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**DETAILED SYLLABUS**

**FOR**

**DISTANCE EDUCATION**

**B.Sc. General**

**(Physics, Chemistry, Biology)**

**(YEARLY SYSTEM)**

## B.Sc. General(Physics, Chemistry and Biology)

Year – 1 – 3

Course Title : B.Sc. General (Physics, Chemistry and Biology)

<b>COURSE TITLE</b>	<b>Paper Code</b>	<b>MARKS</b>				
		<b>THEORY</b>		<b>PRACTICAL</b>		<b>TOTAL MARKS</b>
		<b>INTERNAL</b>	<b>EXTERNAL</b>	<b>INTERNAL</b>	<b>EXTERNAL</b>	
Mechanics and Relativity	PCB/Y/110	40	60	40	60	100
Electricity and Magnetism	PCB/Y/120	40	60	40	60	100
Mathematical Methods and Waves	PCB/Y/130	40	60	40	60	100
Inorganic Chemistry – I	PCB/Y/140	40	60	40	60	100
Organic Chemistry – I	PCB/Y/150	40	60	40	60	100
Physical Chemistry – I	PCB/Y/160	40	60	40	60	100
Non Chordata	PCB/Y/170	40	60	40	60	100
Genetics	PCB/Y/180	40	60	40	60	100

**Duration : 03 Years**

**Total Degree Marks : 2400**

**FIRST YEAR**

**SECOND YEAR**

<b>COURSE TITLE</b>	<b>Paper Code</b>	<b>MARKS</b>					
		<b>THEORY</b>		<b>PRACTICAL</b>		<b>TOTAL MARKS</b>	
		<b>INTERNAL</b>	<b>EXTERNAL</b>	<b>INTERNAL</b>	<b>EXTERNAL</b>		
Kinetic Theory and Thermodynamics	PCB/Y/210	40	60	40	60	100	
Optics	PCB/Y/220	40	60	40	60	100	
Electronics	PCB/Y/230	40	60	40	60	100	
Inorganic Chemistry – II	PCB/Y/240	40	60	40	60	100	
Organic Chemistry – II	PCB/Y/250	40	60	40	60	100	
Physical Chemistry – II	PCB/Y/260	40	60	40	60	100	
Chordate	PCB/Y/270	40	60	40	60	100	
Ecology	PCB/Y/280	40	60	40	60	100	

**THIRD YEAR**

<b>COURSE TITLE</b>	<b>Paper Code</b>	<b>MARKS</b>					
		<b>THEORY</b>		<b>PRACTICAL</b>		<b>TOTAL MARKS</b>	
		<b>INTERNAL</b>	<b>EXTERNAL</b>	<b>INTERNAL</b>	<b>EXTERNAL</b>		
Classical Mechanics and Statistical Mechanics	PCB/Y/310	40	60	40	60	100	
Atomic and Nuclear Physics	PCB/Y/320	40	60	40	60	100	
Solid State Physics and Devices	PCB/Y/330	40	60	40	60	100	
Inorganic Chemistry – III	PCB/Y/340	40	60	40	60	100	
Organic Chemistry – III	PCB/Y/350	40	60	40	60	100	
Physical Chemistry - III	PCB/Y/360	40	60	40	60	100	
Bio Chemistry	PCB/Y/370	40	60	40	60	100	
Bio Technology	PCB/Y/380	40	60	40	60	100	

## YEAR-I

### Mechanics and Relativity

Course Code: PCB/Y/110

#### Conservation of Energy and Linear Momentum

Mechanics of a particle work energy theorem. Conservative and non-conservative forces and their examples. Conservative forces as negative gradient of potential energy. Center of mass of a system of particles. Conservation of linear Momentum and energy. Systems of variable mass, single and multistage rockets. Elastic and inelastic collisions.

#### Rotational Dynamics

Rigid body motion, Rotational motion, torque and angular momentum, moment of inertia and its calculations for disc, cylinder, spherical shell and solid sphere. Body rolling down on an inclined plane, Fly wheel, Motion of top.

#### Motion Under Central Forces

Concept of central force, Kepler's laws of planetary motion, Gravitational Law, Gravitational potential and fields due to spherical shell and solid sphere, Gravitational potential energy and escape velocity. Two particle central force problem and reduced mass. Motion of planets and satellites.

#### Properties of matter

Elasticity, small deformations, Hooke's Law, elastic constants and relation among them. Beam supported at both the ends, cantilever, torsion of a cylinder, Maxwell's needle and Searl's method.

Streamline and turbulent flow, equation of continuity, viscosity, Poiseuille's law, critical velocity, Reynold's number, Stoke's law and terminal velocity. Surface tension and surface energy, molecular interpretation of surface tension, pressure on a curved liquid surface.

#### Relativity

Reference System, Inertial frames, Galilean invariance, Michelson-Morley's experiment, Einstein's postulates for the special theory of Relativity. Lorentz transformation equations, Length contraction and time dilation. Concept of simultaneity. Relativistic addition of velocities. Variation of mass with velocity. Mass energy equivalence. Momentum -energy relations.

## **Electricity & Magnetism**

**Course Code: PCB/Y/120**

### **Electrostatics**

Coulomb's law in vacuum expressed in vector form. Force between a point charge and a continuous charge distribution. Electric field in a material medium. Dielectric polarization and dielectric constant. Polarization vector  $P$  and Displacement vector  $D$ . Gauss Law in a dielectric medium. External field of a dielectric medium, Clausius-Mossotti equation and its molecular interpretation. Langevin-Debye equation. Boundary conditions satisfied by  $E$  and  $D$  at the Interface between two homogeneous dielectrics.

### **Varying and Alternating Currents**

Kirchoff's law & Analysis of multiloop circuits, Growth and Decay of Currents in LR circuits. Charging and Discharging of a capacitor through a resistance and through a LR circuit. Measurement of high resistance by leakage method.

AC circuits containing R,L&C. Impedance and admittance, Phasor diagram for current and voltage in AC circuits, Analysis of AC using operator, Series and parallel resonant circuits, Q-factor, Power consumed by an AC circuit. Choke coil.

### **Magnetostatics and Magnetic Properties of matter**

Force on a moving charge. Lorentz force equation. Definition of magnetic induction  $B$ . Force on a straight conductor carrying current in a uniform magnetic field. Biot Savart law and its applications to a straight conductor, circular coil and solenoid. Ampere's law and its applications. Motion of a charge particle in magnetic field and cyclotron. Torque on a current loop in a magnetic field. Theory of Ballistic galvanometer, critical dampening, current and charge sensitivity.

Magnetic permeability and susceptibility, Relation between them. Hysteresis. Theory of Para-, Di- and Ferro magnetism.

### **Electromagnetic Induction.**

Faraday's law, Lenz's law, Electromotive force, Energy stored in a magnetic field, Energy stored in an inductor conducting rod moving in a magnetic field. Mutual and self inductance, transformer, Maxwell's displacement current. Statement of Maxwell's equations and their significance.

### **Electromagnetic waves**

Wave equation satisfied by  $E$  and  $B$ . Plane electromagnetic waves in a vacuum. Poynting's vector, reflection at a plane boundary of dielectrics, polarization by reflection and total internal reflection

**Vector Analysis**

Scalars and Vectors dot and cross product, Triple and Quadruple vector product of vector, scalars and Vector fields, Gradient of a scalar and Vector field, Gauss divergence theorem, Green's theorem and Stokes's theorem.

**Matrices**

Definition of matrix, addition, Subtraction and multiplication of the matrices. Transpose of a matrix, symmetric and skew-symmetric matrix. Adjoint of a matrix. Hermitian matrices, Inverse of a matrix, Singular and non-singular matrices. Orthogonal matrices. Rank of a matrix.

