PUBLIC SERVICE COMMISSION, WEST BENGAL

161A, S.P. Mukherjee Road, Kolkata – 700 026

Recruitment to the posts of Lecturer in (i) Electrical Engineering, (ii) Mechanical Engineering & (iii) Chemistry

for Govt. Polytechnics in W.B.G.S. under the Deptt. of Technical Education & Training Govt. of W.B.

vide Commission's **Advt. No. 14[3(ix)]/2014, 14[3(x)]/2014 & 14[3(xxvii)]/2014** respectively

Scheme of the <u>Preliminary Screening Test</u> for *each* subject is as follows:-

- ❖ Date of examination: Sunday, the 12th June, 2016

- ❖ Type of Question: M.C.Q.

- ❖ No. of questions – 100; each carrying 1 mark

- ❖ Full Marks – 100

- ❖ Duration – 1 hour 30 minutes

    N.B: There will be 'negative marking' for wrong answers as per norms (1/3rd of the full

    mark for each wrong answer)

SYLLABUS FOR PRILIMINARY SCREENING TEST FOR RECRUITMENT TO THE POST OF LECTURER IN ELECTRICAL ENGINEERING FOR GOVT. POLYTECHNICS IN THE W.B.G.S. UNDER THE TECHNICAL EDUCATION & TRAINING DEPARTMENT

Full Mark: 100

Time: 1hr. 30 mins.

1. **ENGINEERING MECHANICS :**

   Elements of vector algebra, Basic dimension and units. Idealisation in Mechanics. Newton's Laws, equilibrium equations, frictional forces, properties of surfaces. Elements of vector calculus. Rectilinear and Curvilinear motion of a particle.

   Alemberts principle, Methods of momentum, work, power and energy Mass moment of inertia, rotation of rigid bodies, Energy consideration.

2. **PHYSICS :**

   Angular momentum and torque. Moment of inertia. Parallel and perpendicular axes theorem. Calculation of moment of inertia of some common solids. Rotational dynamics of a rigid body.

   Newton's law of Gravitation. Calculation of gravitational field and potential of a spherical distribution of mass. Motion under a central force. Kepler's laws.

   Relationships among different elastic constants. Bending moment. Cantilever problems. Elastic, Plastic and Visco-elastic behavior of materials.

3. **MATHEMATICS :**

   Review of limit, continuity and differentiability. Successive differentiation. Rolle's Theorem. Mean value Theorems.

   Limit and continuity. Partial derivatives. Differentials.

   Definition and properties. Fundamental Theorem of integral calculus.

4. **APPLIED MECHANICS**

   Belt, Pulley and Chain Bodies in rolling contact. Gear Wheels in trains, Epicyclic gear trains, Laws of machines etc. Four-bar linkages-velocity analysis (relative velocity method) acceleration analysis-simple problems.

   Stress, Strain, Elasticity, Y.P., Stress-Strain diagram, factor of safety, working stress problems in direct tension, compression-statically determinate cases, Thermal stresses.

   Torsion of circular shafts, angle of twist, Torque, power transmission shearing force and bending moment in beams maximum moment and pt. of confraflexture.

P. T. O

5. ELECTRONICS :

Elementary physics of semiconductor materials, p-n junction semiconductor diode, zener diode, bipolar junction device-transistor, Field effect transistors JFET & MOSFET. Modelling of semiconductor devices-diode, junction transistors and field effect transistors-Hybrid, parameters.

Bipolar transistor biasing, common-emitter, common base and common collector configurations, low frequency response of RC coupled common emitter amplifiers FET biasing, MOSFET biasing. Transistor power amplifiers, class A, class B and class AB amplifier complimentary symmetry amplifiers.

Linear microcircuits : Operational amplifiers, offset voltage and currents, bias currents, common-mode rejection ratio, frequency response, slew rate, uses of operational amplifiers as inverting summing amplifier, integrator,non-inverting amplifier, differential input instrumentation amplifiers and oscillators.

IC voltage regulator : A typical industry standard (e.g. 723 or 3085) and its use as both dissipative and switching regulator, current limiting ordinary feedback.

