain various types of curriculum.
5. Understand the Bases of Curriculum.
6. Know the Concept, Characteristics and Utility of Curriculum Evaluation.
7. Differentiate Formative and Summative Evaluation.
8. Understand the curriculum recommended by Indian Education Commission (1964-66).

Course Contents:

Unit-I: Concept of Curriculum

a) Definition of Curriculum, Characteristics and Functions of Curriculum.
b) General Principles of Curriculum Construction.
c) Types of Curriculum- Explicit & Hidden Curriculum, Core and Activity based Curriculum.

Unit-II: Bases of Curriculum:

a) Philosophical
b) Psychological
c) Sociological

Unit-III: Curriculum Evaluation and Recommendation

a) Meaning, Characteristics and Utility of Curriculum Evaluation
b) Formative and Summative Evaluation
c) Indian Education Commission (1964-66)

Suggested Books:

- Brent, Allen. (1978); Philosophical Foundations for the Curriculum, Baston: Allen and Unwin.
- Brady, L. (1995). Curriculum development, New Delhi: Prentice Hall.
- Flinders, D.J (Ed) (1977); The Curriculum Studies; New Delhi: Atlantic Publishers
- Ornstein, A.C. & Hunkins, E (1998). *Curriculum. Foundations, Principles and Issues*. Boston: Allyn & Bacon, Boston.
- Oliva, P.F. (2001). *Developing the curriculum* (Fifth Ed.). New York, NY: Longman.
- Saylor, J.G. & Alexander W.M.(1956); Curriculum Planning for Better Teaching and Learning: Rinehart& Company, Inc. New York.
- Sharma, R.A. (2012) Curriculum Development and Instruction, Meerut: R. Lall Book Depot.
- Taba, H. (1962). Curriculum development-theory and practice. New York: Harcourt Brace, Jovanoich.
- Talla, Mrunalini (2012) Curriculum Development- Perspectives, Principles and Issues, Delhi, Chennai & Chandigarh: Pearson
- Tanner, D. and Tanner, L.(1975) Curriculum development- theory and practice. New York: Macmillan Publishing Co. Inc.
- Tyler, R.W.(1941). Basic principles of curriculum and instruction. Chicago: University of Chicogo Press.
- Vashist, R.P., Curriculum Development

CC8 – Educational Technology [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Know the Concept, Nature, Need and Scope of Educational Technology.
2. Know the Problems of Educational Technology.
3. Know the Approaches of Educational Technology.
4. Understand the Concept, Nature, Types, and Components of Communication.
5. Know the Barriers of Classroom communication and strategies of overcoming barriers in communication
6. Know the various Media used in Education.
7. Recognize the Concept of Teaching, Learning and Instruction.
8. Understand the various Phases of Teaching such as Pre-active, Inter-active & Post-active.
9. Understand the various Levels of Teaching.
10. Identify the families of Models of Teaching.

C**ourse Contents:**

Unit-I: Educational Technology

a) Meaning, Nature, Need and Scope of Educational Technology.
b) Problems of Technology of Education.
c) Approaches of ET: Hardware, Software, and System

Unit-II: Classroom Communication and Media used

a) Meaning, Nature, Types, and Components of Communication
b) Barriers of classroom communication and strategies of overcoming barriers in communication
a) Media used in education: Audio (Radio), Visual (Projector), Audio-visual (TV)- Merits

and Demerits

Unit-III: Phases, Levels, and Models of Teaching

a) Phases of Teaching: Pre-active, Inter-active & Post-active.
b) Levels of Teaching: Memory, Understanding, Reflective.
c) Models of Teaching: Concept, Components, Families, Bruner's Concept Attainment Model and Asubel's Advance Organizer Model.

Suggested Books:

- Aggarwal J C (2001), Essentials of Educational Technology, Vikash Publishing House, New Delhi.
- Kumar, K.L. Educational Technology,
- Mohanty, J. (2001) Educational Technology, New Delhi: Deep & Deep publication.
- Mangal S K and Mangal U, (2009) Essentials of Educational Technology, PHI Learning Pvt. Ltd.
- Sampath, Pannerselvan, Santhanam, Introduction to Educational Technology.
- Sharma R. N., & S.S. Chandra, (2003) Advanced Educational Technology 2 Vols. Set, Atlantic Publishers & Dist.
- Sharma Y. K., (2005) Fundamental Aspects of Educational Technology, Kanishka Publishers.
- Sharma, V. P. & K. Prasad, (2010), Advanced Educational Technology, Pacific Books International.
- Vashist, S.R. (1997) Research in Educational Technology, Guwahati: Eastern Book House.

CC9 – Pedagogy [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Know the meaning and concept of Pedagogy, theories of teaching and methods of teaching.
2. Understand the relationship between teaching and learning.
3. Discuss the Nature of classroom teaching and Function of a teacher.
4. Differentiate between traditional and constructivist teaching.
5. Discuss the Factors affecting Perception, Attention and Attitude and Teaching Methods.

Course Contents:

Unit-I: Teaching

a) Science of Teaching: Relation between teaching and learning;
b) Factors affecting teaching process: Input and Output variables;
c) General principles of teaching: Maxims of Teaching, Fundamentals of teaching.

Unit-II: Teacher and Classroom Teaching

a) Nature of classroom teaching.
b) Differences between traditional and constructivist teaching.
c) Functions of a teacher as a Planner, as a Facilitator, as a Counsellor, as a Researcher

Unit-III: Teaching Methods

a) Factors: Perception, Attention and Attitude.
b) Teaching Methods: Demonstration and Story Telling

c) Further Methods of Teaching: Lecture and Problem Solving

Suggested Books:

- Aggarwal, J.C. Principles, Methods and Techniques of Teaching, New Delhi: Vikas Publishing House.
- Aggarwal J C (2001), Essentials of Educational Technology, New Delhi: Vikash Publishing House.
- Fry, H.; Ketteridge,S. & Marshall, S. (2009) A Handbook for Teaching and Learning in Higher Education, New York: Routledge
- Kochhar, S.K. (2010) Methods and Techniques of Teaching, New Delhi: Sterling Publishers
- Nimbalkar, M. R. (2011) Educational Skills & Strategies of Teaching: Principles and Maxims of Teaching, Neelkamal.
- Virk,J.K. Billing, H.; Deshwal, P. (2015) Learning and Teaching, Twentyfirst Century Publications

CC10 – Comparative Education [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Define Comparative Education.
2. Know the Nature, Scope and Importance of Comparative Education.
3. Know the Methods of Comparative Education.
4. Know the various Factors of Comparative Education.
5. Know the Aims and Objectives of Education at various levels in India, USA and UK.
6. Understand the Structure and Curriculum of Education at various levels in India, USA and UK.
7. Know the Administration System of Education in India, USA and UK.
8. Make comparison among the countries like India, USA and UK with respect to their Educational Aims, Objectives, Structure, Curriculum, Administration system of Education.

Course Contents:

Unit-I: Meaning, Nature, Scope, and Methods of Comparative Education

a) Meaning and Nature of Comparative Education
b) Scope and importance of Comparative Education
c) Methods of Comparative Education:

    i) Philosophical Method
    ii) Sociological Method
    iii) Psychological Method

Unit-II: Factors and Forces of Comparative Education:

a) Natural Factors: Historical, Racial, Linguistic and Social Factors.

b) Spiritual Factors: Religious and Philosophical Factors.

c) Secular Factors: Factor of Humanism, Socialism, Nationalism and Democracy.

Unit-III: Elementary, Secondary and Higher Education in India, UK & USA

a) Structure, Aims and Objectives.
b) Curriculum, Methodology and Evaluation system.
c) Administration including Finance.

Suggested Books:

- Bereday, George (1964) Comparative Method in Education. New York: Holt, Rinehart and Winston
- Chaube, S.P. and Chaube, A (1998) Comparative Education, New Delhi: Vikas Publishing House Pvt.Ltd.
- Cramer J.F. and Browne C.S.(1956) Contemporary Education. New York: Harcourt, Brace
- Dutta, B.S.V (2004) Comparative Education-A Comparative Study of Educational Systems, Guwahati: DVS, Publishers & Distributors.
- Gezi, K.I. (1971) Education in Comparative and International perspective, New York: Halt, Rinehart & Winston, Inc.
- Hans, Nicholas (1994) Comparative Education
- Hans Collins (ed) (1964) Comparative Education, London: Routledge and kegan Paul Limited.
- Khan, M.A. (2004) Modern Comparative Education, New Delhi: Anmol Publications Pvt. Ltd.
- Priestly, K.E. (1961) Education in China. Cornell University: Dragonfly Books.
- Rao, V.K. (2004) Comparative education. The methods of Analysis and Enquiry, Guwahati: DVS, Publishers and Distributors.
- Rao, V.K. eddy, R.S.(1997) Comparative Education. New Delhi: commonwealth Publishers.

- S. P. Chaube & A. Chaube – Comparative Education
- Sharma, R.A. (2009) Comparative Education, Meerut: R.Lall Book Depot.
- Sodhi, T.S. (1998) Textbook of Comparative Education, New Delhi: Vikas Publishing House Pvt. Ltd.
- Sharma, Y.K. 92004) Comparative Education, New Delhi: Kanishka Publishers, Distritutors.
- UNESCO (1971) Developing of education in Asia, unesco/mineda's/paris.

CC11 – Educational Administration **[Credit: 5+1]**
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Understand the Meaning and Functions of Educational Administration.
2. Know the Meaning and Purpose of Supervision.
3. Understand the various Factors affecting Managerial behaviour of teachers.
4. Know the Meaning, Need and Significance of Educational Planning.
5. Recognize the Strategies and Steps in Educational Planning.
6. Know the last Five Year Plan in Primary and Secondary Education.
7. Know the Functions of various Agencies / Bodies of Administration.
8. Distinguish between Inspection and supervision.

Course Contents:

Unit-I: Educational Administration and Supervision

a) Educational Administration: Meaning and Function.

b) Supervision: Meaning, Purpose; Distinguish between Supervision and Inspection.

c) Factors affecting Managerial behaviour of teachers: Personal, Social, Cultural, Political and Institutional.

Unit-II: Educational Planning

a) Educational Planning: Meaning, Needs and Significance.

b) Types of Educational Planning; Strategies and Steps in Educational Planning.

c) Brief outline of the last Five Year Plan in Primary and Secondary Education.

Unit-III: Functions of Various Administrative Bodies

UGC, NAAC, NCERT and NCTE

Suggested Books:

- Aggarwal, J.C. Educational Administration, Management and Supervision.
- Bala, M. (1990) Leadership Behaviour and Educational Administration. New Delhi: Deep & Deep Publications.
- Bhatia, S.K. (2008) Managing Organizational Behaviour. New Delhi: Deep and Deep Publications.
- Bhatnagar, R.P. and Aggarwal, V. (1987) Educational Administration: Supervision Planning and Financing. Meerut: India Surya Publications.
- Bush, T. & Bell, L. (2003) The Principles and Practice of Educational Management. London: Paul Chapman Publishing, New Delhi: Sage Publication.
- Chand, T. & Prakash, R. (1997) Advanced Educational Administration. New Delhi: Kanishka Publishers.
- Chandrasekaran, P. (1994) Educational Planning and Management. New Delhi: Sterling Publishers.
- Gakhar, S.C. (2005) Educational Administration and Management. NM Publication.
- Greene, J.F. (1975) School Personnel Administration. Pennysylvania: Chilton Book Company.
- Gupta, S.K. & Joshi, R. (2007) Organisational Behaviour. New Delhi: Kalyani Publishers.
- Jolliffe, A., Ritter J. & Stevens D. (2003) The Online Learning Handbook. London: Kogan Page.
- Kaur, K. (1985) Education In India (1981-1985) Policies, Planning and Implementation. Chandigarh: Arun and Rajive Pvt. Ltd.
- Khan, N.S. & Khan, M.S. (1980) Educational Administration. New Delhi: Ashish Publishing House.
- Lulla, B.P. & Murthy, S.K. (1976) Essential of Educational Administration. Chandigarh : Mohindra Capital Publishing.