**Oscillations**

Potential well and periodic oscillations, case of harmonic oscillations, differential equation and solution of simple harmonic oscillations. kinetic and potential energy. Examples of simple harmonic oscillations. Spring and mass system. Simple and compound pendulum. Torsional pendulum. Helmholtz resonator, LC circuit, vibrations of magnet. Oscillations of two masses connected by a spring.

Superposition of two simple harmonic motions of same frequency are same along the same line. Interference, Superposition of two mutually perpendicular simple harmonic vibrations of the same frequency. Lissajous figure, case of different frequencies. Free and forced oscillations. Effect of damping on resonance.

**Waves**

Waves in media, speed of transverse waves on a uniform string, speed of longitudinal waves in a fluid, Energy density and energy transmission in waves over liquid surface, gravity waves and ripples. Group velocity and phase velocity and their measurements.

Superposition of waves. Linear homogeneous equation and the superposition principle, nonlinear superposition and consequences. Standing waves as normal mode of bounded systems. Harmonics and the quality of sound, production and detection of ultrasonic and infrasonic waves and applications.

**Acoustics**

Noise and Music. The human ear and its responses, limits of human audibility, intensity and loudness, bel and decibel, musical scale, temperament and musical Instruments.

Reflection, refraction and diffraction of sound, acoustic impedance of a medium, percentage reflection and refraction at a boundary, impedance matching for transducers, diffraction of sound, principle of a sonar system, sound ranging.

Applied acoustics: Transducers and their characteristics. Recording and reproduction of sounds, various system, Measurements of frequency, waveform, intensity and velocity. The acoustics of halls, reverberation period, Sabine's formula.

## **Inorganic chemistry –I**

**Course Code: PCB/Y/140**

### **Atomic Structure**

Dual nature of matter and idea of de Broglie matter waves, de Broglie equation; Wave mechanical model, Heisenberg's uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of  $\Psi$  and  $\Psi^2$  quantum numbers, shapes of s,p,d orbitals. Aufbau and Pauli's exclusion principles, Hund's multiplicity rule. Electronic configuration of the elements.

### **Periodic properties**

Atomic and ionic radii, ionization energy, electron affinity and electro negativity –definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behavior.

### **Chemical bonding**

**Covalent Bond-** Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electrons pair repulsion(VSEPR) theory to **NH<sub>3</sub>, H<sub>3</sub>O<sup>+</sup>, SF<sub>4</sub>, ClF<sub>3</sub>, ICl<sub>2</sub> and H<sub>2</sub>O** MO theory. homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

**Ionic Solids-** Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semi conductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions. Fajan's rule. Inert pair effects in lead bond, odd electron bonds, hydrogen bond.

**Weak Interactions-** Hydrogen bonding VanderWaals forces

### **s-block elements**

Comparative study, diagonal relationship, characteristics including their positions in the periodic table, abnormal behaviour of Li and Be. Preparation, properties and uses of Lithium hydride, sodaamide and Basic beryllium acetate. Comparative study of groups 13-17 elements, characteristics including their positions in the periodic table, Abnormal behaviour of nitrogen, oxygen and fluorine compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-di-borane and higher boranes, borax, carbides, peroxy acids of sulphur, sodium thiosulphate, interhalogens, freon Teflon.

## **Chemistry of noble gases**

Isolation of noble gases, chemistry of xenon, structure and bonding in xenon compounds.

## **Organic chemistry -I**

**Course Code: PCB/Y/150**

### **Structure and Bonding and Mechanism of Organic reactions**

Hybridization, bond lengths and bond angles, bond energy, vander Waals interactions, resonance, hyper conjugation, aromaticity, inductive and field electromeric, hydrogen bonding.

Curved arrow notation, drawing electron movements with arrows half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles. Types of organic reaction. Energy consideration.

Reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrene (with examples). Assigning formal charges on intermediates and other ionic species.

### **Stereochemistry of Organic Compounds**

Concept of isomerism. Types of isomerism.

Optical Isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, meso compounds, resolution of enantiomers, racemization.

Relative and absolute configuration, sequence rules, D&L and R&S systems of nomenclature.

Geometric isomerism-determination of configuration of geometric isomer. E&Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism – conformational analysis of ethane and n-butane, confirmation of cyclohexane, axial and equatorial bonds, Newman projection.

### **Alkanes and cycloalkanes**

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reaction of alkanes.

Mechanism of free radical halogenations of alkanes; orientation, reactivity and selectivity. Cycloalkanes-nomenclature, methods of formation, chemical reactions, Bayer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings.

### **Alkenes, Dienes And Alkynes**

Nomenclature of alkenes, method of formation, mechanisms of dehydration of alcohols and dehalogenation of alkyl Halides, regioselectivity in alcohol dehydration. The Saytzeff rule,



Hffman elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes –mechanisms involved in hydrogenation, electrophilic and free radical additions, Markovnikov's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ , Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes

.Industrial applications of ethylene and propene. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of Butadiene, methods of formation, polymerization. Chemical reactions-1,2 and 1,4 additions, Diels-Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reaction, hydroboration-oxidation, metal ammonia reductions, oxidation and polymerization.

### **Arenes and Aromaticity**

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of Benzene; molecular formula and Kekule structure, Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity-the Huckel rule, aromatic ions.

Aromatic electrophilic substitution-general pattern of the mechanism, role of  $\sigma$ - and  $\pi$ -complexes. Mechanism of nitration, halogenation. Sulphonation, mercuration and Friedel-Crafts reaction. Activating and deactivating substituents, orientation and ortho:para ratio. Side chain reactions of benzene derivatives.

Methods of formation and chemical reactions of alkyl benzene, alkylbenzene. Alkyl and aryl halides. Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}1$  reactions.

Methods of formation of Aryl halides, nuclear and side chain reactions. The addition-elimination and elimination-addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

## **Physical Chemistry-I**

**Course Code : PCB/Y/160**

### **Mathematical concepts and Computers**

#### **Mathematical Concepts**

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

## **Computers**

General introduction to computers, different component of a computer, hardware and software, input output devices ;binary numbers and arithmetic; introduction to computer languages.Programming, operating systems.

## **Gaseous State**

Postulates of kinetic theory of gases, derivation from ideal behaviour, vander Waals equation of state.

Critical phenomena: PV Isotherms of real gases, continuity of states, the isotherms of vander waals equation , relationship between critical constants and vander Waals constants.

, the law of corresponding states,reduced equation of state .

Molecular velocities: Root mean square , average and most probable velocities . Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameters.Specific heats of gases.Liquification of gases(based on Joule-Thomson effect).

## **Chemical equilibrium**

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action, reaction isotherm, reaction isochore, Clapeyron equation and Clausius- Clapeyron equation, application, Le Chatelier's principle.

Statement and meaning of the terms-phase , component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system-water and S system.

## **Phase Equilibrium**

Phase equilibria of two component system-solid –liquid equilibria, simple eutectic –Pb-Ag system and desilverisation of lead.

Liquid-liquid mixture-ideal liquid mixtures, Raoult's and Henery's law.

Non ideal system-azeotropes-HCl-H<sub>2</sub>O and ethanol-water systems.

Partially miscible liquids –Phenol water, tri methylamine –water systems.Lower and upper consolute temperature Effect of impurity on consolute temperature.

Nernst distribution Law , limitations thermodynamics derivation, distribution law in case of association and disassociation.

## **Colloidal State**

Definition of collides, classification of colloids.