6. CIRCUIT THEORY

Review of Laplace Transform. Concept of complex frequency, Circuit elements in transient. Transform equivalent, Laplace transform of impulse and step waveforms.

Solutions of RL, RC, LC and RLC circuits in transient with or without stored energy, Concept of natural frequency and damping.

Applications of network theorems in transient domain. Formulation of network equations. Source transformations. Loop variable analysis and mode variable analysis.

Two port networks, Short circuit Admittance parameters, Open circuit Impedance parameters, Transmission parameters, hybrid parameters, series, cascade and parallel connections of two port networks.

7. ELECTRICAL ENGG. MATERIALS :

Atomic structure of materials energy levels and electronic states. Electronic distinction between metals. Insulators and intrinsic semi-conductors. Interatomic distance, Cohesive forces and energies Gross electrical and thermal properties of materials in terms of cohesive energies.

States of insulating materials and their applications.

Electrical conductivity of metals-Lorents theory, free electron theory.

Alloys-High resistivity alloys. Thermocouple alloys, Strainguage alloys.

Semiconductor : Intrinsic and impurity semiconductors. Acceptors and donor, p-n diodes and transistors. Temperature dependence of p-n junction.

8. **HYDRAULICS & WATER POWER**

Properties of Fluid and Units; Fluid Statics; Fluid Kinetic; Introduction; Ideal Fluid Flow; Viscous Fluid Flow; Flow through pipes; Flow Measurements; Momentum equation and Fluid dynamics.

Fluid Machineries; Reciprocating pumps & Gear Pumps; Centrifugal pumps.

Elementary Hydrology.

9. **ELECTRICAL MACHINES :**

D.C.Generator : Function of commutator, Commutator and brush system. No load operation of d.c. generator; emf equation.
Excitation systems : Shunt, series and compound excitation, Building up of d.c. shunt generator. D.C.Motor torque equation, Motoring and generating action, Elementary starters for motors.

A.C.Machines : Frequency of the induced emf. mechanical and electrical angles. Elementary winding configuration of three phase machines. D.C.Excitation of alternators. Three phase balanced excitation. Development of rotating magnetic field.

Basic principle of operation of synchronous and Induction machines :
Slip speed and slip of an induction motor. Single phase a.c. excitation, oscillating field. emf induced in a rotating coil in an alternating field. Rotational and speed emf's. Double revolving field. Basic principle of operation of single phase a.c.motors.

Transformers - Constructional details :
Core materials, winding material and insulating materials. Core and, coil construction E.M.F. equation derivation of core losses and leakage reactance. No-load operation, equivalent circuit, phasor diagram under load, dependence of circuit parameters on v and f.
Transformer oil, inhibited oil, dry type transformer, Transformer accessoriesbreather, conservator. Buchlolz's relay, explosion vent, bushing etc. Different types of cooling methods. Regulation, efficiency, all-day efficiency, Parallel operation, O.C. and S.C. test-separation of eddy current and hysteresis loss.

Single-phase auto transformer : Phasordiagram, Comparison of weight, copper loss, equivalent reactance with 2-winding transformer.

10. **POWER PLANNING & DISTRIBUTION :**

Legal aspects of electricity supply. Electricity acts, rules and codes. Standards followed in power supply. Environmental and safety measures.

Technical aspects of electricity supply. Domestic, Commercial and Industrial wiring, estimation of main, submain and subcircuit wiring. Earthing practice. Testing of installation. Special lighting connections. Fuse, Stranded conductors. Disconnecting devices. Lightning arrester. Lift, Pump, Air conditioning-Basic principle of operations safety & control. PART-II : Power Distribution : Structure of power system, primary and secondary distribution. Types of conductors and insulators in distribution system.

11. FIELD THEORY :

Electrostatics :
Coulomb's Law, Field intensity and potential, Potential gradient, Electric displacement, Gauss Law (Integral form) and its applications, Electric images and inversion, Electric dipoles, field and potential, Polarization, Divergence theorem (gauss law in differential form), Poisson and Laplace's equations in Cartesian, cylindrical and spherical coordinates in 2 and 3 dimensional fields using circular and spherical symmetry, Boundary conditions. Electric stress and mechanical force on charged conductor surfaces, Electrostatic energy, capacitance calculations, Energy transfer amongst connected capacitors in a system.