- Lynton, R.P. & Pareek, U. (2000) Training for Organizational Transformation Part I & II. New Delhi: Sage Publications.
- Mukherji, S.N. (1970) Administration and Educational Planning and Finance. Baroda: Acharya Book Depot.
- Mukhopadhyay, M. (2005) Total Quality Management in Education, New Delhi, Thousand Oaks, London: Sage Publications
- Philip, H.C. (1985) The World Crisis in Education Oxford University Press.
- Prasad, L.M. (2008) Organisational Behaviour. New Delhi: Sultan Chand & Sons.
- Robbins, S.P, Judge, T.A. & Sanghi, S. (2007) Organisational Behaviour (12th edition). New Delhi: Pearson Prentice Hall.
- Rudestam, K.E. & Schoenholtz, R.J. (2002) Handbook of Online Learning. New Delhi: Sage Publications.
- Sayeed, O.B. (2001) Organisational Commitment and Conflict. New Delhi: Sage Publications.
- Sharma, R.A. (2012) Educational Administration and Management, Meerut :R. Lall Book Deport.
- Sharma, Y.K. and Sharma, M. (2006) Educational Technology and Management. New Delhi: Kanishka Publishers, Distributors.
- Sindhu, I. S. (2008) Educational Administration and Management. Meerut: International Publishing House.
- Thakur, D. & Thakur, D.N. (1996) Educational Planning and Administration. New Delhi: Deep and Deep Publications.
- Thomas, I.S. (1980) Educational Governance and Administration. America: Prentice Hall.
- Trivedi, P.R. & Sudershan, K.N. (1996) Management Education. New Delhi: Discovery Publishing House.

CC12 – Research Methodology in Education [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Know the Concept, Nature, Scope and Importance of Educational Research.
2. Know the Sources of Knowledge.
3. Know the Need of Research in Education.
4. Understand the various Methods and Types of Educational Research.
5. Identify the criteria of good Research Problem.
6. Know the Concept, Characteristics and Types of hypothesis.
7. Know the concept of Population , Sample and Sampling Techniques
8. Know the Concept, Nature and Sources of Qualitative and Quantitative Data.
9. Know the Research Tools.
10. Write and Evaluate the Research Proposal.

Course Contents:

Unit-I: Educational Research- Meaning, Nature and Types

a) Meaning, Nature & Scope of Educational Research
b) Sources of Knowledge (Authority, Tradition, Personal Experience, Deduction, Induction). Need of Research in Education
c) Types of Research: Basic, Applied & Action Research; Longitudinal and Cross Sectional Research. Historical, Descriptive and Experimental research (meaning only); Importance of Educational Research

Unit-II: Basic Ideas of Research

a) Criteria of selecting a good Research Problem.
b) Research Hypothesis – Meaning, Nature and Types.

c) Population, Sample and Sampling Techniques (Probability & Non Probability).

Unit-III: Research Data:

a) Qualitative and Quantitative data: Concept, Nature and Sources
b) Tool of data collection and their characteristics, merits and demerits
c) Parameters of good research tools

Suggested Books:

- Aggarwal, J.C.(2002) Educational Research, Agra: Aryan Book Depot.
- Best, J.W. & Kahn, J.V.(1989). Research in Education, (6th edition). New Delhi: Prentice Hall.
- Gay, L.R. & Airasian, P. (2000) Educational Research : Competencies for Analysis and Application, New Jersey Mersil.
- Good, C.V, Barr & Douglas, E. Scates. (1962). Methodology of Educational Research New York: Appleton Crofts.
- Kothari, C.R.(2009) Research methodology methods and techniques, New Delhi: New age international (P) Ltd publishers.
- Kerlinger F.N. (1978). Foundation of Behavior Research. Delhi: Surjeet Publications
- Koul, L. (1998). Methodology of Educational Research. New Delhi: Vikash Publications.
- Sukla S.P,& Others.(1974). Elements of Educational Research. (3rd edition), Bombay: Allied Publishers
- Van Dalen, D.B & Meyer, W.J. (1979). Understanding Educational Research. New York: Mcgraw Hill C.

CC13 – Statistics in Education **[Credit: 5+1]**
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

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

1. Know the Concept Scope and Need of Educational statistics.
2. Make organization, tabulation and graphical representation of Data.
3. Measure the Central Tendency.
4. Measure the Variability.
5. Calculate the Percentile and Percentile Rank.
6. Compute Coefficient of Correlation by using various methods.
7. Know the Concept of Normal Distribution, its Properties and Uses.
8. Calculate the Skewness and Kurtosis.
9. Calculate the Derived Scores.

C**ourse Contents:**

Unit-I: Educational Statistics

a) Concept, Scope and Need of Educational Statistics
b) Organization and Tabulation of Data- Frequency distribution table
c) Graphical Representation of Data

Unit-II: Descriptive Statistics

a) Meaning of Central Tendency: Mean, Median and Mode
b) Measure of Variability: Range, AD, SD, QD and Percentile and Percentile Rank
c) Concept of Correlation: Computation of Co-efficient of Correlation by Rank difference method and Product moment method, Interpretation of Co-efficient of

Correlation

Unit-III: Normal Distribution and Derived Score

a) Concept of Normal Distribution: Properties and Uses
b) Divergence from Normality: Skewness and Kurtosis
c) Derived Scores: Z-Score, Standard Score

Suggested Books:

- Aggrwal, Y.P. (1988): Statistical Methods-Concepts, Application and Computation, New Delhi: Streling.
- Ferguson, G.A. (1976). Statistical Analysis in Psychology and Education,New York:McGraw Hill.
- Garret. H.E (1988). Statistics in Psychology and Education Bombay: Vakils, Ferrer & Simons Ltd
- Guilford, J.P. & Fruchter, B. (1974).Fundamental Statistics in Psychology & Education. New York: McGraw Hill
- Mangal, S.K. (2008). Statistics in Education and Psychology, New Delhi: Prentice Hall.
- Rath, R. K.(1999) Fundamentals of Educational Statistics & Measurement, Orissa: Taratarini Pustakalaya.
- Sahu, B.K. (2004) Statistics in Psychology & Education, Kalyani Publishers.
- Saha, Kaberi (2012) Statistics In Education And Psychology, New Delhi: Asian Books Private Ltd

CC14 – Education and Mental Health [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

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

1. Know the Concept and Nature of Mental Health.
2. Know the Concept and Scope of Mental Hygiene
3. Know the relationship of Mental Health and Mental Hygiene.
4. Know the Concepts and Need of adjustment.
5. Understand the adjustment mechanism.
6. Understand the Freud contribution.
7. Know the Classification and Causes of Mental Disorder.
8. Know the Treatment and Prevention of the different forms of Mental Disorders.

C**ourse Contents:**

Unit-I: Mental Health and Hygiene

a) Concept and Nature of Mental Health
b) Concept and Scope of Mental Hygiene
c) Relation between Mental Health and Mental Hygiene

Unit-II: Adjustment

a) Adjustment: Concepts, Need, adjustment mechanism and Role of family and School
b) Maladjustment: Meaning, Causes, different forms of maladjustment, Role of family and School.
c) Contribution of Freud to understand maladjustment.

Unit-III: Mental Disorder

a) Classification with Symptoms of Mental Disorder
b) Causes of Mental Disorder
c) Treatment and Prevention of the different forms of Mental Disorders

Suggested Books:

- Arkoff, Abe (1968) Adjustment and Mental Health, US: McGraw-Hill Inc.
- Bhatnagar, S. (2002); Advanced Educational Psychology, Agra: Bhargava Book House.
- Bron, R.A & Allyn Bacon. (2002); Essentials of Psychology, Guwahati: Nibedita DK Distributors.
- Crow, R.B & Crow, A (1964); Educational Psychology, New Delhi: Eurasia Publishing House
- Hilgard, E.O (1976); Theories of Learning (4th Ed), New York: Appleton Century Crgts 10. Woodworth R.S. (1995); A Study of Mental Life, New York: Century.
- Mangal, S. K. (2010). Advanced Educational Psychology (2nd Edition). Phi Learning Private Limited.

Department Specific Electives Subjects Syllabus

DSE1 – Measurement and Evaluation in Education [Credit: 5+1]

60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Unit-I: Measurement and Evaluation in Education

a) Concept, Scope and Need of Evaluation
b) Relation between Evaluation and Measurement
c) Scales of Measurement: Nominal, Ordinal, Interval and Ratio.

Unit-II: Tools and Techniques of Evaluation

a) Tools: Tests- Essay type and Objective type; Short answer type and Oral type
b) Personality and Interest Test: Projective and Non-projective Tests
c) Techniques: Observation, Self-reporting (Interview, Questionnaire)

Unit-III: Characteristics of a good test

a) Objectivity: Meaning and nature
b) Evaluation Process: Concept, Types (Formative and Summative)
c) Concept of Gradation and Credit system.

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

DSE2- Contemporary Issues in Education [Credit: 5+1]

60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

After completion the course the learners will be able to:

Unit-I: Universalization of Elementary Education

a) Universalization of Elementary Education: Meaning, Constitutional Provision with special reference to RTE Act
b) Role of DPEP
c) SSA-SSM

Unit-II: Universalization of Secondary Education

a) Meaning, aims and objectives
b) Role of RMSA
c) Problems of Secondary Education

Unit-III: Higher Education and RUSA

a) Concept and Objectives of Higher Education in India

b) Higher Education and RUSA

c) Problems of Indian Higher Education

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

DSE3- Life Skill Education [Credit: 5+1]
60 lectures (60 hrs)

Instructor: Dr. Pratap Kumar Panda

Course Objectives:

After completion the course the learners will be able to:

UNIT – I: Communication Skill

a) Concept of Communication
b) The Process and Barriers of Communication
c) Skills of Communication: Listening, Speaking and Writing

UNIT – II: Critical Thinking and Problem Solving

a) Creativity: Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving
b) Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group
c) Group Dynamics, Managing Team Performance & Team Conflicts

UNIT – III: Leadership Skills

a) Leadership, Levels of Leadership and Types of leadership
b) Transactions Vs Transformational Leadership
c) Development Leadership Skills

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

DSE4- Contributions of Great Educators [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

After completion the course the learners will be able to:

UNIT-I: Contribution of Great Indian Educators:

a) Swami Vivekananda
b) R.N. Tagore
c) Sri Aurobindo

With special reference to Aims, Curriculum, Methods of Teaching, Discipline and Role of Teachers

UNIT-II: Contribution of Great Foreign Educators

a) Rousseau
b) Froebel
c) Montessori

With special reference to Aims, Curriculum, Methods of Teaching, Discipline and Role of Teachers

UNIT-III: Contribution of Modern Educators

a) Amartya Sen: Capability Pedagogy
b) Paulo Freire: Critical Pedagogy
c) R.S. Peters: Philosophy of Education

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology

2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences

3. H.E. Garret- Statistics in Education and Psychology

4. R. A. Sharma- Mental Measurement and Evaluation

5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

DSE5- Teacher Education [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

To develop an understanding of

d) Concept, development and agencies of Teacher Education.

e) Teacher Education programmes at Different Levels – Their Objectives, Structure, Curriculum, and Role and Competencies of the Teacher

f) Need for Teacher Education at Tertiary Level

g) Issues, Problems and Innovative Practices in Teacher Education

h) Research and professionalism in Teacher Education

UNIT-I: Concept of Teacher Education

a) Meaning and Nature of Teacher Education

b) Need and Scope of Teacher Education
c) Changing Context of Teacher Education in the Indian Scenario

UNIT-II: Development of Teacher Education in India

a) Teacher Education in Pre-Independence India
b) Teacher Education in Post-Independence India
c) Problems of Teacher Education and suggestions for improving conditions of Teacher Education in India

UNIT-III: Agencies of Teacher Education

a) SCERT, UGC, NCTE and UNESCO
b) Concept of Profession and Professionalism – Teaching as the noblest profession
c) Characteristics of professional teaching

Suggested Books:

1. Arora, G.L. (2002) Teachers and Their Teaching Delhi, Ravi Books.

2. Chaurasia Gulab (2000) Teacher Education and Professional Organizations Delhi, Authorspress.

3. Dillon Justin and Maguire Meg (1997) Becoming A Teacher : Issues in Secondary Teaching Buckingham, Open University Press.

