Syllabus for Material Sciences and Technology PGQP08(xiii)

Mechanics: Unit vectors, displacement, area element, volume element, velocity and acceleration in Cartesian, Spherical polar and cylindrical coordinate system. Inertial and non-inertial frames of references, uniformly rotating frame; Coriolis force and centrifugal force. Inverse square law of force: Concept of central and non-central forces. Kepler's laws and Satellite motion.

Oscillation: Differential equation and its solution, Compound , torsional pendulum, Oscillation of two masses connected by spring, Driven harmonic oscillator, Solution of differential equation, power absorption and power dissipation, Sharpness of resonance, Quality factor, Electrical resonance.

Relativity: Galilean transformations and conservation laws: conservation of momentum and energy, Search for ether and Michelson-Morley experiment, Lorentz transformations, Length contraction, Time dilation, velocity theorem, mass energy equivalence, Doppler's effect.

Vector Calculus: Basic idea of vector algebra, Scalar and vector fields, Gradient of a scalar field and its physical interpretation, Line, surface and volume integrals, Divergence of a vector field and its physical significance, Gauss's divergence theorem, Stokes' theorem

Electrostatics: Gauss's law in integral and differential forms, Line integral of electrostatic field, Poisson's and Laplace's equations, Dielectrics, Polar and non-polar molecules, Atomic polarizability, Electric susceptibility, Gauss's law in a dielectric medium (differential and integral forms).

Electric current and Magnetostatics: Current and current density, Equation of continuity, Electrical conductivity, Microscopic form of Ohm's law, Biot-Savart's law, Ampere's circuit law (integral &differential forms),Displacement current, Magnetic scalar and vector potentials, Divergence of vector potential, Current loop as a magnetic dipole, magnetic dipole moment and angular momentum.

Time varying fields: Self-inductance of a solenoid, Mutual inductance of two solenoids, Self-inductance of a solenoid, Mutual inductance of two solenoids, Self- inductance and mutual inductance of current loops, Reciprocity theorem of mutual inductance, Relation between self and mutual inductance, coefficient of coupling, Maxwell`s equations, Poynting theorem.

Electromagnetic waves: Electromagnetic waves in vacuum, electromagnetic waves in dielectric medium, Electromagnetic waves in conductor, modified wave equations, skin depth and characteristic impedance.

Heat and Thermodynamics: Conduction, convection and radiation, laws of thermodynamics.

Waves: Velocity of transverse waves in a string, velocity of longitudinal waves in a fluid, phase and group velocity, Stationary/standing waves, eigen functions, eigen frequencies.

Optics: Young's double slit experiment, theory of interference fringes, Fresenal's Biprism, Newton's rings, Michelson's interferometer and its applications. Fresnel's diffraction, Fresnel's half-period zones, rectilinear propagation of light, zone plate, diffraction at a straight edge, Fraunhofer diffraction, diffraction grating, width of principal maximum, dispersive & resolving power of grating. Polarization by reflection, Brewster's law, quarter wave plate &half wave plate.

Statistical Mechanics: Macro and micro states, Boltzmann's distribution law, Maxwell's distribution of speeds and velocities, mean, r.m.s. and most probable speeds, Bose- Einstein (B-E) statistics and distribution law, Fermi-Dirac (F-D) statistics and its distribution law.

Quantum Mechanics: Compton Effect, Wave-Particle Duality, Davisson and Germer Experiment, Wave Packet, Phase and Group velocity, Uncertainty Principle, Tunneling effect, Harmonic Oscillator.

Atomic Physics: Larmor's Precession, Bohr's Corresponding Principle, Stern Gerlach Experiment, Vector Atom Model (ls, jj coupling), Normal and Anomalous Zeeman Effect.

Solid state physics: Lattices and bases, unit cell and Winger-Seitz cell, symmetry operations, Bravais lattices in two and three dimensions, Miller indices, Reciprocal lattice and its application to simple cubic, bcc and fcc. Laue`s theory of X-ray diffraction, Bragg`s law, Experimental methods in X-ray diffractions. Einstein`s theory and Debeye`s model of specific heat of solids. Superconductivity, Meissner effect, type I & II superconductors, BCS theory, Schottkey and Frankel defects. Law of crystallography, X-ray diffraction by crystal, Bragg's equation. Determination of crystal structure of ionic solids.

Quantum Optics: Raman effect – classical and quantum mechanical explanation, properties of spectral lines, Luminescence, Optical fibre and its types, Critical angle of propagation, Acceptance angles, Numerical aperture, Pulse dispersion, Attenuation and its various mechanism, Attenuation of light in an optical medium, Population inversion, pumping, Principal pumping schemes (three and four levels), Types of lasers (Ruby, He-Ne and semiconductor).

Electronics: Kirchoff`s law, voltage and current sources, source transformations, maximum power, series RL, RC, LCR circuit, resonance condition, impedance variation, PN junction diode as a half wave and full wave rectifier, ripple factor and efficiency of HWR and FWR, Zener diode and its characteristics, zener diode as a voltage regulator, characteristics of unijunction diode, tunnel diode and light emitting diode, working and characteristics of UJT, SCR, JFET. Characteristics of a transistor in common base and common emitter transistor, operational amplifier and applications, logic gates.

Atomic Structure, Chemical Bonding, s and p Block Elements: Idea of de- Broglie matter wave, quantum numbers, effective nuclear charge, Heisenberg uncertainty principle, periodic properties. Molecular orbital theory, dipole moment & electronegativity difference, types of hybridization. Diagonal relationship, salient features of hydrides, salvation and complexation tendencies in bio-systems, chemistry of fullerenes, carbide, fluorocarbons and inter-halogen compounds.

Acid and Bases: HSAB concept, acid base strength and hardness & softness, symbiosis, non-aqueous solvent; their physical and chemical properties.

Oxidation and Reduction: Use of redox potential data-analysis of redox cycle; redox stability in water, structure and properties of silicon and phosphazene.

Gaseous State: Gas laws, relationship between critical constants and van der Waal's constant, law of corresponding states.

Structure and bonding: Types of hybridization in carbon compounds, bond length, bond angle and bond energy.

Nomenclature of organic compounds: D&L and R&S and E&Z system of nomenclature, mechanism of nucleophilic additions to carbonyl group with particular emphasis on Benzoin aldol, Perkin, Wittig reaction.

Chemistry of transition elements: General characteristics of 3-D elements, Werner co-ordination theory, effective atomic no. concept, nomenclature of co-ordination compounds. Electronic configuration and characteristics of lanthanides and actinides, lanthanide contraction and application.

Magnetic properties of complexes: Magnetic susceptibility, LS-coupling, application of magnetic moment, data for structure analysis of complexes.

Black body radiations: Stefan`s law, Boltzman law, Wein`s displacement law.

Spectroscopy: IR and Raman spectroscopy, vibrational spectroscopy, NMR spectroscopy.

Carbohydrates: Synthesis and properties of monosaccharide and their inter conversions, osazone formation.