Electromagnetics
Magnetic field and intensity, Magnetic scalar and vector potentials, Lorentz force, Motoring and Generating principles, Faraday's Law Induced e.m.f. in conductor and coils, Ampere's Law. Magnetic polarisation, Poisson equations and solution.

12. NUMERICAL ANALYSIS & COMPUTER PROGRAMMING

Numerical Analysis : Solution of linear equations, Gaussion elimination, Matrix inversion using Gauss-Jordan, Jordan elimination.

Interpolation : Lagrange, Newton's forward, backward and divided difference formulas and errors. Least square curve fitting, Numerical integration using trapezoidal, Simpson's rule.

Programming : Basic concepts and technology of computer system and system software, Concepts of flow-chart and algorithm, recurrsion. Overflow and underflow. Program in Fortran and Pascal. Introduction to data structures.

13. ELECTRIC POWER UTILISATION :

Illumination.
Fundamentals of Light-Radiation and vision, quantities, units, standards and measurement. General classification of lamps : Incandescent, TL and HID lamps, basic principle of their operation. Laws of illumination.

Elementary Lighting Design-Definitions of design parameters. Basic luminaries classification and their distribution characteristics. Lighting calculations for indoor applications.

Lighting circuits-Starters for fluorescent lamps and ignitors of HID lamps, multiple input of lamp.

Emergency lighting and Stand by power sources-Exterior, Interior, portable on site emergency lighting-storage batteries.

Electric Welding, resistance welding and equipment for such welding.

14. POWER SYSTEMS PROTECTION AND SWITCHGEAR

Analysis of asymmetrical faults in power system. Series unbalances in power system. Fundamental principles of protective relays, their properties and block diagrams. Single input relays, overcurrent, earth fault and over voltage relays.

Motor protection, Different types of pilot protection wire, carrier and wireless pilot.

Different forms of Switchgears and their functions. Contact wipe, contact travel and auto reclosing circuit breaker. Power system transients.

Different types of circuit breakers-their relative merits and demerits. Specific field of usage. Testing of circuit breakers.

Full Mark: 100   Time: 1hr. 30 mins.

1. **ELECTRICAL TECHNOLOGY**

   Electrical Units, and dimensions. Electro magnetism, Magnetic circuits, D.C.generators and motors, speed control. Starters. Electrical measuring instruments-principles of operation and construction.

2. **MATHEMATICS**

   Function of a single variable: Successive differentiation. Rolle's theorem. Mean value theorems. Taylor's theorem and Maclaurin's series. Maxima and minima. Indeterminate forms. Tangent, normal and curvature.

   Functions of several variables; limit and continuity. Partial derivatives. Differentials. Partial derivatives of a composite function. Implicit function. Jacobian. Taylor's theorem. Maxima and minima. Lagrange's method.

   Reimann integration : Definition, Properties. Fundamental theorem of integral calculus. Improper integrals. Gamma and Beta functions.

   Multiple integrals : Existence of integrals (statement only) Properties of double integral. Evaluation of double integral. Change of the order of integration and change of variables.

3. **ENGINEERING MECHANICS**

   Laws of Coulomb's friction, equilibrium of rigid bodies, principle of virtual work, application of friction in machines, properties of surfaces, centre of mass, and centre of gravity, shear force and bending moment diagrams.

   Introduction to elasticity, problems in uni-axial stress field.

   Thin-walled beams, unsymmetrical bending, energy principles, Castigliano's theorems, curved beams, thick-walled cyclinders under radial pressure. Lame's equation, theories of failure.

   Work-energy principle, momentum principle, central force motion.

                                                        P.T.O.

4. PHYSICS

Angular momentum and torque. Moment of inertia. Parallel and perpendicular axes theorem. Calculation of moment of inertia of some common solids. Rotational dynamics of a rigid body.

Newton's law of Gravitation. Calculation of gravitational field and potential of a spherical distribution of mass. Motion under a central force.
Kepler's laws.