4. Dunking, Michael, J. (1987) The International Encyclopaedia of Teaching and Teacher Education Oxford, Pergamon Press.

5. Elahi, Nizam (1997) Teacher's Education in India New Delhi, APH Publishing Corporation

6. Kundu, C.L. (1998) Indian Year Book on Teacher Education New Delhi, Sterling Publishers Privatization Ltd.

7. McNergney, Robert F. and Herbert, Joanne M. (2001) Foundations of Education : The Challenge of Professional Practice Boston Allyn and Bacon.

8. Misra, K.S. (1993) Teachers and Their Education Ambala Cantt., The Associated Publishers.

9. Mohanty Jagannath (2000) Teacher Education in India

10. Murray, Frank B. (Ed.) (1996) Teacher Educator's Handbook; Building A Base for Preparation of Teachers, San Francisco, Jossey – Bass Publishers.

11. National Council for Teacher Education (NCTE) (1998) NCTE Document New Delhi, Published by Member Secretary, NCTE.

Skill Enhancement Subjects Syllabus
SEC1- Educational Guidance and Counselling [Credit: 2]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

After completion the course the learners will be able to:

- Explain the concept, nature, scope, types & importance of guidance
- .Discuss the concept, nature, scope, types & importance of Counselling. Explain the concept of tools and techniques of Guidance & Counselling. Discuss the concept and nature of mental health and Adjustment.
- Illustrate the Meaning, Nature, Scope, determinants and functions of Curriculum. Discuss the types and Bases of Curriculum.

- Explain the concept of curriculum Framework and NCF-2005.
- Discuss the basis of curriculum construction, evaluation and innovation. Describe the definition and types of curriculum theories

Unit-I: Concept of Guidance

a) Meaning, Nature and Importance of Guidance.

b) Different Types of Guidance-

    i) Educational: Meaning, Characteristics, Purpose & Functions.

    ii) Vocational: Meaning, Characteristics, Purpose & Functions.

    iii) Personal: Meaning, Characteristics, Purpose & Functions.

c) Guidance at different stages of Education with special emphasis on Secondary stage of Education.

Unit-II: Concept of Counselling

a) Meaning, Nature and Importance of Counselling

b) Types of Counselling-

   i) Directive: Meaning, Characteristics, Purpose & Functions.

   ii) Non-directive: Meaning, Characteristics, Purpose & Functions.

   iii) Eclectic: Meaning, Characteristics, Purpose & Functions.

c) Steps of Counselling; Characteristics of good Counsellor.

Unit-III: Tools and Techniques of Guidance and Counselling

a) Basic data necessary for Educational Guidance- Pupils abilities, Aptitudes, Interests and Attitudes, Educational Attainments and Personality Traits.

b) Measurement of Intelligence, Personality and Motivation

c) Difference between Guidance, Counselling and Teaching.

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

SEC2- Education to Include the Excluded [Credit: 2]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

After completion the course the learners will be able to:

UNIT-I: Inclusive Education and Standard for Engaging all Students in Learning

a) Inclusive Education: Meaning, Need and Programme

b) Equality and Equity in Education: Meaning, importance, causes of inequality, Role of education to remove inequality in education
c) Connecting students' prior knowledge, life experiences, and interests with learning goals

UNIT-II: Standard for Creating and Maintaining Effective Environments

a) Creating a physical environment that engages all students;
b) Establishing a climate that promotes fairness and respect behaviours in a fair, equitable way
c) Promoting social development and group responsibility

UNIT-III: Standard for Planning Instruction and Designing Learning Experiences

a) Drawing on and valuing students' backgrounds, interests, and developmental learning needs
b) Establishing and articulating goals for student learning
c) Developing and sequencing instructional activities and materials for student learning

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

SEC3- Computer Application in Education [Credit: 2]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

After completion the course the learners will be able to:

UNIT-I: Computer

a) Definition, Characteristics, Applications
b) Components of Computer System, Input/Output Devices
c) Concept of Memory, Magnetic and Optical Storage Devices.

UNIT-II: Operating System and Word Processing

a) Definition & Functions of Operating System
b) Basic Components of Windows, Managing files and folders, Control panel – display properties, add/remove software and hardware, setting date and time, screensaver and appearance.
c) Introduction to Word Processing, Menus, Creating, Editing & Formatting Document, Spell Checking, Printing, Views, Tables, Word Art, Mail Merge, Excel and PPT.

UNIT-III Computer Communication

a) Internet and its applications
b) Surfing the Internet using web browsers
c) Creating Email Id, Viewing an E-Mail, Sending an E-Mail to a single and multiple users, Sending a file as an attachment.

REFERENCES BOOKS

1. Sinha, P.K. & Sinha, Priti, Computer Fundamentals, BPB
2. Dromey, R.G., How to Solve it By Computer, PHI
3. Microsoft Office – Complete Reference – BPB Publication

SEC4- Yoga Education [Credit: 2]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

After completion the course the learners will be able to:

1. Know the Concept of Yoga and Yoga Education.
2. Understand the Role of Yoga in Education
3. Describe Yoga education with specific reference to Aims, Curriculum, Role of Teacher and Educational Implications.
4. Understand the History of Yoga and the contributions of Sagacious Yogis.
5. Describe the Types of Yoga.
6. Understand the Asans.
7. Practice of Yoga for Health Issues.

UNIT- I: Introduction to Yoga Education

a) Meaning and Definitions of Yoga and Yoga Education
b) Role of Yoga in Education
c) Yoga education with specific reference to Aims, Curriculum, Role of Teacher and Educational Implications.

UNIT-II: History of Yoga and Sagacious Yogis:

a) Yoga in various Periods / times.
b) Sagacious Yogis: Swami Vivekananda, B. K. S. Iyengar: Father of Modern Yoga and their contributions for the development and promotion of Yoga.
c) Types of Yoga: Karma Yoga of Bhagavgita, Surya Namaskar, Ashtanga Yoga, Inte[illegible] Yoga of Sri Aurobindo.

UNIT-III: Yoga Practices:

a) The Five Yamas (Eternal Vows), Dharana (Concentration) and its method,

b) Different Asans / Mudras and their effects to promote a sound physical and mental health.
c) Special Techniques of Yoga for Nasal allergy, Diabetes, Hypertension

Suggested Readings:

- Ghorote, M.L. : Yoga Applied to Physical Education Lonavala; Kaivalyadhama.
- Iyengar, B.K.S. (2000). *Astadala Yogamala*. New Delhi, India: Allied Publishers. p. 53. ISBN 978-8177640465.
- Madhav Pundalik Pandit, *Sri Aurobindo and His Yoga*, Lotus Press 1987 ISBN 0-941524-25-6
- NCTE (2015) Yoga Education diploma in Elementary Education, New Delhi, pp.15-18.
- Nagendra, H.R. and Nagarathna R : New Perspectives in Stress Management (V.K.Yogas, Bangalore,1988)
- Prabhupada, S. (ed.). (2007). *Srimagbhat GitaAs It Is.* Nadia: Bhaktibedanto Book Trust.
- Pal, T., Rath, S.K. & Roy S.C. (2014) Yoga Education at a Glimpse, Romania: Bri Center..
- Radhakrishnan, S. (1993), *The Bhagavadgītā*, Harper Collins, ISBN 81-7223-087-7, p. 289.
- R Nagarathna and Dr H R Nagendra : Integrated Approach of Yoga Therapy for Positive Health, Swami Vivekananda Yoga Prakashana, Bangalore, 2003.
- Swami Satchidananda, The Yoga Sutras of Patanjali, Integral Yoga Publications, Yoga Ville, Virginia, USA, 1990.
- Sri Aurobindo. (1999), *The Synthesis of Yoga*, fifth edition, Sri Aurobindo Ashram Trust 1999
- Swami Niranjanananda Saraswati, Yoga Darshan, Yoga Publications Trust, Bihar, India, 2002.
- Swami Satyananda : Yoga Education For Children Saraswati (Bihar Schools of Yoga, Munger, 1990).
- Tulsidas Chatterjee, *Sri Aurobindo's Integral Yoga*, Aurobindo Ashram, Pondicherry 1970
- Udupa, K.N. : Stress and its Management by Yoga (Motilal Banarsidass, Delhi)
- Werner, Karel (1998). *Yoga And Indian Philosophy*. Motilal Banarsidass Publ. ISBN 81-208-1609-9. p. 119-20

Generic Elective Courses

GE1 – Philosophical and Sociological Foundations of Education
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen
[Credit: 5+1]

Course Objectives:

After completion the course the learners will be able to:

Unit-I: Concept, Scope and Aim of Education

a) Meaning, Nature and scope of Educational Philosophy
b) Individualistic and socialistic aim.
c) Relation between education and philosophy

Unit-II: Philosophy and Education

a) Western Schools of Philosophy: Idealism and Pragmatism: special reference to principles, aims of education, curriculum, teaching method, teacher, discipline
b) Indian Schools of Philosophy and Education: Vedanta, Jainism and Buddhism
c) Great Educators and their educational philosophy:
    i) Swami Vivekananda and Rabindranath Tagore
    ii) Rousseau and Dewey.

Unit-III: Sociology in Education

a) Meaning, nature and scope of Educational sociology
b) Social groups and education – Primary, Secondary and Tertiary Group
c) Social change: definition, characteristics, factors, Constraints and education as an instrument of social change, Education and Social Mobility

Suggested Books:

J. C. Aggarwal- Theory and Principles of Education

1. J. C. Aggarwal - Philosophical and Sociological Bases of Education
2. S. P. Chaube & A. Chaube – Foundations of Education
3. K. K. Shrivastava- Philosophical Foundations of Education
4. Y. K. Sharma – Sociological Philosophy of Education
5. A. P. Sharma – Indian and Western Educational Philosophy
6. S. S. Ravi – A Comprehensive Study of Education
7. M. Sharma – Educational Practices of Classical Indian Philosophies
8. S. S. Chandra & R. K. Sharma- Philosophy of Education
9. N. Arora – Educational Philosophy
10. M. K. Goswami- Educational Thinkers: Oriental and Occidental, Thoughts and Essays

11. B. R. Purkait – Great Educators

GE2 – Psychology of Learning and Development [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

After completion the course the learners will be able to:

Unit-I: Learning

a) Definition and characteristics of Learning; Factors influencing learning
b) Theories of learning: Classical and Operant conditioning; Trial and Error
c) Attention & Interest: Factors of Attention and Relation between Attention and Interest

Unit-II: Growth and Development

a) Stages and aspects of development in human life
b) Physical, Social, Emotional and Cognitive development during Infancy and Childhood
a) Need of studying development in the context of learning

Unit-III: Some Theories of Development

a) Freud's Theory of Development of Libido
d) Piaget's Theory of Cognitive development
e) Bandura's Social Learning Theory

Suggested Book:

GE3 – Development of Education in India [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Dr. Pratap Kumar Panda

Course Objectives:

After completion the course the learners will be able to:

Discuss the development of education in India in historical perspectives.

Discuss the British Indian education system.

Explain the significant points of selected educational documents and report of ancient, medieval and British India.

Describe the Constitutional Provision of Education.