Solids in Liquids(sols):, properties – kinetic , optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number, zeta potential.

Liquids in Liquids (Emulsions):types of emulsion , preparation , Emulsifier.

Liquids in solids(gels): classification and preparation and properties, inhibition, general application of collides.

Elementary idea of sol-gel transformation and thixotropy.

## **Chemical Kinetics and Catalysis**

Chemical kinetics and its scope, rate of reaction, factors influencing the rate of a reaction-concentration , temperature, pressure, solvent, light , catalyst. Concentration dependence rates, mathematical characteristics of a simple chemical reactions-half order, zero order, first order

,second order , third order, nth order, pseudo order, half life and mean life.Determination of the order of the reaction-differential method, method of integration, method of half life period and isolation method.

Theories of chemical kinetics:effect of temperature on rate of reaction,Arrheneius equation, concept of activation energy.

Simple collision theory of uni molecular reaction , transition state theory(mathematical treatments)Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

Catalysis, characteristics of catalyzed reaction , classification of catalysis, miscellaneous examples of catalysis, acid-base catalysis, enzyme catalysis including its kinetics.

## **Non Chordata**

**Course Code: PCB / Y/ 170**

Introduction, Protozoa: Characters and Classification,Euglena, Trypanosoma, Leishmania, amoeba Proteus, Entamoeba Hystolytica,Elphidium Polystomella, Radiolaria,Monocystis, Plasmodium(Malarial Parasite),Eimeria, Paramecium, Vorticella, Nutrition in Protozoa, Reproduction in Protozoa, Economic Importance of Protozoa Objective Protozoa, Metazoa, Porifera :Characters And Classification, Leucosolenia, Scypha(Sycon), Histology of Sponges, Canal System in Sponges, Skeleton in Sponges, Reproduction in Sponges, Economic Importance of Sponges Objective:Porifera, Colenterata:Characters and Classification, Hydra , Obelia, Aurelia,Metridium, Coral and Coral reefs, polymorphism Objective:Colentereta, Ctenophora:Characters and Classifications Pleurobrachia, Platyhelminthes:Characters and Classification, Dugesia(Planeria), Fasciola Hepatica, taenia solium, Echionococcus granulosus Objective Platyhelminthes,Aschelminthes:Characters and Classifications , Ascaris Lumbricoides,Anchylostoma, Wuchereria(=Fileria)bancrofti, Parasitism and Parasitic Adaptations Objective :Aschelminthes, Annelida:Characters and Classification, Neanthes-Nereis, Pheretima posthuma, Hirundinaria granulose, Archiannelida , Segmentation in Annelida, Excretion in Annelida Objective:Annelida, Arthropoda: Characters and Classification, Neanthes-Nereis, Pheretima posthuma, Hirundinaria granulose, Archiannelida, Segmentation in Annelida Objective Annelida, Arthropoda :Characters and Classification, Palaemon,

## **Genetics**

**Course Code: PCB / Y/180**

**Introduction:** earlier concepts of heredity- germplasm theory- heredity and variations- genotype- phenotype- hereditary diseases- phenocopy- some milestones in the history of genetics.

**The cell:** history- prokaryotic and eukaryotic cells- comparison- prokaryotic cell- eukaryotic cell- cell wall- plasma membranes chemical composition- membranes functions structure of the membranes- membrane models- bilayer models- fluid mosaic model- micellar models- cytoplasm- nucleus- nucleolus- nucleic acids DNA- mitochondria- chloroplasts- chlorophylls- endoplasmic reticulum- ribosomes- golgi complex- vacuoles- lysosomes- centrosomes- peroxisomes- glyoxysomes.

**Microscopy:** the working of a microscope- simple microscope- comparison of different types of microscopes- bright field microscope- magnification- resolving power- working of oil immersion lens- dark field microscope- phase contrast microscope- fluorescence microscope ultraviolet microscope- interference microscope stereo microscope- electron microscopy- basic construction of electron microscope- basic construction of electron microscope- transmission electron microscope (TEM)- preparation of specimen for (TEM) – scanning electron microscope (SEM)- preparation of specimen for (SEM)- micrometry.

**Mendelism:** pre Mendelian hybridization experiments- mendel's experiments- main reasons for mendel's success characters chosen by Mendel- technique of crossing in pea plants- terms used in mendelian experiments- monohybrid cross- laws of Mendel- test cross- dihybrid cross- law of independent assortment- deviations from mendelism (incomplete dominance)- significance of mendel's work- is mendelism an exception or rule in genetics ?

**Interaction of Genes:** lethal genes- combs in fowls- flower color in sweet pea- coat color in mice- plumage in poultry- polymeric genes- duplicate genes in capsella.

**Multiple factor inheritance:** grain color in wheat- skin color in human beings- ray size in flower heads of compositae- mechanism of gene action in a polygenic system- modifier genes- transgressive variations.

**Multiple Alleles:** coat color in wheat- dye color in drosophila- wing size in drosophila- sexual incompatibility in Nicotiana – blood groups in man- Rh factor.

**Linkage and Crossing Over** coupling and repulsion hypothesis- Morgan's concept of linkage- linkage in maize- linkage in drosophila- linkage in mammals- linkage in bacteria- crossing over- meiotic cross over- mechanism of crossing over- cytological demonstration of crossing over- types of cross over- mitotic crossing over significance of crossing over- chromosome mapping linkage map in maize.

**Sex Determination:** brief history- discovery of sex chromosomes- theories of sex determination heterogametic males- heterogametic females- genic balance theory- intersexes and super sexes- freemartin cattle- environmental determination of sex- mechanism of sex determination in plants.

**Sex Linked Inheritance :-** holandric genes- X linked genes- Sex linked inheritance in drosophila- Sex linked inheritance in man- Sex linked inheritance in poultry- sex influenced genes- Sex limited genes- Non disjunction of sex chromosomes.

**Cytoplasmic Inheritance :-** plastid inheritance in mirabilis- Plastid inheritance in Maize- Male sterility in plants- cytoplasmic inheritance in chlamydomonas- petite characters in Yeasts- Kappa particles in paramecium- coiling of shells in snails- Merogenic hybrids in urodeles – Cytoplasmic inheritance in Ephestia- other instances of cytoplasmic inheritance.

**Gene mutation:-** History- frequency of mutations- classification of mutations- Spontaneous mutations- induced mutations- Chemical mutagens- CLB method- mullers method- Detection of autosomal mutations- somatic mutation- mutations at the molecular level- practical applications of mutations.

**Breeding in Animals And Plants:** plant breeding- aims and objectives of plant breeding – Methods of plant breeding- Hybridization- Heterosis – Breeding in self pollinated crops- Breeding of vegetatively propagated crops- Breeding of cotton- Maize- and sugarcane.

**Eugenics :-** History- Aims and objectives- negative Eugenics- Positive eugenics- Eugenics.

**Genetic Engineering:-** Outline procedure of genetic engineering- Restriction enzymes- isolation of Gene-shotgun method- Obtaining DNA from RNA- Vectors-plasmids- Bacteriophages- Cosmids- phasmids- cloning organisms- techniques used for identification of clones- Polyacrylamide gel electrophoresis- PFGE-Southern blotting technique- construction of Chimeric DNA- Cohesive ends- dA-dTtailing Blunt End Ligation-cDNA Libraries-Transfer of Recombinant DNA into Cloning organism-Expression of cloned DNA—Applications of Genetic Engineering-Scope-nif genes-Genetically Engineered insulin-Human growth hormone-Vaccine for Rabies virus-Biohazards and Safeguards of Genetic Engineering.