5. THERMODYNAMICS

Microscopic & Macroscopic viewpoints in Thermodynamics; Fundamental concepts of system, control volume, state, properties, equilibrium, processes etc. Zeroeth Law; Survey of units & Dimensions; Forms of energy and energy interactions, heat & work;

Ideal & Real Gases; Equations of state; Compressibility Factor; Generalised compressibility chart; First Law of Thermodynamics for closed systems internal energy;

First Law for Control Volumes; Steady flow & unsteady flow applications.

Definitions of Heat Engine, Heat Pump, Thermal Efficiency, COP; Carnot Cycle.

Second Law of Thermodynamics; Statements and Corollaries; Entropy; Concept of Reversibility and irreversibility.

Second Law analysis of Control Volumes; Concept of Entropy Generation. Reversible work, availability & Irreversibility.

T-dS relations; Maxwell equations; Clapeyron Equation; Clausius-Clapeyron equation, Joule-Thompson Coefficient; Compressibility & expansion co-efficient.

6. MATERIALS & METALLOGRAPHY

Unit cells, packing efficiency and co-ordination number, bonds and bond energy, plastic deformation and mechanical testing of metallic materials.

Strengthening mechanism, heat treatment of steels, cast iron and carbon steels, important alloy steels, important non-ferrous alloys.

7. STRENGTH OF MATERIALS

Thin pressure vessels, torsion of circular shafts, close-coiled helical springs, stresses in beams due to bending and shear.

Deflection of beams, combind bending and torsion, concept of elastic stability with particular reference to buckling of columns. Strain energy.

8. **FLUID MECHANICS**

Properties of Fluid, Classification of Fluid ideal and real fluids, Newtonian and Non-Newtonian Fluids. Compressible and Incompressible fluids.

Steady and Unsteady flow. Uniform and non-Uniform flow. Path line, Stream line and stream tube, One, two and three-dimensional flow. Continuity Equation-differential and integrated form. Rotational and Irrotational flow. Vortex motion. Laminar and Turbulent flow.
Darcy-Weisbach equation, Moody's diagram. Flow through non-circular ducts. Minor losses-heat losses at sudden expansions, sudden contractions and bends. Head losses in pipes in series and parallel, pipe line problems.

Dimentional Analysis, similarity etc. to sink and Doublet.

Review of Irrotational flow, left around symmetrical bodies. Specific speed and classification of fluid machinery. Design methodology of axial and radial flow machines (pumps and fans).

9. **DESIGN OF MACHINE ELEMENTS**

Introduction to design. Factor of safety, calculatioin of allowable stress under various types of loading, stress-concentration, endurance diagram and design criteria.

Review of stress calculation in various situation-direct, bending and torsional loads and their combined effect.
Buckling
Design of pin-joint, cotter-joint etc.
Transmission screws.
Screw-joints, pre-loaded bolts, etc.
Rivets and riveted joints, etc.
Design of weldments.
Key, shaft and axle.
Belt drive : Flat & V-belt, pulleys.

Coupling : rigid and flexible.
Toothed gear drive : Spur, straight, and helical tooth.

Gears for non-intersecting shafts : Beval & Hypoid gears.
Brakes and clutches : Band & shoe brake, friction clutch, jaw clutch and certrifugal clutch.
Springs : Tension, compression, torsion and leaf springs.

10. **DYNAMICS OF MACHINES**

Gyroscopic motion, force analysis of machines-analysis of fly-wheels & governors.
Balancing of rotating and reciprocating masses.

10. DYNAMICS OF MACHINES (CONTD.)

Vibration of spring-mass systems, introduction to vibrations of elastic bodies-transverse vibration of beams and critical speed of shafts, Torsional vibration with multiple discs.

11. I.C. ENGINES & GAS TURBINE

Principle of working; basic engine types; comparison of air standard cycles; air cycle analysis with variable specific heats; introduction to fuel air cycle analysis; actual cycles, mep; thermal efficiency.

Combustion calculations related to I.C.Engine fuels. Desirable characteristics for fuels for I.C.engine.