Discuss the contributions of Education Commission in post Independent India.

Explain the Functions of Some Major Educational Organization in India.

Explain the Meaning, Constitutional Provision with special Education reference to RTE Act. DPEP, SSA-SSM of Universalization of Elementary Education.

Describe the Meaning, aims & objectives, significance of Universalization of Secondary Education and Role of RMSA.

Explain the concept, role of Higher Education and Knowledge Commission and RUSA.

Unit-I: Education in 19th Century in India

a) Charter Act of 1813 and its educational significance
b) Macaulay Minuets- (1835)- its educational significance
c) Wood's Despatch (1854) and Hunter Commission (1882-83) and their impact on Indian education

Unit-II: Education in 20th Century in India (1901-1944)

a) Educational reformer- Lord Curzon
b) National education movement- Causes, Phases and Importance in Education
c) Basic Education- Concept, characteristics, merits and demerits

Unit-III: Education in Post Independence India

a) University Education Commission (1948-49) – Aims and Objective, Rural University Examination System, Teacher and Teaching Education, Vocational Education, Women Education
b) Secondary Education Commission (1952-53) – Structure of Education system, Aims and Objective, Curriculum and Evaluation system and Language Policy
c) Indian Education Commission (1964-66) – Structure of Education system, Aims and Objective, Curriculum, Language Policy, Exam System and Teacher Education, Equality in Educational Opportunity

Suggested Books:

1. B. R. Purkait- Milestones of Modern Indian Education

2. J. C. Aggarwal - Landmarks in the History of Modern Indian Education

3. S. S. Ravi – A Comprehensive Study of Education

4. J. P. Banerjee – Education in India: Past, Present and Future

5. S. P. Chaube & A. Chaube – Education in Ancient and Medieval India

6. B. K. Nayak- History Heritage and Development of Indian Education

7. B. N. Dash –History of Education in India

8. S. S. Ravi – A Comprehensive Study of Education

9. J. C. Aggarwal- Theory and Principles of Education

10. R. P. Pathak – Development and Problems of Indian Education
11. B. K. Nayak- Modern Trends and Issues in Education of India

GE4 – Pedagogy [Credit: 5+1]
60 lectures (60 hrs)
Instructor: Mr. Samir Kumar Sen

Course Objectives:

After completion the course the learners will be able to:

a. The meaning and concept of Pedagogy, theories of teaching and methods of teaching.

b. Discuss the Nature of classroom teaching and Function of a teacher.

c. Discuss the Factors affecting Perception, Attention and Attitude and Teaching Methods.

Unit-I: Teaching

a) Science of Teaching: Relation between teaching and learning
b) Teaching process: Input and Output variables
c) General principles of teaching: Maxims of Teaching, Fundamentals of teaching

Unit-II: Teacher and Classroom Teaching

a) Nature of classroom teaching
b) Differences between traditional and constructivist teaching
c) Functions of a teacher as a Planner, as a Facilitator, as a Counsellor, as a Researcher

Unit-III: Factors Influencing Teaching Methods

a) Factors: Perception, Attention and Attitude

b) Teaching Methods: Demonstration and Story Telling
c) Further Methods of Teaching: Lecture and Problem Solving

Suggested Books:

1. S. K. Mangal- Statistics in Education and Psychology
2. A. K. Singh – Test, Measurement and Research Methods in Behavioral Sciences
3. H.E. Garret- Statistics in Education and Psychology
4. R. A. Sharma- Mental Measurement and Evaluation
5. Y. P. Aggarwal- Statistics Methods Concepts, Application and Computation

Syllabus for AEL1-to be done

Syllabus for AEL1 -to be done

U.G. Choice based credit system 3 years (6 semesters) syllabus in History

Sidho-Kanho-Birsha University,Purulia,West Bengal

Program

Semester	Paper	Course Title	Course Code	Contents & Class Teachers Name	Course Outcome
I	I	Early History of India (Proto-History to 6th Century B.C.)	BHISCCRT101	1. Reconstructing Ancient Indian History: Sources and approaches of historical reconstruction – 15 classes(AT) 2. Pre-history and Proto-history: Paleolithic, Neolithic habitation; growth of Chalcolithic culture; economic and technological evolution – 20 classes(AT) 3. The Harappan civilization and its origin, antiquity, morphology of major cities, agricultural base and development; growth of commerce and trade; religious beliefs and practices – 15 classes(JD) Background to early historic India: the Aryan problem: d ebate and reconstruction; the Vedic age: economy, polity, society and religion; latter-Vedic age: economy, polity, society and religion; Sixteen Mahajanapadas – Rise of Magadha, Persian and Greek invasion - 25 classes(JD)	Students will enrich their knowledge about stone age, Harappan civilization, Vedic civilization of ancient India.
				1. Foundation of Delhi Sultanate- Qutb-uddin Aibak , Iltutmish, Raziya, Balban and his achievements, Khalji Revolution, Alauddin Khalji- expansion of empire, economic measures, Muhammad Bin Tughlaq and his policies, Firoj Shah Tughlaq-reforms,downfall of the	Students will be aware of the

Teacher-in-Charge
Ramananda Centenary College
P.O. - Laulara, Dist.-Purulia

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II	II	Selected themes under Delhi Sultanate & Mughal India(1206-1707)	BHISCCRT201	Sultanate 15 classes(BK) 2. Mongol Menace,Iqta system,Sultani administration,Bhakti and Sufi Movements – characters and spread of Bhakti and Sufi movements – 15 classes(AT) 3. Provincial Kingdoms: Bengal under the Muslim rule- Shams uddin Ilias Shah, Raja Ganesh,Hussain Shah, literature,art and economic life; Vijaynagar Empire- Krishnadev Roy, administration, religion, economic life of Vijaynagar empire; The Bahamani kingdom- role of Mamud Gawan – 15 classes(JD) 4. Emergence and consolidation of Mughal state – Babar as founder, Sher Shah as reformer, Akbar-expansion of empire, Rajput policy,Religious policy, Mansabdari systm,Nur Jahan, Shah Jahan-golden era of Mughal empire – 15 classes(JD) Aurangzeb- religious and deccan policy, rise of Shivaji and his administration , Mughal administration,crisis of Mughal empire- nobility and party politics,economy, society and cultural life – 15 classes(AT)	various aspects of the sultanate period and the Mughal period in India's medieval history.
	III			1. Chuar Rebellion in South west Bengal; Wahabi and Faraizi Rebellion, Santal Hull, Uprising of 1857- causes, nature and aftermath. - 15 classes(AT) 2. Indigo rebellion, Pabna revolt, Deccan riots. Munda revolt- role of Birsha munda ; Partition of Bengal and Swadesi Movement. - 15 classes(AT)	Students will learn about various

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Teacher-in-Charge
Ramananda Centenary College
P.O. - Laulara, Dist.-Purulia

III		Popular Resistance in Colonial India(1765-1947)	BHISCCRT301	3. Freedom struggle under M.K.Gandhi – Kheda, Amedabad & Champaran satyagraha, Rowlett Satyagraha - 15 classes(BK) 4. Non cooperation, Civil disobedience Movement and Quit India Movement.- 15 classes(JD) 5. Peasant and workers movement between the two world wars,the Naval revolt, Tebhaga and Telengana movements. – 15 classes(JD)	movemens in India during colonial rule, nationalist movement of Mahatma Gandhi and various peasant revolts.
	SEC -I	Local Popular Culture	BHISSERT304	1. Popular culture of South west Bengal specially Manbhum, Tribal culture: The Santal festivals and songs: *Baha, Saharay,Dasai* – socio-religious life – 15 classes(JD) 2. Performing Art: *Chhou* Dance; different types,characters, leading *Chhou* Artists : Gambhir Sing Mura Dhananjoy Mahato, Nepal Mahato and others, evaluation of *Chhou* Dance, Natua Dance- features – 15 classes(AT)	Students will know about the various festivals and performing art of the people of South West Bengal especially Manbhum such as Baha, Saharay, Dasai, Chhou dance etc.
	IV			1. The French Revolution – background, reign of terror; rise of Napoleon Bonaparte- reforms, Continental system ,downfall; Vienna settlement of 1815, the Metternich system, Concert of Europe, Revolution of 1830 & 1848 in France – 20 classes(AT) 2. Unification of Italy- role of	Students will get a proper understanding of the history of Europe by studying the French revolution and its impact on world history,

IV		Selected Periods of Modern Europe(1789-1945)	BHISCCRT401	Mazzini, Cavour, Garibaldi; unification of Germany-role of Bismarck, Crimean war of 1854, Reforms of Alexander II, Industrial revolution in England, Utopian and Marxian socialism – 20 classes(JD) 3. Triple Alliance and Triple Entente ; The Eastern question, First World War, Russian Revolution of 1917, peace settlement of 1919, The League of Nations – 20 classes(BK) 4. Fascism in Italy, Nazism in Germany, outbreak of Second World War , The U.N.O – 15 classes(AT)	the rise and fall of Napoleon Bonaparte, the July revolution and the February revolution, the industrial revolution, the Balkan problem, the Russian revolution, world war I & II.
	SEC-II	Indian Art and Architecture(1200-1800)	BHISSERT404	1. Indian art : major developments in *Stupa*, cave, and temple art and architecture; Sultanate and Mughal art and architecture – 15 classes(AT) Modern and contemporary Indian art: the colonial period; Art movements: Bengal School of Art; major artists and their art work – 15 classes(BK)	Students will gain a thorough knowledge of Indian architecture-sculpture, painting as well as various Indian painters and their works.
	DSE-I	China and Communist	BHISDSRT1	1. The nature of Chinese traditional society; colonial penetration and Chinese response – 15 classes(AT) 2. Restoration, reform and revolution: Self-Strengthening movement; Reform Movement of 1898; Republican Revolution of 1911; the New Nationalism – 25 classes(JD) 3. The rise of Kuomintang; the May Forth movement; rise of the Communist part and Kuomintang-Communist conflict; the	Students will gain knowledge about the history of China especially the reform movement in 1898 AD, movement in 1911 AD, rise

Ramananda Centenary College ESTD-1971

V		Movements		People's Republic of China – 20 classes(JD) 4. Economic development and industrialization: growth and change of China's foreign trade; Compradors and Chinese capital – 15 classes(BK)	of Kuomintang, May Forth movement, economic development and industrializatio n etc.
	DSE-II	India after 1947	BHISDSRT2	1. Framing of the Indian Constitution, Fundamental Rights, Principle Objectives, Economic Planning's, Movements for Social Justice.-15 Classes(AT) 2. Foreign Policy of India – Principles of Objectives, Nehru's Foreign Policy – India and Non alignment Movement – SARC.-15 Classes(JD) 3. India and her neighbours – Indo-Pak relations, India and the liberation war of Bangladesh, the Liberation war of Vietnam.-15 Classes(BK) 4. Indio-Chiense relation, India and Soviet Russia, The Suez crisis and Hungrian Crisis – role of India.-15 Classes(BK)	Students will learn about framing of the Indian constitution, foreign policy, Jawaharlal Nehru's non alignment movement and India's relations with countries like Pakistan, Bangladesh, Vietnam, China, Russia and India's role in the Suez and Hungrian crisis.
	SEC-III	Popular Culture: Performing Art	BHISSERT504	Defining popular culture and performing art; understanding it historically; popular culture of South West Bengal specially Manbhum-Purulia.-15 Classes(JD) 2. Folk songs:Jhumur, Tusu, Bhadu; different types of those songs, literary importance and socio-economic and cultural life; Folk songs and festivals (selected): Karam, Jaoya, Jhapan, Badna festival-rituals and social importance.-15 Classes(AT) 3. Tribal Culture: The Santal	Students will gain knowledge about various religious festivals and songs of West Bengal especially Manbhum, namely

				festivals and songs: Baha, Saharay, Dasai-socio-religious life.-15 Classes(BK) 4. Performing Art: Chhou Dance; different types, characters, leading Chhou Artists: Gambhir Sing Mura, Dhananjoy Mahato, Nepal Mahato and others, evaluation of Chhou Dance, socio-economic and religious importance, Natua Dance-features, Hari ram Kalindi, Gunadhar Sahis in Natua dance.-15 Classes(JD)	Jhumur, Tusu, Bhadu, Chau, Karam, Jawa, Jhapan, Badna and various religious festivals and songs of santals.
	GE-I	Colonialism and Developments in the Environment: India	BHISGERT2	1. Geography, ecology and cultures in pre-Colonial India: land, forests, ecology of hills and mountains – 15 classes(AT) 2. Colonialism and developments: new regimes of land, forests, irrigation; tribal and peasants resistance – 25 classes(AT) 3. Environmental issues in Independent India: displacement and degradation – 20 classes(JD) Environmental movements in Independent India – 15 classes(BK)	Students will learn about forests, land, irrigation and the position of tribes and various environmental movements in colonial India.
	DSE-III	Local History: Study of Manbhum	BHISDSRT3	1. Manbhum: historical background; evolution of geographical boundary – 10 classes(AT) 2. Language Movement in Manbhum; position of Manbhum after Partition of Bengal(1905), language Movement in Manbhum before independence(1912-47) – 20 classes(JD) 3. Language Movement after independence; Rise and role of *Loksevak* Sangha,Bhasa Satyagraha(1949-51) – 20 classes(JD) 4. State Reorganization Commission in Manbhum district, *Tusu Satyagraha* (1	From the formation of Jungalmahal district in 1805 AD to the formation of Manbhum district in 1833 AD and the annexation of Purulia district to Bengal, the students will know about the history especially the language movement of Purulia and the