## YEAR-II

### **Kinetic Theory and thermodynamics**

**Course Code: PCB/Y/210**

#### **Kinetic Theory of Matter(I)**

Ideal Gas: Kinetic Model, deduction of Boyle's law, interpretation of temperature, estimation of rms speeds of molecules. Brownian motion, estimate of the Avogadro's number. Equipartition of energy, specific heat of monoatomic gas, extension to di and tri atomic gases, Behavior at low temperatures. Adiabatic expansion of an Ideal gas, application to atmospheric physics.

Real gas: Van Der Waal gas, equation of state nature of Van der Waal forces, comparison with experimental P-V curves. The critical constants, gas and vapor. Joule expansion of Ideal gas, and of a Vander waals gas, Joule coefficient, estimates of J-T cooling.

#### **Kinetic Theory of Matter(II)**

Liquification of gases: Boyle's temperature and Inversion temperature. Principle of regenerative cooling and of cascade coiling, liquification of hydrogen and helium. Refrigeration cycles, meaning of efficiency.

Transport phenomena in gases: Molecular collision, mean free path and collision cross sections. Estimates of molecular diameter and mean free path. Transport of mass, momentum and energy and interrelationship, dependence on temperature and pressure.

#### **Thermodynamics(I)**

The laws of thermodynamics: The Zeroth law, various indicator diagrams, work done by and on the system, first law of thermodynamics, internal energy as a state function and other applications. Reversible and irreversible changes. Carnot cycle and its efficiency, Carnot theorem and the second law of thermodynamics. Different versions of the second law, practical cycles used in internal combustion engines. Entropy, principle of increase of entropy. The thermodynamic scale of temperature, its identity with the perfect gas scale. Impossibility of attaining the absolute zero; third law of thermodynamics.

#### **Thermodynamics(II)**

Thermodynamic relationship: Thermodynamic variables: extensive and intensive, Maxwell's general relationships, application to Joule-Thomson cooling and adiabatic cooling in a general system, Van der Waal gas, Clausius-Clapeyron heat equation. Thermodynamics potential and equilibrium of thermodynamical systems, relation with thermodynamical variables. Cooling due to adiabatic demagnetization

### **Thermodynamics(III)**

Black body radiation: Pure temperature dependence, Stefan-Boltzmann law, pressure of radiation. Special distribution of black body radiation. Wien displacement law. Rayleigh-Jeans law, the ultraviolet catastrophe, Planck's quantum postulates. Planck's Law, complete fit with experiment Interpretation of behavior of specific heats of gases at low temperature.

## **Optics**

**Course Code: PCB/Y/220**

### **Geometrical Optics**

Fermat's principle: Principle of extremum path and its simple applications reflection, refraction and straight line motion of light.

General theory of image formation: Cardinal points of an optical system, general relationships, thick lens, combination of two thin lenses, Nodal slide and Newton's formula. Huygen's and Ramsden's eyepieces. Aberration in imager: Chromatic aberration, achromatic combination of lenses in contact & separated lenses. Monochromatic aberration and their reduction; crossed lens, aplanatic points, oil immersion objectives.

### **Physical Optics(I)**

#### **Interference**

Interference of light: The principle of superpositions, two slit interference, coherence requirement of the sources, optical path retardation, lateral shift of fringes, Rayleigh refractometer and other applications. Thin films, application for precision measurements for displacements. Interference in thin films, Newton's ring, its application in determination of wavelength, refractive index of liquid.

### **Physical Optics(II)**

#### **Interference**

Michelson interferometer, its application for precision determination of wavelength, wavelength difference, refractive index of thin transparent film and width of spectral lines, Intensity distribution in multiple beam interference. Fabry-perot interferometer & etalon.

#### **Diffraction**

#### **Diffraction of light:**

Fresnel diffraction, intensity due to cylindrical wave front by Fresnel half period zone method, zone plate. Diffraction at straight edge.

Fraunhofer diffraction: Diffraction at a slit & circular aperture. Diffraction at N-parallel slits, its intensity distribution, plane diffraction grating, concave grating and different mountings. Resolution of images; Rayleigh criterion, resolving power of grating, telescope and prism.

## **Physical Optics(IV)**

### **Polarization**

Double refraction and optical rotation :refraction in uniaxial crystal ,its electromagnetic theory ,Phase retardation, quarter waveplate and half wave plate ,double image prism, Rotation of plane polarization, Fresnel explanation of rotation.

## **Electronics**

**Course Code: PCB/Y/230**

### **A.C. Network Analysis and A.C. bridges.**

Kirchoff's Laws , statement and explanation of superposition theorem , Thevenin's theorem, Norton's theorem and Maximum power transmission theorem

A.C Bridge: General balance conditions , Maxwell's Inductance bridge, Anderson Bridge,Deasuty Bridge,Schering Bridge

### **Semi conductor physics and devices**

Intrinsic and extrinsic (p-type)semiconductors, p-n junction diode:working and V-I characteristics of under forward and reverse bias, breakdown mechanism , diode equation , stitching action of diode, Zener diode and its V-I characteristics , Bipolar transistor:npn and npn transistors and their working , Characteristic of transistor in common base and in common emitter configuration .Transistor parameters  $\alpha$  and  $\beta$  D.C.Load line and switching action of transistor.

### **Rectifiers and power supplies**

Rectifiers :Working of half wave and full wave (center tap and bridge)rectifiers using p-n junction diode ; calculation of ripple factor and efficiency of half wave and full wave rectifiers.Comparison of full wave center tap and bridge rectifiers.

Filters: Shunt capacitor filter , series inductor filter, Choke input(L-section filter, capacitor input( $\pi$ - section) filter.

D.C power supplies using zener diode voltage regulator and transistor series voltage regulator.

### **Amplifiers**

Basic principle of amplification, Gain of Amplifier, transistor CE and CB amplifiers , expression for voltage gain, comparison of CE and CB amplifiers. Transistor biasing :fixed bias and voltage divider bias A practical single stage transistor amplifier with voltage divider bias and its working. Classifications of Amplifier :Class A, Class B, Class C amplifiers .Qualitative analysis of two stage dry-C coupled and transformer coupled amplifiers along with the discussion of their frequency response curves.

### **Oscillators**

Definition .Feedback in Amplifiers, Barhausan criterion for oscillators.Comparison between amplifier and oscillator.Sinusoidal and non-sinusoidal oscillators. Qualitative analysis of tuned collector. Hartley oscillator



## **Digital Electronics**

Number Systems: Binary and decimal number systems, Conversion of binary to decimal and decimal to binary .

Logic Gates: Positive and negative logic , Basic gates-OR gate, AND gate, NOT, NAND, NOR gates(their truth table , Boolean equation , Circuit diagram and operation), Exclusive OR gate, simple combination of basic gates.

## **Inorganic Chemistry -II**

**Course Code : PCB/Y/240**

### **Radio activity**

Disintegration theory, Group displacement law, rate of disintegration. Half life period, Average life period, Disintegration series , Radioactive equilibrium, Artificial Radioactivity, types of Nuclear reactions, Nuclear fission and fusion, Applications of Radioactivity.

### **Chemistry of Elements of First transition Series**

Characteristic properties of d-block elements

Properties of the elements of the first transition series , their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

### **Chemistry of Elements of Second and Third transition Series**

General characteristics, comparative treatment with their 3d –analogous in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

### **Coordination compounds**

Werner's coordination theory and its experimental verification, effective atomic number concept chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes and its limitations.

### **Acids and Bases**

Arrhenius, Bronsted-Lowry, and Lewis and Usanovich concepts of acids and bases.