Mixture requirement for S.I.Engine; carburetion presure drop-flow relation; fuel air-ratio; complete carburetor. Petrol injection. Ignition system in S.I.Engine-Battery, Magneto, and Electronic ignition systems; ignition timing and spark advance.

Fuel oil injection in C.I.Engine-requirements; fuel injection systems; injection pumps and nozzels.

Supercharging I.C.Engine-requirements; supercharging limits; Turbocharging. Scavenging of I.C.Engines-two stroke S.I. and C.I.Engines; scavenging parameters; ideal scavenging processes; actual scavenging; scavenging pumps.

12. MACHINE TOOLS

Machine tool design : Features of construction, function and principles involved in the design of machine tool elements : layout of speeds for various machine tool drives; hydraulic and electric drives; design of gear boxes for speed and feed changes; rigidity and vibration analysis of machine frames; columns, beds and spindles.

Economics of machine tool selection : economic tool life.

Full Marks : 100   **Time : 1 Hour 30 Minutes**

Group - A
Organic Chemistry

1. **Bonding in organic molecules** :

   σ and π bonds, bond distance, bond angle, and bond energy. Dipole moment of organic molecules. Inductive, resonance and hyperconjugative effect. Hydrogen bond. Tautomerism; Aromaticity, Huckel's rule, aromatic, non aromatic and anti aromatic compounds. Effects of structure, substituents and solvent on acid and base strength.

2. **Stereo Chemistry of carbon compounds** :

   Elements of symmetry. Chirality, Eanantiomerism and diastereo isomerism. Optical purity, racemization, resolution. Projection structure of stereoisomers – Fischer, Sawhorse, Newman, Flying – wedge DL, RS and EZ notations. Examples of enantiotopic and diastereotopic ligands and faces. Conformations of alkanes (upto 4 carbon), Cyclohexane, dimethylcyclohexanes and 1, 2 – glycols. Stereoisomerism in allenes and biphenyls (excluding RS notation).

3. **Reaction mechanism** :

   General methods of study of mechanism of organic reactions illustrated by examples – use of isotopes, cross-over experiement, intermediate trapping, kinetic studies, stereochemistry. Energy profile diagrams of simple organic reactions, thermodynamic and kinetic control of reactions.

4. **Reactive intermediates :**

   Generation, geometry, stability and reactions of carbocations, carbanions, free radicals, carbenes and benzynes.

5. a) **Substitution reaction** – $S_N 1$, $S_N 2$, $S_N i$ and NGP. Electrophilic and nuclephilic substitution of aromatic compounds.

   b) **Elimination reaction** – E_1, E_2, E_1CB and Syn - elimination.

   c) **Addition reaction** – electrophilic addition to C=C and C≡C, nucleophilic addition to C=O, conjugated olefins and carbonyls.

   d) **Rearrangement reaction** :
      Pinacol-pinacolone, Hofmann, Beckmann, Claisen, Baeyar-Villiger, Favorskii.

6. **Chemistry and mechanism of** :

   Aldol condensation, Claisen condensation, Perkin reaction, Knoevenagel reaction, Wittig reaction, Michael reaction Arndt Eistert reaction, Acyloin condensation, Friedel-Craft reaction and Von Richter reaction.

7. **Synthetic uses of reagents** :

   OsO_4, HIO_4, $Pb(OAc)_4$, SeO_2, $LiAlH_4$, $NaBH_4$, B_2H_6, NBS, PCC, Na or Li in liq-NH_3, Alkyl lithium, Lithium dialkylcuprate, Lithium diisopropylamide, Aluminium isopropoxide.

8. IUPAC nomenclature. Synthesis and reactions of alkanes, alkenes, alkynes, alkyl halides, ethers, alkanols, alkanals, alkanones, alkanoic acids, esters, amides, nitriles and amines.

9. **Pericyclic reaction** :

   Definition and classification. FMO approach of electrocyclic, cycloaddition reactions and sigmatropic H-shifts.

10. Basic principles and applications of UV, IR, and NMR spectroscopy of simple organic molecules. Road-map problems related to spectroscopy and organic reactions.