Teacher-in-Charge
Ramananda Centenary College
P.O. - Laulara, Dist.-Purulia

				954), Banga Satyagraha (1956) and creation of new Purulia district – 25 classes(JD)	various popular folk cultures of Manbhum such as Tusu, Bhadu, Karam etc.
VI	DSE-IV	Patterns of Capitalism in Europe 16th Century to 20th Century	BHISDSRT4	1.Industrial Revolution in England – Causes, Nature & results.-15 Classes(BK) 2. Industrial Capitalism in France – Genesis & Nature.-15 Classes(JD) 3. Growth of Industries in Germany – background of Industrialization – impact.-15 Classes(JD) 4. Impact of Industrial Revolution on European society, Policy and Economy.-15 Classes(AT)	Students will learn about the industrial revolution and its impact on European society, economy, politics etc.
	SEC-IV	Understanding Heritage	BHISSERT604	1.Defining Heritage: antiquity, archaeological site, tangible heritage, intangible heritage, art treasure-15 Classes(AT) 2.Heritage and travel: heritage sites, cultural heritage, landscape, recent travel trends-15 Classes(JD) 3. Indian heritage: heritage-related government departments; conservative initiatives; major Indian heritage-15 Classes(BK) 4. Local heritage:local sentiments and heritage preservation; majorsignificant heritages of Manbhum-15 Classes(JD)	Students will learn about the meaning of heritage, various archaeological sites in India and their conservation policies.
	GE-II	Historians of India	BHISGERT2A	1. R.C. Majumdar, D.D. Kosambi, Romila Thapar, R.S. Sharma – 20 classes(AT) 2. Iswari Prasad, Jadunath Sarkar, Satish Chandra, Irfan Habib – 20 classes(AT) 3. Amalesh Tripathi, Bipan Chandra, Sumit Sarkar – 20 classes(JD) N.K. Sinha, Nihar Ranjan Roy, Dinesh Chandra Sen – 15 classes(JD)	Students will gain a thorough knowledge about the lives and writings of various historians of ancient, medieval and modern India.

Teacher-in-Charge
Ramananda Centenary College
P.O. - Laulara, Dist.-Purulia

Ramananda Centenary College
ESTD-1971

Syllabus and Lesson Plan of Philosophy

U.G. Choice based credit system 3 years(6 semesters) Syllabus in Philosophy Sidho- Kanho- Birsha University, Purulia, West Bengal.

Honours

Semester	Paper	Course Title	Course Code	Contents & Class Teachers Name
I	I	General features of Indian Philosophy and Nastik Sampradaya	BPHICCH T101	1. Introduction and characteristics. 2. Rta.rna,yajna. 3. Carvaka- Epistemology,Metaphysics, Ethics. 4. Buddhism- Noble Truths, Pratityasamutpada, Ksnabhangavada, Schools of Buddhism. 5. Jainism- Dravya,Guna,Paryaya,Jiva,Ajiva,Anekantavada,Syadvada,Nayavada. -------M.S. 60 classes
	II	Pre-Socratic period to Aristotle	BPHICCH T102	1. Introduction to Zeno.----S.D 2. Heraclitus,Empedocles,Greek Atomism,Anaxagoras,Sophists------U.H 3. Socrates,Plato, Aristotle, St.Thomas Aquinas--------T.A 60 classes
II	III	Indian Ethics	BPHICCH T201	1. Introduction:concerns and presuppositions 2. Theory of Karma, Rebirth. 3. Dharma: Its meaning and definition.-------M.S 4. Niskama Karma, Lokasamgraha. 5. Purusarthas and their interrelations. 6. Buddhist Ethics.----------S.D 60 classes
	IV	Western Logic	BPHICCH T202	Chapter- 5-7-----U.H 8-10 ------T.A 60 classes
III	V	Western Ethics	BPHICCH T301	Good, right, duty and obligation, crime and punishment, free will and responsibility, Kant's categorical imperative, hedonism, utilitarianism.---------U.H 60 classes
	VI	Astik Sampradaya(Indian Philosophy)	BPHICCH T302	1. Nyaya- Four Pramanas. 2. Vaisesika- Padarthas, Causation, Classification of causes, Astakarya Vada, Paramanuvada. 3. Samkhya- Satkaryavada, Prakrti and its constituents, evolution and arguments for its existence, purusa, relation between prakrti and purusa. 4. Yoga- Citta, Cittavritti, Cittabhumi, God and astanga yoga. 5. Advaita Vedanta- Nature of Brahma, adhyasa, vivarta vada, maya,three grades of satta. 6. Visistadvaita vada- Distinction between advaitavada and visistsdvaitavada, saguna Brahma, refutation of mayavada, Parinamavada.--------M.S 60 classes
	VII	Medieval Age.Western Philosophy)	BPHICCH T303	Decartes, Spinoza, Libnitz, Locke, Berkley, Hume, Kant.----S.D 60 classes
	S.E.C-I	Method of Induction & Probability	BPHISEHT 305	I.M.Copi- Introduction to Logic , Chapter 11to 14------T.A 24 classes
IV	VIII	Existentialism	BPHICCH T401	1. Chief features of Exixtentialism. 2. Existence precedes Essence.

				3. Anxiety. 4. Freedom. 5. Authentic and inauthentic Existence. 6. Being in itself and being for itself. 7. Bad faith. --------T.A 60 classes.
	IX	Philosophy of Religion	BPHICCH T402	1. The Judaic Christian concept of God. 2. Arguments for the exixtence of God. 3. Arguments against the existence of God. 4. The Problem of Evil. 5. The problem of religious language. -------U.H 60 classes
	X	Indian Logic and Epistemology- Tarkasamgraha by Annambhatta	BPHICCH T403	Tarkasamgraha with Deepika from saevavyavahara heturguna buddhijnanam to smrtirapi dvividha yatharthr ayatharthascheti(excluding Sabda and Upamana).------S.D 60 classes
	S.E. C-II	Practical Ethics	BPHISEHT 405	Environmental ethics, Feminism, Euthanasia.-------M.S 24 classes
V	XI	Special Text. (Indian) Vedantasara	BPHICCH T501	Full Text- M.S 60 classes
	XII	Special Text(Western) The Problems of Philosophy	BPHICCH T502	Appearance and reality, existence of matter, idealism, knowledge by aquintance and knowledge by description, on Induction.------T.A 60 classes
	D.S. E-I	Text from classical western Philosophy- An Enquiry Concerning Human Understanding by D.Hume	BPHIDSHT 1	Full Text- U.H 60 classes
	D.S. E-II	Text from modern Indian thought- Practical Vedanta by Swami Vivekananda	BPHIDSHT 2	Full Text-S.D 60 classes
	D.S. E- III	Text from Western Epistemology- Central Question of Philosophy by A.J.Ayer	BPHIDSHT 3	Chapter-I: The claims of Metaphysics Chpter-II: Meaning and Common Sense. U.H 60 classes N.B- Any two from D.S.E list
VI	XIII	Contemporary Indian Philosophy	BPHICCH T601	1. Background. 2. K.C.Bhattacharya- Negation, absolute idealism, the grades of consciousness, science and Philosophy. 3. Ambedkar- untouchability, caste and religion. 4. Sri. Aurobindo- Mind and Super Mind, integral yoga. 5. S. Radhakrishnan- An idealist view of life. 6. M.K. Gandhi- God and truth, non-violence, satyagraha. --------U.H 60 classes
	XIV	Contemporary Western Philosophy- Language,	BPHICCH T602	Chapter I,II and III-------T.A 60 classes

		Truth & Logic by A.J.Ayer		
	D.S. E-IV	**Text from Modern Indian Thought**	**BPHIDSHT 4**	**Full Text- S.D** **60 classes**
	D.S. E-V	**Hind Swaraj by M.K.Gandhi**	**BPHIDSHT 5**	**Full Text- M.S** **60 classes**
	D.S. E-VI	**Text from Western Political Philosophy-Communist Manifesto By Karl Marx and Frederik Eangles**	**BPHIDSHT 6**	**Full Text- M.S** **60 classes** **N.B- Any two from D.S.E list**

Program Course

Semester	Paper	Course Title	Course Code	Contents and class teachers Name
I	**I**	**General features of Indian Philosophy**	**BPHICCRT101**	**1. Introduction.** **2. Carvaka- Perception as the only source of knowledge, refutation of inference, dehatmavada.** **3. Buddhism- Four Noble Truths.** **4. Nyaya- Theory of Pramanas.** **5. Vaisesika- Seven Categories.** **6. Samkhya Theory of evolution, nature and proof for the existence of prakriti and purusa.** **7. Advaita Vedanta- Nature of Brahma, Jiva and Jagat.** **----S.D,U.H,M.S,T.A** **60 classes**
II	**II**	**Western Logic**	**BPHICCRT201**	**Western Logic-** **1. Classes and their relations- Boolean interpretation of A,E,I,O proposition, square vof opposition, existential import of propositions.---U.H** **2. Conversion, Obversion** **3. Syllogism, Figure and mood.-------T.A** **4. Venn Diagram-S.D** **5. Test of truth functional arguments by truth table.—M.S** **60 classes**
III	**III**	**Indian Ethics**	**BPHICCRT301**	**1. Introduction:concerns and presuppositions** **2. Theory of Karma, Rebirth.**