### **Chemistry of Lanthanides and Actinide Elements**

Electronic structure , oxidation states atomic and ionic radii, lanthanide contraction, complex formation, magnetic properties separation of Lanthanides.

### **Chemistry of Actinides**

General features and chemistry of extraction of uranium, similarities between the later actinides and the later lanthanides.

## **VIII. Quantitative Analysis**

Chemistry and principles involved in the volumetric analysis. Numerical problems based on the quantitative volumetric estimation-redox, iodometric and iodimetric titrations. Chemistry and principles involved in the reacti metric estimation of Ba,Cu and Ni.

## Organic Chemistry-II

Code: PCB/Y/250

### **Alcohols**

Classification and nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature, reactions of alcohols.

Dithere alcohols- nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol-pinacolone rearrangement. Trihydric alcohols- nomenclature and methods and structure of formation, chemical reactions of glycerol.

### **Phenols**

Nomenclature Structure and bonding, preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction and Picric acid.

### **Ethers and Epoxides**

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions- Cleavage and autoxidation, Ziesel's method.

Synthesis of epoxide. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagent with epoxides.

### **Aldehydes and ketones**

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids, properties.

Benzaldehyde, salicyl aldehyde and acetophenone.

Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Cannizzaro reaction. Clemmensen and Wolff-Kishner reduction.

An introduction to  $\alpha,\beta$  unsaturated aldehydes and ketones.

### **Carboxylic Acids**

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation, reactions of carboxylic acids Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation.

Methods of formation and chemical reaction of Halo acids. Hydroxyl acids:malic, tartaric and citric acids.

Benzoic acids, Salicylic acid, Anthranilic acid.

Methods of formation of and chemical reactions of unsaturated monocarboxylic acids, Acrylic acid, Crotonic acid, cinnamic acid.

Dicarboxylic Acid:succinic acid, malonic acid and phallic acid.

### **Carboxylic Acid derivatives**

Structure and Nomenclature of acid chlorides, esters, amides(urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives .Chemical reaction.Mechanisms of esterification and hydrolysis(acidic and basic).

### **Organic compounds of nitrogen**

Preparation of nitroarenes.Chemical reactions of nitro alkanes.Mechanisms of nucleophilic substitution in nitroarenes and their reduction in acidic neutral and alkaline media.

Halonitroarenes:reactivity.Structure and nomenclature of amines, physical properties. Separation of a mixture of primary , secondary and tertiary amines .Structural features effecting basicity of amines.Preparation of alkyl and aryl amines(reduction of nitro compounds nitriles), reductive amination of aldehydic and ketonic compounds.Gabriel-phthalimide reaction, Hofmann bromamine reaction .

Reaction of amine , electrophilic aromatic substitution in aryl amines , reactions of amines with nitrous acid.Synthetic transformations of aryl diazonium salts, azo coupling.

### **Numerical problem**

Based on structure and reactivity of compounds.

## **Physical Chemistry-II**

**Code: PCB/Y/260**

### **Thermodynamics –I**

Definition of thermodynamic terms:system , surroundings etc. Types of systems, intensive and extensive properties .State and path functions and their differentials.Thermodynamic process.Concept of heat and work.

First Law of thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law - Thomson coefficient and inversion temperature. Calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Thermochemistry: standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermochemical data, temperature, dependence of enthalpy. Kirchhoff's equation.

## **Thermodynamics-II**

Second Law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

Concept of Entropy: entropy as a state function, entropy as a function of  $V$  &  $T$ , entropy as a function of  $P$  &  $T$ , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third Law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions: Gibbs function ( $G$ ) and Helmholtz function ( $A$ ) as thermodynamic quantities,  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of  $G$  and  $A$  with  $P$ ,  $V$  and  $T$ .

## **Liquid State**

Intermolecular forces, structure of liquids (a qualitative description)

Structural differences between solids, liquids and gases.

Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases. Thermography and even sement cell.

## **Solid state**

Definition of lattice, unit cell.

Laws of crystallography - (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals.

X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CaCl (Laue's method and powder method).

## **Electrochemistry-I**

Electric transport-conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.

Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitation, weak and strong electrolytes, Ostwald's dilution law and its uses and limitation. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number,  $m$  definition and determination by Hittorf method and moving boundary method.

Applications of conductivity of measurements: determination of degree of dissociation, determination of  $K_a$  of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

## **Electrochemistry –II**

Types of reversible electrodes-gas –metal ion, metal –metal ion, metal insoluble salt –anion and redox electrodes. Electrode reaction , Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode –reference electrodes –standard electro potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells.

EMF of a cell and its measurements. Computations of all EMF, Calculations of thermodynamic quantities of cell reactions( $\Delta G$ ,  $\Delta H$  and  $K$ ), polarization , over potential and hydrogen over voltage.

Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficients, potentiometric titrations.

Definition of pH and pKa determination of pH using hydrogen, quinhydrone and glass electrodes , by potentiometric methods.

Buffers-mechanism of buffer action , Henderson-Hassel equation .Hydrolysis of salts.

Corrosion-types, theories and method of prevention.

## **Chordate**

**Course Code : PCB /Y/270**

- Chordates: Characters and Classification
- Origin of Chordates
- Animal Tissues
- Objective: Tissue
- Hemichordata: Characters and Classification
- Balanoglossus
- Subphylum Urochordata: Characters and Classification
- Herd mania
- Salpa
- Doliolum
- Amphioxus (Branchiostma)
- Objective: Protochordata
- Agnatha
- Petromyzon
- Objective: Cyclostomala
- Pisces: Characters and Classification

- Scoliodon
- Lebeo rohita (Rohu, A Bony Fish)
- Dipnoi
- Origin and Evolution of Fishes
- Air Bladder in Fishes
- Accessory respiratory organs in fish
- Weberian ossicles
- Electric organs in Fishes
- Parental care in fishes
- Economic importance of fish
- Objectives: Pisces
- Amphibia: Characters and Classification
- Rana tigrina
- Parental care in Amphibia
- Neoteny & Paedogenesis
- Stegocephalia
- Objective: Amphibia
- Stegocephalia
- Origin and Evolution of Amphibia
- Objective: Amphibia
- Reptilila : characters and classification
- Uromastix hardwickii
- Snakes
- Chelonians
- Skull in Reptiles
- Sphenodon
- The origin and Adaptive Radiation of Reptiles
- Objectives : Reptilia
- Aves : Characters and Classification
- Pegeon (Columa Livia)
- Bird are glorified Reptiles

**Ecology**

**Code : PCB / Y/280**

**Introduction**

**Ecological Factors**

Soil formation, Parental rock, Biota, Major soil groups, Soil Erosion, Food and feeding Relationship, Feeding Behavior, Feeding Adoption, Choice of food, Nutritional values, Digestibility, Size of Food Item, Availability, Protective Devices, measurement of Productivity, Primary production, Secondary production, Light, Intensity of Light, Duration and Amount of Light, Light in Water, Biological effects of Light, Photoperiodism, Temperature, Thermoregulation in Homoiotherms, Thermoregulation in Poikilotherms, Adaptations Developing in Response to Extreme temperature.

### **Weathering of Soils**

Mechanical Weathering, Frost Action, Insolation, Unloading, Saline Crystal Growth, Root Wedging, Chemical Weathering, Relation of Disintegration to Decomposition, Processes of Chemical Weathering, Hydrolysis, carbonation, Oxidation, Hydration, Solution, Biochemical Weathering, Rates of Weathering, The Role of Climate, parent Rock, Acid Rain, Spheroidal Weathering, The Decay of Granite, Soil, Factors Governing soil Development, Soil Horizons, Major kinds of Soils, Soil Erosion.