Group - B
Inorganic Chemistry

1. **Chemical bonding :**
   a) **Ionic bonding ;**
   polarizing power and polarizability, ionic potential, Fajan's rules.

   b) **Covalent bonding :**
   Lewis structures, VSEPR theory, Valence Bond theory (Heitler-London approach), Directional character of covalent bonds, hybridization, Bent's rule, concept of resonance. Molecular orbital theory (MO) elementary approach – sigma and pi bonds, multiple bonding, MO diagrams of simple homonuclear and heteronuclear diatomic molecule, simple triatomic molecules like BeH_2, CO_2, BF_3, bond order, bond energy.
   Shapes of the molecules and ions containing lone pairs and bond pair.

   c) **Weak Chemical forces :**
   Vander Waals forces; Hydrogen bonding, Effects of chemical forces on physical properties.

   d) **Metallic bonding :**
   Qualitative ideas of band theory, Conducting, Semiconducting and insulating properties.

2. **Chemical periodicity :**
   a) **Periodic Table :**
   Classification of elements on the basis of electronic configuration, Modern periodic Table (current IUPAC version).
   b) **Atomic and ionic properties :**
   Effective nuclear charge, screening effect, Slater rules, atomic radii, ionic radii, covalent radii, ionization energies, electron affinity, electro-negativity, inert pair effect.

3. **Acid-Base Concepts :**
   Bronsted and Lowry's concept, Lewis concept, HSAB principle.

4. **Non-aqueous solvents :**
   Liquid ammonia and liquid sulphur dioxide.

5. **Coordination Compunds :**

   Double and complex salts, Werner's theory, Chelate complexes, nomenclature of complex compound, stereo chemistry and coordination number, isomerism of coordination compounds – geometrical and optical isomers in respect of coordination numbers 4 and 6.

   Bonding in coordination compounds : valence bond descriptions and its limitations, crystal field theory (elementary). Crystal field stabilization energies in weak and strong field cases mainly of octahedral and tetrahedral complexes.

6. **Magnetism and Colour :**

   Origin of magnetic moments, paramagnetism, diamagnetism, ferro and antiferromagnetism, orbital and spin contributions, spin only moments of $3d^n$ ions.

   Theoretical aspects of d-d spectra (elementary idea) selection rules for spectral transitions.

7. **Organo metallic compounds :**

   Definition and classification, Metal-Carbon bonded complexes of transition metals – their preparation, properties and stability. Application of 18 electron rule to carbonyl, nitrosyl and cyanides of transition metals.

8. **The Chemical elements and its compounds :**

   (a) (i) Group trends and periodic trends of effective nuclear charge, atomic and ionic radii, ionisation energies, electron affinity and electronegativity with respect to s-, p-, d- block elements.

   (ii) General trends of variation of electronic structures, elemental forms, oxidation states, catenation and properties of important class of compounds such as oxides, oxyacids, halides and formation of complex compounds with respect to the following groups of (i) Li, Na, K (ii) Be, Mg, Ca, Sr and Ba (iii) B, Al, Ga, In, Tl (iv) C, Si, Ge, Sn, Pb (v) N, P, As, Sb, Bi (vi) O, S, Se, Te (vii) F, Cl, Br, I. and (viii) Chemistry of noble gases.

9. **Extraction/Preparation/Isolation of the following elements :**

   (i) Extraction and purification of Li, Mg, Sn, Pb.
   (ii) Extraction and purification of Ti, V, Cr, Mn, Pt, Ag, Au, U.
   (iii) Manufacture of Steel, Alloy Steels.

10. **Radioactivity and Atomic structure :**

   (a) **Radioactivity** : Radioactive decay, half-life, Average life of radio elements, radioactive equilibrium Group displacement law, isotopes (uses of isotopes), isobars and isotones.

   (b) **Atomic nucleus** : Fundamental particles of atomic nucleus, nuclear stability, neutron-proton ratio, nuclear binding energy. Nuclear forces.

   Transmutation of elements, fission, fusion reactions.

   (c) **Extra nuclear structure** : Bohr's theory and its limitations, Sommerfield's modification, spectrum of H-atom.