				3. Dharma: Its meaning and definition. 4. Niskama Karma, Lokasamgraha. 5. Purusarthas and their interrelations. 6. Buddhist Ethics. 60 classes
	S.E.C-I	Critical thinking & Decision Making	BPHISERT304	1. Necessitry of Religion: a critical analysis of Indian and western perspectives.------U.H 2. Secularism and Humanism. 3. Inter Religious dialogue and religious pluralism.----S.D 4. Morality and Religion-T.A
IV	IV	Western Ethics	BPHICCRT401	1. The nature of ethics: its concerns. Voluntary and non-voluntary actions. 2. Hedonism- Utiliterianism.---T.A 3. Kant's categorical imperative. 4. Theories of punishments, moral language.----U.H 60 classes
	S.E.C-II	Philosophy of Education	BPHISERT404	1. Concept and meaning of Philosophy of Education. 2. Education from the perspective of Rabindranath Tagore, Swami Vivekananda and M.K.Gandhi.-----S.D
V	V	Applied Ethics Or, Vedanta	BPHIDSRT1 OR, BPHIDSRT2	Nature and scope of applied Ethics, Anthropocentricism & Non-Anthropocentricism, Feminism, Animal Ethics, Environmental ethics.-------U.H & T.A 60 classes Or, Vedanta Khyativada-Bibaranprameya Samgraha by Vidyaranyamuni.------S.D 60 classes
	S.E.C-III	Psychology-Part-I	BPHISERT504	1. The scope and limits of Psychology. 2. The mind and the body. 3. Attention 4. Imagery. 5. Intelligence and intelligence testing. ------S.D. & M.S 24 classes
VI	VI	Logic Or, Nyaya	BPHIDSRT3 OR, BPHIDSRT4	Methods of Inductive Logic and Probability-Introduction to Logic by I.M.Copi(14th edition). ----U.H & T.A 60 classes Or, Nyaya- Tarkasamgraha by Annambhatta.-------S.D 60 Classes
	S.E.C-IV	Psychology-Part-II	BPHISERT604	1. Human Learning and Memory. 2. Personality. 3. Anxiety and Guilt Feeling. 4. The Sub- Conscious Mind. 5. Dream. ------S.D & M.S 24 classes

Generic Elective(Hons. other than Philosophy)

Semester	Paper	CourseTitle	CourseCode	Contents & class teachers Name
I	G.E-I	Ethics in the public Domain(Western)	BPHIGEHT11	1. Morality. 2. Cultural Relativism. 3. Subjectivism 4. Media Ethics. 5. Caste and Poverty. -----S.D, U.H, M.S, T.A

				60 Classes
II	G.E-II	Formal Logic	BPHIGEHT11A	1. Basic Logical Concept. 2. Aristotelian Logic. 3. Propositional Logic. 4. Symbolic Logic. ----S.D, U.H, M.S, T.A 60 classes

Generic Elective(Program other than Philosophy)

Semester	Paper	CourseTitle	CourseCode	Contents & class teachers Name
V	G.E-I	Ethics in the public Domain(Indian)	BPHIGERT11	1. Special features of Indian Ethics. 2. Four Purusarthas. 3. Karmavada- Sakama & Niskama. 4. Buddhist Ethics(Ahimsa and Pancasila) 5. Jaina Ethics(Anubrata, Mahabrata & Triratna). ---- S.D, U.H, M.S, T.A 60 classes
Vi	G.E-II	Formal Logic	BPHIGERT11A	1. Basic Logical Concept. 2. Aristotelian Logic. 3. Propositional Logic. 4. Symbolic Logic. ----S.D, U.H, M.S, T.A 60 classes

U.G.Choice based credit system 3 years (6 Semesters) Syllabus, Subject: Political Science (Honours)

Semester	Paper	Course Title	Course Code	Syllabus	Outcome
I	**CC-1**	Understanding Political Theory	BPLSCCHT101	1. What is Politics & Political Theory, Approaches to Political Theory: Normative, Empirical and Marxist. 2. Critical and contemporary perspectives in political theory: Feminism & Post-modernism. 3. Basic concepts: Rights, Liberty, Equality, Justice, Democracy & Citizenship 4. Ideology: Meaning & variants—(a) Anarchism(b) Liberalism (c) Neo-liberalism (d)Socialism 5. Theories of the State: Idealist, Marxist & Gandhian. 6. Modern western Marxism: Gramsci's 'hegemony'.	Students will gain a deeper understanding of political systems and ideologies, enabling them to critically analyze and evaluate political issues and debates. It also provides a framework for understanding the relationship between individuals and the state, as well as the distribution of power and resources within societies.
	CC-2		BPLSCCHT102	1. Philosophy of the Indian Constitution, Significance of the Preamble, Salient features of the Indian Constitution. 2. Fundamental Rights and the Directive Principles of the State Policy. 3. Nature of the Indian Federation, Recommendations of Sarkaria Commission and Venkat Chellaiah Commission. 4. State Autonomy: Meaning of the concept in Indian context, variants and factors. 5. Regionalism: emergence, evolution and recent trends. 6. Grass roots Politics: Institutions, Problems & Prospect.	Studying constitutional government and politics in India can provide individuals with a comprehensive understanding of the Indian political system, its institutions, and the roles and responsibilities of different branches of government. It also helps individuals to analyze and evaluate the Indian Constitution, which is the supreme law of the land, and its impact on Indian society.
II	**CC-3**	Governance and Democratic Politics in India	BPLSCCHT201	1. Governance: Meaning & Origin 2. Empowerment & Decentralization: Merits & Interrelations. 3. Participation and Governance. 4. Role of Civil Society & NGOs. 5. Quest for Good Governance: Its indicators & parameters. 6. Minimum government and maximum governance.	Studying this paper can help student develop a better understanding of the country's political system and its functioning. By analyzing India's governance and democratic politics, one can gain knowledge of the country's policymaking processes, political institutions, and the role of

					civil society in shaping public policy..
	CC-4	Political Process in India	BPLSCCHT202	1. Disintegration of the Congress system & advent of coalition era. 2. Politicization of caste, new trend of Ambedkarization of politics. 3. Judicial autonomy and Judicial Activism. 4. Indian Secularism; Factors leading to the rise of communalism. 5. Lokpal debate with special reference to Jana Lokpal movement. 6. Political culture in India.	This paper helps in better understanding of Political System in the country. This can provide insights into the functioning of political parties, elections, and the role of interest groups in shaping public policy. By analyzing the political process in India, one can also gain knowledge of the country's political culture, including the role of caste, religion, and regionalism in shaping politics. Ultimately, such an understanding can help develop strategies to strengthen India's democratic institutions and promote a more inclusive and representative political system.
III	CC-5	Comparative Government and Politics	BPLSCCHT301	1. Comparative Govt & Comparative politics: Distinction & Three Approaches to the understanding of Comparative Politics: Institutionalism, Developmentalism & NeoInstitutionalism. 2. Comparative study between British Prime Minister and American Presidency. 3. Constitutional development in Nepal. 4. Democracy & its crises in Pakistan: Brief historical sketch & recent trends. 5. Local Government in India & Bangladesh: A comparative study. 6. Comparative study between Indian & US Judiciary.	Studying comparative government and politics provides an understanding of the different political systems around the world, including their institutions, processes, and policies. It enables individuals to compare and contrast the similarities and differences between these systems, providing insights into the factors that shape their development and functioning.

	CC-6	Public Administration	BPLSCCHT302	1. Public Administration: Definition & Evolution; Contribution of Woodrow Wilson, Distinction between Public & Private Administration. 2. Scientific Management School & Human Relations approach. 3. New Public Administration & New Public Management. 4. Major concepts: Hierarchy, Unity of Command, Span of Control, Authority, Centralization, Decentralization, Line & Staff. 5. Bureaucracy: Views of Karl Marx & Max Weber. 6. E-Governance.	Studying public administration provides students with a broad understanding of the management and operations of public sector organizations, such as government agencies, nonprofit organizations, and international organizations. The study of public administration can help individuals to understand the complex interplay between politics and public policy, and the role of public institutions in shaping society.
	C-7	Indian Administration	BPLSCCHT303	1. Indian Administration: A broad historical Perspective 2. Union Administration-PMO-Cabinet Secretariat, Distinction between Secretariat & Directorate. 3. Institutional Reforms in Indian Civil Service: Background, motives and Globalization & liberalization as drivers of reforms in Indian Civil Service. 4. UPSC: Composition & Functions. 5. State Administration: Composition of State Secretariat, Role of Chief Secretary, Divisional Commissioner, DM. 6. Rural Administration, role of BDOs; Participatory Planning.	Studying Indian Administration provides students with a comprehensive understanding of the Indian bureaucratic system, its structures, and processes. It enables individuals to develop a critical understanding of the challenges and opportunities involved in managing a large and diverse country like India. Additionally, studying Indian Administration helps individuals to analyze and evaluate the effectiveness of Indian policies and programs, as well as the role of the Indian bureaucracy in implementing them.
	SEC-1	Legislative Process in India	BPLSSEHT305	1. The Union Legislature –The Rajya Sabha or the Council of States—its Composition, power and functions. The Lok Sabha of the House of People-Its composition, power and functions.	Studying the legislative process in India provides individuals with a comprehensive understanding of

				Speaker of Lok Sabha-His Election, Tenure of office, Power and Functions; Relations between the Rajya Sabha and the Lok Sabha. 1. Classification of Bills: a) Public Bill or Govt. Bill b) Private Members' Bill Types of Public Bill: i) Ordinary Bill, (ii) Money Bill and (iii) Financial Bill (iv) Budget, (v) Vote on Account. 2. Procedure of Passing bills and role of President. 3. Role of Opposition in Parliament.	how laws are made in India. It enables individuals to analyze and evaluate the role of the Indian parliament, its structures, and processes, and the factors that influence legislative decision-making in India. Additionally, studying the legislative process in India can help individuals to understand the complexities of Indian politics, including the role of political parties, Opposition, interest groups, and individual legislators in shaping the legislative agenda.
IV	**CC-8**	International Relations: Basic Theories and Approaches	BPLSCCHT401	1. International Relations as an academic discipline. 2. Realism & it's different variants. 3. Liberalism: Classical & Modern 4. Marxist theories of International Relations: World System theory, Critical theory & New Marxists. 5. Social Constructivists: Meaning, Features & Trends. 6. Feminism as an alternative perspective	This paper provides an understanding of how different social, political, economic, and cultural factors interact and influence each other. It can help them gain insights into the complexities of global issues. Additionally, studying international relations can develop critical thinking and analytical skills that are essential in today's interconnected world.
	CC-9	World Politics: Issues and Challenges	BPLSCCHT402	1. Non-Aligned Movement: its origin and Evolution. 2. Climate Diplomacy in the post-WWII era. 3. Human Rights: Three Generations of Human Rights & Humanitarian Intervention. 4. Politics in Middle East: Oil politics and Palestine Crisis. 5. International migration in a Globalising World. 6. Arab Spring in Egypt, Tunisia & Libya.	This paper can help students in understanding of the complex dynamics that shape international relations. This can include gaining knowledge of the historical, political, economic, and cultural factors that influence the relationships between nations, as well as the challenges

					faced by the international community, such as security, economic development, and human rights
	CC-10	Western Political Thought	BPLSCCHT403	1. Ancient Political Thought: Greek & Roman Period 2. Medieval Political Thought: Main features with reference to St. Augustine, St. Thomas Aquinas & Marsilius of Padua. 3. European Renaissance & Machiavelli: His concepts of Power & Secularization of Politics. 4. Hobbes's Materialism and John Locke's ideas of liberalism, natural rights, property & limited Government. 5. Rousseau: General Will. 6. Karl Marx: Pillars of Scientific Socialism.	This paper provides students with a comprehensive understanding of the evolution of political ideas in the Western world. This includes gaining knowledge of the works of influential political thinkers such as Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, and Marx, among others. Additionally, studying Western political thought can help students develop critical thinking and analytical skills, as they learn to evaluate different perspectives on political concepts such as democracy, liberty, justice, and equality. Such an understanding can provide students with the tools to analyze contemporary political issues and develop informed opinions on political affairs.
	SEC-2	Parliamentary Procedures in India	BPLSSEHT405	1. Parliamentary Procedure when the House is in session: Question Hour, Zero Hour, Stared and Unstarred question. 2. Various Motions: Adjournment motion, Calling Attention, Casting vote, No-confidence motion, Resolutions, Cut motion. 3. Committee system in Indian Parliament; Different	Studying parliamentary procedures in India can provide students with an understanding of the functioning of the Indian parliament and its procedures for lawmaking and policymaking. It can include gaining knowledge of the Indian Constitution,