### **Inter-Relationship**

Symbiotic relationship, Insects as Vectors of Diseases, Insects in Relation to Viruses and Mychplasmalike, Disease Agents, Insects in Relation to Bacteria, Spirochetes, Insects in Relation to Protozoa, insects in Relation to Fungi, Insects in relation to Helminths.

### **Pelagic Food Webs**

Epipelagic Food Webs, Mesopelagic food Webs, Gravitational transport, Active Organismal transport, The Biological Advantages of daily vertical. Migrations, Bathypelagic Food Webs.

### **Terrestrial Ecosystems**

Temperature Deciduous Forests, The Plant Community, Adaptation of Climate, Community Succession in Deciduous Forests, What humans have done with deciduous woodland, Coniferous Forests, Boreal forest, Southern conifers: A Fire Climax, Grasslands, Biology of Grasses, Grassland Communities, Grazing and overgrazing, Drought, Dust and Deserts, Desert Plants: Many solution of one problem, Animal Adaptation to the Desert: A table of water conservation, Chaparral, Land and People.

### **Aquatic Ecosystems**

The Oceans the Biggest part of the World, Drifting Continents and Changing Oceans, Ocean habitats, Rock and Sand: Marsh and Muck, lakes: Quite changes, Seasonal Turnover, Nutrients, Pollution and Aging, Rivers and Streams: Running water, The food web of an open System, Adaptation of Currents: Don't's get carried away, A Special way of Life in water.

### **Freshwater Environments**

The Water Cycle, Streams, Soil plant Atmosphere continuum, General characters of Stream Organisms, Rythron, Potamon, Natural Impoundments, Bogs, Marshes and Swamps, Beaver Impoundments, The Estuary.

### **The Ecological Niche**

History and Definitions, Parameters of Niche, Factors Affecting the Niche and its Parameters, Niche Separation, Niche Overlap, Measures of Niche Widths, Separation and Overlap, Niche

Relationships and community Structure, , Parallel Niches, Niche Overlap and Competition, Guild Structure, Specialization Versus Generalization, Time ,Matter and Energy Budgets, Foraging Tactics and Feeding Efficiency, Optimal use of Patchy Environments, Evolution of Niches.

### **Isolation**

Isolating Mechanism, Geographical Isolation, Spatial isolation or Isolation due to Sheer Distance, Reproductive Isolation, Prezygotic Isolation Mechanism, Genetic Basis of Isolating Mechanism, Origin of Reproductive Isolation, Role Isolation in Evolution.

### **Adaptation**

Structural Adaptation, Cursorial Adaptation, Fossorial or Subterranean Adaptation, Aquatic Adaptation, Scansorial or Arboreal Adaptation, Volant Adaptations, Cave Adaptations, Desert Adaptation, Deep Sea Adaptation, Physiological Adaptation, protective Adaptations, animal Association Adaptation, Socialism Commensal Adaptation, Symbiotic Adaptation, parasitic Adaptation.

### **Adaptive Radiation**

Types of Adaptive Radiation, Local Adaptive Branching, Continental Adaptive Radiation, Contemporaneous Radiation, Successive Radiation in Time, The Mesozoic radiation, Cretaceous Radiation, Tertiary Radiation, Tooth radiation in Mammals.

### **Variation**

Kinds of Variations, Blastogenic or Germinal Variation, Somatogenic or Somatic Variation, Continuous Variation , Discontinuous variations, Indeterminate Variation, Determinate variation, Meristic Variation, , Sources of Variation, Light Temperature , water, Nutrition, Endocrine Glands, Use and Disuse of Organs, Cytological Basis, Significance of Variation.

### **Species and Origin of Species**

Polytypic Species, Sub –Species, Clines, race, Supra species, Clone, Linage, Origin of Species, Speciation, Transformation of a Species in Time.

### **Coloration and Mimicry**

Color Production, Chemical Color, Physical Colors, Biological Significance of Colors, valuable Colors, cryptic Coloration, Warning or Revealing Colors, Alluring Colors, Mimetic Colors, Signal Marks, Recognition Marks, Confusing Coloration, Sexual Coloration, Biological Cause of Coloration, value of Coloration, Vision Of Predators, Distastefulness of Models, Mc A Tee's Investigation, Mimicry, Types of Mimicry, Batesian and Mullerian, Mimicry, Causes of Mimicry, Objection to the Theory of mimicry, Atavism, Tail in Man, Mammary Glands, hairs on the Body and face, Appearance of Hind Limbs in Whales, Family Atavism, Race Atavism, Atavism of Teratology.



## YEAR-III

### Classical Mechanics and Statistical Mechanics

Course Code: PCB/Y/310

#### Classical Mechanics(I)

Constraints, degree of freedom, Generalized coordinates. Generalized notations of displacement, velocity, acceleration and force. Configuration space D' Lambert's principle, Deduction and Lagrange's equation of motion using D' Lambert's Principle. Applications of Lagrange's equation of motion to conservation theorem.

#### Quantum Mechanics(II)

Wave particle duality, de Broglie's hypothesis of matter waves, wave and group velocity, experimental demonstration of matter waves, quantization in hydrogen atom. Heisenberg's uncertainty relation for  $p$  &  $x$  and its extension to energy and time, diffraction at a slit, particle in a box, position of electron in Bohr orbit.

#### Quantum Mechanics(III)

Wave function, position probability, Schrodinger's equation, postulatory basis of quantum mechanics: operators, expectation value, eigen value and eigen function. Solution of Schrodinger's equation for a particle in a rigid one- and three- dimensional boxes, linear harmonic oscillator, Transmission across a potential barrier

#### Statistical Physics(I)

Simple laws of permutations, Probability of any event & its few examples, Equilibrium states and its relation with probability, principle of equal a priori probabilities. Macroscopic and microscopic systems, Thermodynamic properties for macroscopic system as Entropy, Enthalpy, Helmholtz free energy, Gibbs free energy.

Phase space,  $u$ -space and  $T$ -space; Example of phase space for one dimensional oscillator, Ensemble and ensemble density, Merits of ensemble averages over the time averages for any thermodynamical system. Difference between micro canonical, canonical and grand canonical ensembles.

#### Statistical Physics(II)

Basic difference between classical and Quantum mechanics, Phase value of a quantum cell for one dimensional phase space and then extension to  $n$ -dimensional phase space, the number of phase cell in a given energy range for three dimensional free particle.

Boltzmann canonical distribution function and its derivation with application in law of equipartition of energy. Maxwell's distribution law for velocities, value of RMS velocity, average speed and most probable velocity of gas molecules.

## **Atomic & Nuclear Physics**

**Course Code: PCB/Y/320**

### **Atomic spectra and structure**

Rutherford  $\alpha$  particle scattering experiment, Rutherford scattering formula, Nuclear dimension, Failure of Rutherford atom model, Bohr model of hydrogen Atom Spectral series of Atomic hydrogen, Nuclear motion, Franck –Hertz experiment, Sommerfield's theory of elliptical orbits, Vector atom model, Stern Gerlach experiment, Concept of quantum numbers and Pauli's exclusion principle.

### **Laser**

Spontaneous and stimulated emissions, Temporal and spatial coherence and their relation, Principles of laser, Ruby Laser.

### **Nuclear Disintegration**

Natural and artificial radioactivity, radioactivity decay laws, successive disintegration. Radio active carbon dating, elementary idea of fundamental particles and cosmic rays.