Group - C
Physical Chemistry

1. **Quantum Theory :**

Black-body radiation and Planck's Law, photo-electric effect and photon concept of light, wave particle duality, de Broglie hypothesis, Heisenberg uncertainty principle, Schrodinger's wave equation (time independent), Interpretation of wave function particle in one-dimensional box, quantum numbers, hydrogen atom wave functions separation of radial and angular part, shapes of s, p and d orbitals.

2. **The Gaseous State :**

Kinetic theory of gases, equation of state of real gases, intermolecular interactions, liquefaction of gases and critical phenomena, Maxwell's distribution of speeds, features of kinetic energy distribution, mean speed, root mean square speed, most probable speed, principle of equipartition of energy, specific heats of gases, intermolecular collisions, collision number and mean free-path, viscosity of gases and mean free-path.

3. **The Liquid State :**

Nature of liquid state, surface tension, capillary rise, spreading of liquid over other surface, temperature dependence of surface tension. Measurement of surface tension, viscosity of liquids, origin of viscosity of gases and liquids, determination of viscosity coefficient, Poiseuille's equation, temperature dependence of viscosity coefficients of gases and liquids.

4. **Solid State :**

Forms of solids, laws of crystallography, crystal lattices, crystal systems and crystal classes, Bragg's Law, X-ray diffraction by crystals, crystal structure of NaCl, KCl, structure of diamond and graphite, Lattice energy, Born-Haber Cycle, Einstein's equation for heat capacity of solids, Debye equation (elementary concept).

5. **Thermodynamics :**

a) Thermodynamic systems, states, processes, work, heat and internal energy, first law of thermodynamics, work done and heat absorbed in different types of processes. Reversible and irreversible process, energy and enthalpy changes in various processes and their temperature dependence.

b) Second law of thermodynamics, Carnot's cycle and Carnot's theorem, absolute scale of temperature, entropy as a state function, entropy change in various processes, entropy – reversibility and irreversibility, Free-energy functions, criteria for spontaneity and equilibrium, physical concept of entropy, entropy and probability.

c) Application thermochemistry, laws and their applications, Kirchoff's relation, Maxwell relation, $C_p - C_v$ relation Joule-Thomson expansion, thermodynamic equation of state, Gibbs-Helmholtz equation, Clausius-Clapeyron relation and phase transition, colligative properties of dilute solutions.

6. **Reaction equilibrium :**

a) Homogeneous equilibrium, relationship K_p, K_c, K_x. Van't Hoff's reaction isotherm (deduction using chemical potential). Temperature dependence of equilibrium constant, La-Chateleer's principle, response of equilibria to different conditions.

b) Ionic equilibrium, solubility product, dissociation constant of weak acids, ionic product of water, pH, buffer, indicators, hydrolysis of salt solutions.

7. **Electrochemistry :**

a) Electrical conductance, weak and strong electrolytes, variation of equivalent conductance with dilution, Kohlrausch's law, transport number, determination of transport number by moving boundary method, theory of strong electrolytes, applications of conductance measurements.

b) Galvanic cells, thermodynamic derivation of E.M.F. of chemical cells with examples, Transference cell, liquid junction potential and salt bridge, measurement of e.m.f. of cells and its applications, fuel cells and batteries.

8. **Chemical Kinetics :**

Concentration dependence of rate of reaction, differential and integral rate equations for zeroth, first, second order reactions, rate equations involving reverse, parallel, consecutive and chain reactions, effect of temperature and pressure on rate constant, collision and transition state theories of reaction rates.

9. **Photo Chemistry :**

Absorption of light, Lambert-Beer's law, laws of photochemistry, quantum yield, some typical photochemical reactions, HI-decomposition, CH_3CHO-decomposition, $H_2 - Br_2$ reaction, photosensitized reaction, Fluorescence and phosphorescence.

10. **Surface phenomenon and Catalysis :**

Adsorption from gases and solutions on solid adsorbents, adsorption isotherms – Langmuir and B.E.T. isotherms, determination of surface area. Gibbs adorption isotherms, surfactants, micelle formation. Characteristics and mechanism of homogeneous and heterogeneous catalytic reactions Enzyme catalysis.