				Committees. 4. Privileges of the Members of the Parliament.	parliamentary practices, rules of procedure, and the roles of different parliamentary institutions and officials.
V	CC-11	Indian Political Thought	BPLSCCHT501	1. Ancient Indian Political Thought: Basic Features, Kautilya's Saptanga theory, & Dandaniti. 2. Political thought in medieval India. 3. Raja Rammohun Roy—his social activism and liberal thought. 4. Swami Vivekananda: concept of nation-making & socialism. 5. Rabindra Nath Tagore: concept of Atmasakti & shift from nationalism to humanism. 6. Ambedkar: Different dimensions of his political & economic thought	Studying Indian political thought provides individuals with a comprehensive understanding of the evolution of political ideas and ideologies in India. It also provides an insight into the thoughts of great Indian Scholars like Raja Rammohan Roy, Rabindra Nath Tagore, Swami Vivekananda, Dr.B.R.Ambedkar etc.
	CC-12	Modern Political Philosophy	BPLSCCHT502	1. Modernity & its discourse: Enlightenment, its basic features. 2. Utilitarianism: Basic features, Later shifts in the thought of J.S. Mill. 3. Anarchism: its origin and core points. 4. Feminism: Different Waves; Eco-feminism. 5. Libertarinism. 6. Communitarianism.	Studying modern political philosophy provides individuals with a comprehensive understanding of the major political ideas and theories that have shaped modern Western political thought. It enables individuals to critically analyze and evaluate the various schools of modern political philosophy, such as utilitarianism, anarchism, feminism, libertarianism, communitarianism etc.
	DSE-1	Indian Foreign Policy I	BPLSDSHT1	1. Basic tenets of Indian Foreign Policy. 2. Non-alignment as a strategy of Indian Foreign Policy. 3. India's emergence as a 'soft power'.	This paper can provide insights into India's geopolitical and economic objectives, regional and global alliances, and its responses to emerging international issues. It can

				4. India's neighbourhood policy: Basic features; Gujral Doctrine. 5. India's extended neighbourhood. 6. Look-East & Act-East policy.	also help understand India's strategic partnership with its neighbors its use of soft power and diplomacy etc.
	DSE-2	Human Rights in India	BPLSDSHT2	1. Indian Constitution & Human Rights. 2. History of Dalit movements. 3. History of Civil Liberties movement in India. 4. Human Rights Commissions: National & State. 5. Human Rights Violations in India, cases and trends. 6. Role of Media, Civil Society & Judiciary for the protection of Human Rights	This paper can provide insights into the country's legal framework for protecting human rights, civil liberties movements in India, cases and trends in violation of Human Rights and the role of Media, civil society and judiciary in protection of Human Rights. It also helps in developing an Understanding that, human rights in India is crucial for promoting a culture of respect for human dignity, social justice, and accountability.
VI	CC-13	Political Sociology	BPLSCCHT601	1. The Basic Features of Political Sociology. 2. Political Culture & Political Socialization—Key Aspects & Classification. 3. Elite theories: Mosca, Pareto & C.Wright Mills. 4. Authority: Weberian Classification 5. Ethnicity and politics in India 6. Increasing Dalit mobilization and trasformation in mainstream Indian politics	Studying political sociology can provide students with an understanding of the relationship between politics and society. It can include gaining knowledge of the social and cultural factors that influence political behavior, institutions, and policies

	CC-14	Environment and Politics	BPLSCCHT602	1. Environmental concerns in globalising world. (Pollution of Global Commons, Global Trade versus Environment, Global warming etc.) 2. North South divide in environmental negotiations. 3. Sustainable Development: Meaning, features and critique. 4. United Nations Framework Convention on Climate Change (UNFCCC, 1992): Basic features of the Convention/ Key provisions. 5. India's stand in environmental negotiations. 6. Environmentalism, Major strands of environmentalism; Some major environmental movements in India (Chipko, Narmada Banchao Andolan and Silent Valley movement).	Studying environment and politics can provide students with an understanding of the complex relationship between human activities and the environment. It can include gaining knowledge of environmental movements, environmental policies, laws, and institutions, and their impacts on the environment. Ultimately, such an understanding can help students become informed and engaged citizens who can participate in environmental governance and contribute to the development of sustainable and equitable environmental policies.
	DSE-3	Indian Foreign Policy II	BPLSDSHT4	1. Evolution of India's Nuclear Policy. 2. India's bilateral relations with US & Russia. 3. Sino-Indian relations: Brief Historical Sketch & Contemporary Developments. 4. Indian Ocean and India's maritime security. 5. India & the UNO: India's participation in different UN peace-keeping missions & her demand in favour of UN reform. 6. Post-Cold War Indian Foreign Policy—Continuity & Change	Studying India's foreign policy can provide insights into its geopolitical and economic objectives, regional and global alliances, and its responses to emerging international issues such as climate change, terrorism, and global governance. It can also help understand India's strategic partnerships, its use of soft power and diplomacy, and its position on key international forums like the United Nations.

	DSE-4	Human Rights	BPLSDSHT5	1. Human Rights: Meaning and expanding scope. 2. Universal Declaration of Human Rights & Different Covenants and Agreements . 3. Protective mechanisms in International Laws. 4. Women & Child Rights as Human Rights. 5. Crimes against humanity: Major forms & Humanitarian Intervention. 6. Global Human rights: major issues and need for global awareness	Studying human rights in India can help provide insights into the country's legal framework for protecting human rights, the challenges faced in implementing these laws, and the impact on people's life. Understanding human rights in India is crucial for promoting a culture of respect for human dignity, social justice, and accountability.

U.G.Choice based credit system 3 years (6 Semesters) Syllabus, Subject: Political Science Honours(GE)

Semester	Paper	Course Title	Course Code	Syllabus	Outcome
III	**GE**	Gandhi and Contemporary World I	BPLSGEHT13	1. Gandhi's critique of modern civilization 2. Gandhi's ideas of Non-violence. 3. Gandhi's ideas of Satyagraha 4. Gandhi's ideas of Trusteeship 5. Gandhi's ideas of Sarvodaya 6. Gandhi's ideas of freedom (Swaraj)	Studying Gandhi and the contemporary world provides an understanding of Gandhi's philosophy, principles, and practices and their relevance to contemporary issues and challenges facing the world
IV	**GE**	United Nations and Global	BPLSGEHT13A	1. Establishment of United Nations and its Charter defining its functions.	This paper can help students understand the role of international

		Conflicts I		2. Role of Different UN institutions viz. General Assembly, Security Council, 3. Demand for reforming Security Council. 4. Role of Secretary General. 5. UN Peace-keeping operations. 6. Assessment of UN achievements and failures.	organizations in promoting peace and resolving conflicts, gain knowledge of the UN and its challenges in maintaining global peace and security, and develop critical thinking and analytical skills to evaluate global issues and develop informed opinions. Ultimately, this knowledge can help students become engaged citizens who can contribute to promoting international cooperation and resolving conflicts.

U.G.Choice based credit system 3 years (6 Semesters) Syllabus, Subject: Political Science (Program)

Semester	Paper	Course Title	Course Code	Syllabus	Outcome
I	CC-1	Political Theory	BPLSCCRT101	1. What is Politics, what is Political Theory, Classical, Behavioural and post-Behavioural phases. 2. Key Concepts: Rights, Liberty, Equality, Justice. 3. State: Minimal state, Welfare state, and Totalitarian state. 4. Debates in Political Theory: a) Is democracy compatible with economic Growth, b) On what grounds censorships justified, c) Does protective discrimination violate equality as fairness? 5. Democracy: Definition and Held's classification, 6. Political Party and Interest Groups.	Studying political theory helps individuals to gain a deeper understanding of political systems and ideologies, enabling them to critically analyze and evaluate political issues and debates.

II	CC-2	Indian Constitution and Politics	BPLSCCRT201	1. Indian Constitution: Basic Features, Fundamental Rights and DPSP. 2. Indian Parliament. 3. Union Executive: President Prime Minister. 4. Indian Judiciary. 5. Federalism; dynamics of Centre-State relations. 6. Party system in India.	Studying Indian constituted politics can provide insights into the country's political system, the role of the constitution in shaping governance, and the interplay between various political institutions. It can also help understand the challenges and opportunities of India's federal structure, the functioning of the judiciary, rights and duties of citizens. Additionally, studying Indian constituted politics can shed light on issues of political representation, identity politics, and the impact of electoral politics on policy outcomes.
III	CC-3	International Relations	BPLSCCRT301	1. International Relations and International Politics: Difference of Meaning, Scope of International Relations, Approaches: Realist, Neo-Realist, Liberal and Marxist. 2. Cold War: Different Phases-Brief Outline. 3. Post-Cold War Era: Basic Features and New emerging centres like European Union. 4. Indian Foreign Policy: Basic Principles. 5. India and Non-aligned Movement. 6. India's Quest for major power status.	Studying International Relations provides a comprehensive understanding of the interactions and interdependence between countries and other global actors. It equips students with the analytical skills and knowledge to explore the economic, political, social, and cultural factors that shape international relations, as well as the challenges and opportunities of global governance.

	SEC-1	Legislative Process in India	BPLSSERT304	1. The Union Legislature –The Rajya Sabha or the Council of States—its Composition, power and functions. The Lok Sabha of the House of People-Its composition, power and functions. Speaker of Lok Sabha-His Election, Tenure of office, Power and Functions; Relations between the Rajya Sabha and the Lok Sabha. 2. Classification of Bills: a) Public Bill or Govt. Bill b) Private Members' Bill Types of Public Bill: i) Ordinary Bill, ii) Money Bill iii) Financial Bill, iv) Budget, and v) Vote on Account 3. Procedure of Passing bills and role of President. 4. Role of Opposition in Parliament.	Studying the legislative process in India provides an understanding of the constitutional framework, procedures, and practices that govern the law-making process in the country. It equips students with the knowledge and skills to critically analyze legislative proposals, identify the actors involved in the law-making process, and assess the impact of legislation on society.
IV	CC-4	Comparative Government and Politics	BPLSCCRT401	1. Nature Scope and Methods of Comparative Analysis. 2. Comparing Political Systems : a) Parliamentary and Presidential. b) Federal and Unitary, c) Democratic and Authoritarian, 3. Characteristics of Modern State and Comparing Strong, Weak and Failed States, 4. Governing Institutions-How they work: a)Federalism in India and the US, b) Judiciary in India and the US, (c) Parliamentary Rule in UK and India, 5. Electoral Systems: Different types, 6. Political Party and Pressure Group, their functions, classification of party system.	This paper provides a comprehensive understanding of the different political systems around the world, including their institutions, processes, and policies. It enables individuals to compare and contrast the similarities and differences between these systems, providing insights into the factors that shape their development and functioning. Additionally, studying comparative government and politics can help individuals understand the impact of globalization and international institutions on domestic politics, as well as the role of culture, religion, and ethnicity in shaping political behavior.