### **Nuclear structure, Nuclear Forces and Nuclear Reactions**

The constituents of nucleus, Nuclear size and method of its determination, Nuclear mass, Binding energy, Semi empirical mass formula, Liquid drop model, Nuclear fission and fusion, Shell model, explanation of magic numbers(qualitative). Properties of ground state deuteron and its simple theory. Meson theory of nuclear force, Q-value of nuclear reaction, Different mechanics of particle induced nuclear reactions(discussions only).

## **Solid State Physics & Devices**

**Course Code: PCB/Y/330**

### **Crystal Structure and its determination-**

Lattice, Transitional vectors, basis, unit cell, classification into systems, different lattice of a cubic crystal, lattice planes of a crystal, Miller indices, Interplanar spacing, NaCl and hcp

structures, X-ray diffraction , Bragg's law, Analysis of crystal structure, Laue method , Rotating crystal method, Powder crystal method, Reciprocal lattice and its properties.

### **Crystal binding**

Binding Energy, Various types of crystal binding, Inert gas , Ionic , covalent and metallic binding in crystals. Quantitative study of the binding of ionic crystals.

### **Lattice Vibrations**

Vibration of monatomic linear lattice, Vibrations of the diatomic linear lattice , Phonon, Phonon momentum, Einstein theory of specific heats.

### **Electron gas in Metal and Fermi Energy**

Maxwell Boltzmann, Bose Einstein and Fermi-Dirac distribution(Qualitative Study). Fermi-Dirac energy distribution among free electrons in metals , Fermi energy. Average free electron energy at absolute zero.

### **Band Theory of Solids**

Motion of electron in periodic lattice, Kronig-Penny model, Formation of energy bands, Classifications of solids on the basis of band structure, Effective mass of electron.

### **Solid State Devices**

Intrinsic and Extrinsic semiconductor (p- type and n-type), Methods of fabrications of p-n junction, Working and characteristics of p-n junction under forward and reverse on the basis of band theory, Tunnel diode, Zener diode, Photo diode, Light emitting diode(qualitative) and their characteristics. Bipolar transistor, its working and characteristics . Bipolar transistor, its working and characteristics on the basis of band theory.

## **Inorganic Chemistry-III**

**Code: PCB/Y/340**

### **Hard and Soft Acids and Bases(HSAB)**

Classification of acids and bases as hard as hard and soft. Pearson's HASB concept, acid base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness, electro negativity and hardness and softness.

### **Metal-ligand Bonding in Transition Metal Complexes**

Crystal field theory , crystal field splitting in octahedral , tetrahedral and square planar complexes, factors affecting the crystal-field parameters. Spectrochemical series, John –Teller effect in octahedral complexes.

### **Magnetic properties of Transition Metal Complexes**

Types of magnetic behavior , methods of determining magnetic susceptibility, spin only formula .L-S coupling, correlation of  $\mu_s$  and  $\mu_{eff}$  values , orbital contribution to magnetic moments, application of magnetic moment data for 3rd metal complexes.

### **Organometallic Chemistry**

Definition , nomenclature and classification of organometallic compounds. Preparation , properties, bonding and applications of alkyl and aryl of Li, Al, Hg, Sn and Pb, a brief account of metal ethylenic complexes and homogenous hydrogenation , mononuclear carbonyls and the nature of bonding in metal carbonyls.

### **Non-aqueous Solvents**

Physical properties of a solvent , types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH<sub>3</sub> and liquid SO<sub>2</sub>.

### **Silicones and Phosphazenes**

Silicones and Phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

**General Methods of extraction and purifications of metals .Chemistry involved in the extraction of the following methods.**

Titanium, vanadium, chromium, Nickel and Platinum

### **Preparations., properties and uses of the following compounds**

Titanium dioxide, Titanium tetrachloride, chromyl chloride, potassium dichromate, potassium permanganate, Potassium ferrous and ferri cyanides, chlorophatinic acid, Sodium cobaltinitrite, sodium nitro prusside.

## **Organic Chemistry –III**

**CODE: PCB/Y/350**

### **Organometallic Compounds**

Organomagnesium compounds :the Grignard reagents-formation , structure and chemical reactions

Organozinc compounds:formation and chemical reactions.

Organolithium compounds:formation and chemical reaction

### **Organosulphur compounds**

Nomenclature, structural features, Methods of formation and chemical reactions with particular emphasis on the mechanism of electrophilic substitution . Mechanism of nucleophilic

substitution reaction in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five and six numbered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skatol synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

### **Organic Synthesis via Enolates**

Acidity of  $\alpha$ -hydrogen. Synthetic applications of diethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol Tautomerism of ethyl acetoacetate.

### **Carbohydrates**

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

### **Amino acids, Peptides, Proteins and Nucleic Acids**

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and Reactions of  $\alpha$ -amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein Denaturation/renaturation.

Nucleic acids: introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA

### **Sulpha drugs**

Bisulphacetamide, Sulphaguanidine, Sulphapyridine, Sulphadiazine, Sulphathiazoles and sulphamethazines, mechanism and action of sulpha drugs

Synthetic Polymers

Addition of chain growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers.

Condensation

Or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and Synthetic rubbers

### **Synthetic Dyes**

Color and constitution (electronic concept). Classification of dyes, Chemistry and Synthesis of methyl orange, Congo red, Malachite green, Phenolphthalein, Fluorescein, Alizarin and Indigo.

## Physical Chemistry –III

Code : PCB/Y/360

### **Spectroscopy**

Introduction:electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppernheimer approximation, degrees of freedom.

### **Rotational Spectrum**

Diatomic molecules.Energy levels rigid rotor(semi classical principles), selection rules spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution)determination of bond length, qualitative description of non-rigid rotor, isotope effect.

### **Vibrational Spectrum**

Infra red spectrum:Energy levels of simple harmonic oscillator , selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an harmonic motion and isotope on the on the spectrum, idea of vibrational frequencies of different functional groups .

Raman spectrum:concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecukes, selection rules.

### **Electronic spectrum**

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle.

Qualitative description of  $\sigma$ , $\Pi$ -and n M.O., their energy levels and the respective transitions.

### **Photochemistry**

Interaction of radiation with matter, difference between thermal and photochemical processes.Laws of phptochemistry:Grothus-Drapper law, Stark-Einstein law, Jabolonski diagram depicting various processes occurring in the exited state, qualitative description of intersystem crossing, quantum yield, photosynthesized reactions energy transfer processes (simple examples).

### **Physical Properties and molecular structure**

Optical activity, polarization –(Clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment , measurement of dipole moment –temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties-Para magnetism, diamagnetism and ferromagnetic

Solutions , Dilute Solutions and Colligative properties.

### **Ideal and non-ideal solution, methods of expressing concentration of solutions, activity and activity coefficient.**

Dilute solution, colligative properties, Raoult's law, relative lowering of vapor pressure, molecular determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of disassociation and association of solutes.

## **Bio Chemistry**

**Code : PCB / Y/370**

### **Protoplasm**

Physical nature of Protoplasm, Properties of Protoplasm, Chemical nature of Protoplasm, Water, Inorganic Compounds, Organic Compounds, Proteins, Structure of Protein, Classification of Protein, Derived Proteins, Properties of Proteins, Biological importance of Protein, Carbohydrates, Structure, Classification, Monosaccharides, Properties of Monosaccharides, Oligosaccharides, Polysaccharides, Functions, Lipids, Prostaglandins, Amino Acids, Nucleotides, and Nucleic Acids.

### **Carbohydrates**

Classifications, Configuration and Conformation, Important Monosaccharides and Derivatives, Properties of Monosaccharides, Cellulose and Other Carbohydrates, Function of Carbohydrates, Mechanism of Glycogen Storage, Utilization of Glycogen as a Fuel, Regulation of Glycogen Storage, Control of Phosphorylation, Regulation of Phosphorylase in Muscle, reversal of Phosphorylase Activation, Regulation of Glycogen Synthesis in Muscle, Phosphorylation of Myosin, Glycogen, Metabolism in the Liver, Summary of Glucose Homeostasis, The Efficiency of Glycogen Storage, genetic Defects in glycogen Metabolism.

### **Cellular Respiration**

The E-M Pathway, Energy Yield of The E-M Reactions, Oxidative Decarboxylation, Krebs Cycle or Tricarboxylic Acid Cycle (TCA), Oxidative Phosphorylation mechanism, chemical Coupling Hypothesis, Chemiosmotic Coupling Hypothesis, Conformation Coupling Hypothesis.

### **Bioenergetics and Cellular Homeostasis**

Concept of Energy, Thermodynamic Principles, Difference between  $\Delta G$  and  $\Delta G^0$ , Energy rich compounds, Classification, Phosphate group compounds, Thioester group compounds.

### **Classification of Lipids**

Fatty Acids and Prostaglandins, Essential fatty acids, Prostaglandins, Fatty Acids Esters of Glycerol, Mono-, Di- and Triglycerols, Phosphoglycerides, fatty Acid Esters not containing Glycerol, Sphingolipids, waxes, Complex Lipids containing amino acids, Peptides and Oligosaccharides, Lipoamino Acids, Lipopolysaccharides, Lipoproteins, Nonsaponifiable Lipids, terpenes, Steroids.

## **Fatty Acid Synthesis**

Acyl carrier Protein, Acetyl coenzyme A Carboxylase, Mitochondrial and Mitosomal fatty Acid Synthesis, Role of Carnitine in Fatty Acid Metabolism, Unsaturated fatty acids, Polyunsaturated Fatty Acids, fatty Acid Synthesis in E. Coli, Synthesis of Unsaturated Fatty Acids in Plants, Role of Polyunsaturated Fatty Acids, Biosynthesis of Cholesterol Fatty Acid Ester of Cholesterol, Cholesterol as Source of Steroid Hormones, Conversion and Cholesterol to Pregnenolone, Conversion of Pregnenolone to Progesterone, Conversion of Progesterone to Cortisol and Cortisone, Conversion of Progesterone to Six Hormones in the Gonads, Formation of The Female Steroid hormone from Testosterone, Formation of Dihydrotestosterone from Testosterone.

## **Proteins**

Classification of Proteins, Primary structure of Proteins, Amino Acid Composition of Proteins, Sequence Determination, Secondary Structure of proteins. Bonds Spatial Arrangements of the polypeptide chain; X-Ray Diffraction Analysis, Tertiary Structure, Origin of the Tertiary structure, Generation of Specific Structure, The Heme Pocket, Sedimentation in the Centrifugal Field, Light Scattering, Osmotic Pressure, optical Rotation, Deuterium Exchange. Tertiary structure from X ray Diffraction Analysis: Myoglobin, Hemoglobin, Denaturation, Quaternary structure, Function of Proteins.

## **Metabolism of Amino Acids**

Transamination, Oxidative Deamination of Glutamate,  $\text{NH}_4^+$  to the Amide group of Glutamine, Synthesis of Urea, L-, D-Amino Acid Oxidases, Overview of Nitrogen Balance and Self Regulation of Nitrogen Metabolism, Metabolic Relationship of Amino Acids, Carbohydrates and Lipids, Glucogenic, Ketogenic, Essential and Non-Essential Amino Acids, Metabolism of Nonessential Amino Acids, Metabolism of essential Amino Acids.

## **Enzymes and Biological Catalysts**

Discovery of Biological catalysts, Enzymes are Highly Specific, Enzymes Transform Different kind of Energy, Enzymes do not alter reaction Equilibria, Enzymes decrease the Activation Energy of Reactions Catalyzed by them, Formation of an Enzyme Substrate complex is the first step in Enzymatic Catalysis, Some Features of Active sites, Thermodynamics of chemical Reaction, Factors Affecting Enzyme Activity, Enzyme Inhibition, Substrate competitive Inhibition, Non-competitive Inhibition, Uncompetitive Inhibition, Enzyme Reactions involving more than one Substrate, Coenzymes, Kinetic Properties of Enzymes, Kinetic properties of Enzyme systems related to their Quaternary structure.

## **Nucleic Acid (Deoxyribo-nucleic Acid)**

Deoxyribo-nucleic Acid or DNA, Physical Structure of DNA, Monomeric components of DNA, Nucleosides, Nucleotides, The Primary structure of DNA, Molecular Weight of DNA, Secondary structure of DNA, various forms of DNA, The Tertiary structure of DNA, Types of DNA's Eukaryotic DNA, Prokaryotic DNA, Extra nuclear DNA, Unique DNA, Repetitive DNA, Satellite DNA, Fold back DNA, Z-DNA, Left handed DNA, Tautomeric form of DNA, Denaturation and Renaturation of DNA, The Helix-coil Transition, The Renaturation of DNA, Single Stranded DNA or Viral chromosomes, Structure of Single Stranded DNA Rigorous



Crystallography, The Chromosomes of Viruses, E.Coli and Yeast are single DNA Molecules, Circular Vs Linear DNA Molecules, Super coiling of Circular DNA, Proteins Containing supercoils, DNA super coil Twice Around Each Nucleosome, Histone-like DNA-binding proteins in Prokaryotes. Topoisomerases change the Linkage Numbers of Supercoiled Structure, Biological Replication of DNA, Enzymes for DNA synthesis, Types of replication.

Biological Replication of DNA, Strand Separation Requires Untwisting of the Double Helix, Base Pairing should Permit very Accurate Replication,  $\Theta$ shaped Intermediates form during the replication of Circular DNA, Overall chain Growth occurs in both  $5' \rightarrow 3'$  and  $3' \rightarrow 5'$  Directions, Small Fragments are Precursors of Many Long Chains, The Leading Vs the lagging strands, DNA Replication in Prokaryotes, Nucleotide Synthesis, Purine Biosynthesis, Pyrimidine Biosynthesis, DNA Synthesis in Vitro, Role of DNA in the Reaction, Evidences in Support of Semi conservative Replication of DNA, Enzymes and Proteins Involved in DNA Replication.

### **Ribonucleic Acid (RNA)**

Molecular weight of RNA, Primary structure of RNA, Primary and Secondary structure of RNA, types of RNA, Transfer of RNA, Ribosomal RNA (rRNA), Viral RNA (vRNA).

### **Biosynthesis of RNA: Transcription**

Binding and Initiation, Elongation of RNA Chains and Direction of Transcription, Chain Termination The Eukaryotic RNA, Polymerase, The Biosynthesis of rRNA, The Biosynthesis of tRNA, The Biosynthesis of mRNA.

## **Bio Technology**

**Course Code : PCB / Y/380**

- Introduction
- Techniques of Biotechnology
- Applications of Biotechnology
- From Biotechnology of Biotics
- Cell Biotechnology
- Genetic Engineering
- Recombinant DNA Technology
- Gene Cloning
- Microbial Relationships
- Food Microbiology and Biotechnology
- Ecology and Food Microbiology
- Microbial Food Spoilage
- Inhibition the growth of Micro-organism
- Microbiology of Anaerobic Digestion
- Strategies for selection of Appropriate Biotechnologies for Industrial Applications
- Fermentation and Selection
- Fermentation Reactions of Anaerobic Digestion

- Biosensors in Fermentation and Environmental Control