	SEC-2	Parliamentary Procedures in India	BPLSSERT404	1. Parliamentary Procedure when the House is in session: Question Hour, Zero Hour, Stared and Unstarred question. 2. Various Motions: Adjournment motion, Calling Attention, Casting vote, No-confidence motion, Resolutions, Cut motion etc. 3. Committee system in Indian Parliament; Different Committees. 4. Privileges of the Members of the Parliament.	This paper provides students with an understanding of the functioning of the Indian parliament and its procedures for lawmaking and policymaking. It can include gaining knowledge of the Indian Constitution, parliamentary practices, rules of procedure, and the roles of different parliamentary institutions and officials.
V	DSE-1	Indian Foreign Policy I	BPLSDSHT1	1. Basic tenets of Indian Foreign Policy. 2. Non-alignment as a strategy of Indian Foreign Policy. 3. India's emergence as a 'soft power'. 4. India's neighbourhood policy: Basic features; Gujral Doctrine. 5. India's extended neighbourhood. 6. Look-East & Act-East policy.	This paper can provide insights into India's geopolitical and economic objectives, regional and global alliances, and its responses to emerging international issues. It can also help understand India's strategic partnership with its neighbors its use of soft power and diplomacy etc.
	SEC-3	Democratic Awareness and Recent Legislations in India	BPLSSERT504	1. National Human Rights Commission: Objectives and compliant procedures. 2. National Commission for Women: Objectives and functions. 3. Right to Information Act, 2005 & Right to Free and Compulsory Education Act, 2009. 4. Consumer Protection Act, 1986.	This paper provides an understanding of the principles, compositions and functions of the National Human Rights Commission, National Commission for Women and brings about awareness about the Right to Information Act, 2005, about Right to Free and Compulsory Education Act, 2009, Consumer Protection Act, 1986

VI	**DSE-2**	Human Rights in India	BPLSDSHT2	1. Indian Constitution & Human Rights. 2. History of Dalit movements. 3. History of Civil Liberties movement in India. 4. Human Rights Commissions: National & State. 5. Human Rights Violations in India, cases and trends. 6. Role of Media, Civil Society & Judiciary for the protection of Human Rights	This paper can provide insights into the country's legal framework for protecting human rights, civil liberties movements in India, cases and trends in violation of Human Rights and the role of Media, civil society and judiciary in protection of Human Rights. It also helps in developing an Understanding that, human rights in India is crucial for promoting a culture of respect for human dignity, social justice, and accountability.
	SEC-4	Democratic Process and Awareness of Recent Legislations	BPLSSERT604	1. Grass root Democratic institutions—Gram Sabha & Gram Sansad and importance of these meetings. 2. The Child labour (Prohibition & Regulation) Amendment Act, 2016. 3. Domestic Violence Act, 2005 and protection of women. 4. The Sexual Harassment at Workplace (Prevention, Prohibition& Redressal) Act, 2013	this paper provides an insights into the functioning of democratic institutions, the importance of citizen participation, and the role of the government in shaping policy. It can also help individuals understand the impact of recent legislation on issues such as civil rights, social justice, and economic development.

Lesson Plan for the Department of Political Science Ramananda Centenary College,

Laulara Purulia District West Bengal 723151

Course Type	Course Title	Number of Hours	Teacher-In-charge
CC-1	Understanding Political Theory	36 Hours	Mrituynjoy Mandal
CC-2	Constitutional Government and Politics in India	36 Hours	Dawa Yangzee Sherpa
CC-3	Governance and Democratic Poitics in India	36 Hours	Dawa Yangzee Sherpa
CC-4	Political Process in India	36 Hours	Mrituynjoy Mandal
CC-5	Comparative Government and Politics	36 Hours	Phatik Roy Mahata
CC-6	Public Administration	36 Hours	Mrituynjoy Mandal
CC-7	Indian Administration	36 Hours	Mrituynjoy Mandal
SEC-1	Legislative Process in India	36 Hours	Dawa Yangzee Sherpa
CC-8	International Relatins: Basic Theories and Approaches	36 Hours	Mrituynjoy Mandal
CC-9	World Politics:Issues and Challenges	36 Hours	Phatik Roy Mahata
CC-10	Western Political Thought	36 Hours	Phatik Roy Mahata
SEC-2	Parliamentary Procedures in India	36 Hours	Dawa Yangzee Sherpa
CC-11	Indian Political Thought	36 Hours	Mrituynjoy Mandal
CC-12	Modern Political Philosophy	36 Hours	Dawa Yangzee Sherpa
DSE-1	Indian Foreign Policy I	36 Hours	Phatik Roy Mahata
DSE-2	Human Rights in India	36 Hours	Phatik Roy Mahata
CC-13	Political Sociology	36 Hours	Dawa Yangzee Sherpa
CC-14	Environment and Politics	36 Hours	Phatik Roy Mahata
DSE-3	Indian Foreign Policy II	36 Hours	Phatik Roy Mahata
DSE-4	Human Rights	36 Hours	Mrituynjoy Mandal

SIDHO-KANHO-BIRSHA UNIVERSITY

Curriculum

BACHELOR OF ARTS(BA) PROGRAM COURSE WITH SOCIOLOGY

Semester	Paper	Course Title	Course Code	Contents and Class Teachers name-Subhash Ch. Mahato)	Course Outcome
I	I	Introduction to Sociology	BSOC CCRT 101	**1. Nature and Scope of Sociology (No. of Classes 30)** History of Sociology Relationship of Sociology with other Social Sciences: Anthropology, Psychology, History **2. Sociological Concepts (No. of Classes: 30)** Status and Role; Groups; Culture; Socialization; Structure and Function; Social Control and Change	**1.Define Sociology and demonstrate nature, scope and subject matter, relationship with other social science.** **2.Acquaint themselves with the basic concept of sociology like society, socialization, social structure and function, social control and social change, status and role, norms and values.** **3.Explain social groups.**
	II	Sociology of India	BSOC CCRT 201	**1.India as a Plural Society (No. of Classes: 5)** **2. Social Institutions and Practices (No. of Classes: 25)** Caste; Tribe; Class; Village; Family and Kinship **3. Identities and Change (No. of Classes: 15)**Dalits' Movement; Women's Movement **4.Challenges to State and Society (No. of Classes: 15)** Communalism; Secularism	**1.Explain India as a Plural Society.** **2.Know the basic social institution like Family Caste, Tribe, Village, Family and Kinship.** **3. Discuss the Dalit Movement and Women's Movement.** **4.Explain Communalism and Secularism.**

III	III	Sociological Theories	BSOC CCRT 301	**1. Karl Marx (No. of Classes: 20)**Alienation Materialist Conception of History Class and Class Struggle **2. Emile Durkheim (No. of Classes: 20)** Social Fact Forms of Solidarity Suicide **3. Max Weber (No. of Classes: 20)**Ideal Types and Social Action Types of Authority	**1.Describe theory of Karl Marks like Alienation, Historical Materialism, Class and Class Struggle.** **2.Describe Social Fact, Divison of Labour and Suicide.** **3.Describing theory of Max Webar like Social Action and types of Authority.**
IV	IV	Methods of Sociological Enquiry	BSOC CCRT 401	**1.The Logic of Social Research (No. of Classes: 20)** What is Sociological Research? Objectivity in the Social Sciences **2.Methodological Perspectives (No. of Classes: 20)** The Comparative Method The Ethnographic Method **3. Modes of Enquiry (No. of Classes: 20)**Theory and Research Analyzing Data: Quantitative and Qualitative	**1.Students are introduces to Sociological research both from a theoretical and methodological perspective. They understand the importance of research in social science.** **2.Explain the Methodological Perspectives like The Comparative method and The ethnographic method.** **3. Student learns that the research method and Theory. Also learn that data collection and data analysis and know that Quantitative and Qualitative data.**
V	V	Sociology of Development I	BSOC SERT5 04	**Sociology of Development I** 1. Basic Concepts: Development, Progress, Growth, Change 2. Sustainable Development: Concept, Goals and Approaches 3. Nature, Culture, Environment and Development: Concepts, Issues and Debates (Displacement and Migration, Women and Development) 4. Alternative Development and Post-development: Concepts and Debates	
VI	VI	Sociology of Development II	BSOC SERT6 04	**Sociology of Development II** 1. Industrialization, Liberalization, Globalization: Concepts 2. Theories of Development:	

				Dependency Theory, Worlds Systems Theory, Capability Approach. 3. Contemporary Issues: Indian Population Issues and Economic Growth	

BACHELOR OF ARTS(BA) PROGRAM COURSE WITH SOCIOLOGY (Continued)

List of Discipline Specific Electives

Semester	Paper	Course Title	Course Code	Content and Teachers Name	Course Outcome
V	V	Marriage, Family and Kinship	BSOCD SRT	**1. Introduction: Kinship (No. of Classes: 15)** Biological and Social Kinship,Cultural Kinship **2.Family and Household (No. of Classes: 20)**Structure and Charactaristic Reimagining Families **3.Contemporary Issues in Marriage, Family and Kinship (No. of Classes: 25)** Choice and Regulation in Marriage Power and Discrimination in the Family Marriage Migration	**1.Impart comprehensive study of concepts relavant for understanding kinship, marriage and family.** **2.Group the historical evolution of kinship theories from a biological deterministic approach to culture of relatedness.** **3.Develop an analytical perspectives kinship theories from a biological deterministic approach to culture of relatedness.** **4.Comprehend the coexistence of multiple perspectives in the study of family, marriage and kinship.**
V	V	Religion and Society	BSOCD SRT	**1. Understanding Religion (No. of Classes: 15)** Sociology of Religion: Meaning and Scope Sacred and Profane **2. Religion in India (No. of Classes: 35)** Hinduism,Islam,Christianity,Sikhism,Buddhism,Jainism Tribal Religion: Salient Features **3. Secularism & Communalism (No. of Classes: 10)**	**1.Student will be acquainted representative texts that symbolize the develop of knowledge in the field of sociology of religion.** **2.They will be able to identity different theories, approaches and cocept that make up the study of religion, distinguish between tem and also use terms specific to the field in specific context.** **3.By encompassing contemporary developments the course anable student to think about linkage between religion and society at various levels.**
VI	VI	Urban Sociology	BSOCD SRT	Urban Sociology: Urban-rural Differences, Urban-rural Continuum Industrialisation, Urbanisation; Urbanism, City, Urban, Rurban, Urban Out-growth, Urban Agglomeration, Metropolis 1. Urban Problems: Unemployment,	1.Expalin nature, scope,importance of urban sociology. 2.Describe town and characteristic. 3.Understand relation between rural-urban

				Poverty, Congestion, Housing Problem, Pollution 2. Migration and Population Explosion	continuum. 4.expalin Migration and Urbanization, 5.Analysis the Urban Problems, unemployment, poverty,congestion, Housing problem and pollution.
VI	VI	Rural Sociology	BSOCD SRT	1. Rural Society: Definition; Rural-Urban Differences, Types of Village; Physical Features, Socio-cultural Features, Demographic Features 2. Rural Institutions: Family, Economy (Folk and Tribal Contexts), Religion, Panchayat 3. Rural Stratification: Caste, Class and Gender 4. Agrarian Movements	1.Describing nature and scope of rural sociology. 2.Develop on understanding of Rural Social System, concept of village, characteristic of rural society. 3.Understand the caste system, Class and Gender. 4.Understanding Panchayati Raj System. 5.Explain Agrarian Movements.

BACHELOR OF ARTS(BA) PROGRAM COURSE WITH SOCIOLOGY (Continued)

List of Generic Elective Courses

Semester	Paper	Course Title	Course Code	Content and Teachers Name	Course Outcome
III		Indian Society: Images and Realities	BSOCGERT	**1. Ideas of India: Civilization, Colony, Nation and Society (No. of Classes: 20) 2. Institutions and Processes (No. of Classes: 40) Village, Town and Region Caste; Religion and Ethnicity; Family and Gender; Political Economy**	**1. The mandate of the course is to introduce the society and culture of India. 2.This paper is expected to bring familiarity in a student about Indian society. 3.Explain Religion and Ethnicity, Family and Gender, Political Economy.**
IV		Family and Intimacy	BSOCGERT	**1.What is Family? Types of Family; Functions of Family (No. of Classes: 15) 2. Family Relationships; Incest Taboo (No. of Classes: 10) 3.Joking Relations; Relations of Avoidance (No. of Classes: 10) 4. Alternatives to Family (No. of Classes: 10) 5. Family and Intimacy: Themes, Critiques and Transformations (No. of Classes: 15)**	**1.Define family, types of family and function of family. 2. understanding Incest Taboo. 3. Student will be exciting Jocking Relations and relations of avoidance. 4.Explain Alternatives to family.**