Syllabus
for
Nanoscience (MTQP08)

Note:

i. The Question Paper which will have 75 questions.

ii. All questions will be based on Subject-Specific Knowledge.

iii. All questions are compulsory.

iv. The Question paper will be in English.

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CHEMICAL SCIENCES:

Periodic Table and periodicity in properties: Chemical bonding and shapes of compounds, VSEPR theory, lattice energy. Main group elements (s and p blocks). Transition metals and innertransition metals (d and f block). Allotropes. Coordination compounds. Organometallic compounds. Stoichiometry. Acids and bases. Oxidation reduction and precipitation reactions.

Radioactivity. Nuclear reactions: fission and fusion.

Quantum mechanics: Chemical bonding. Chemical thermodynamics. Kinetic theory of gases. Electrochemistry & Chemical kinetics: Conductance, EMF, Free energy, Nernst equation, redox systems, electrochemical cells, Reactions of various order, Arrhenius equation, Enzyme kinetics,Catalysis. Solutions. Ionic equilibria in solutions, pH and buffer solutions, Hydrolysis, Solubility product, Phase equilibria–Phase rule. Vapour pressure and Osmotic pressure. Molecular weightdetermination.

IUPAC nomenclature. Stereochemistry. Organic reactive intermediates: Generation, stabilityand reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Common named reactions and rearrangements –applications in organic synthesis. Polymers.

PHYSICAL SCIENCES:

Interference. Diffraction. Polarization. Quantum mechanics: Postulates; Wave-particle duality. Commutators and Heisenberg uncertainty principle. Schrödinger equation (time-dependent and time-independent). Exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom. Tunneling through a barrier. Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magneto statics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Scalar and Vector potentials, Maxwell equations. First and second laws of thermodynamics, Thermodynamic functions, Heat capacity enthalpy, entropy. Bonding in solids, Crystal structures. Bravais lattices. Miller indices.

Reciprocal lattice. Bragg's law and applications; Diffraction and the structure factor. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall Effect and thermoelectric power. Electron motion in a periodic potential, Band theory of solids: metals, insulators and semiconductors. Dielectrics. Ferroelectrics. Magnetic materials. Superconductivity: type-I andtype-II superconductors.

BIOLOGICAL SCIENCES:

Biomolecules: Biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation. Catalysis, enzymesand enzyme kinetics.

Cell Biology: Membrane structure and function; Cell organelles; Cell division and cell cycle.
Microbes, infectious disease biology, cancer and microbial diseases.

Fundamental Processes: DNA replication, repair and recombination, RNA synthesis andprocessing and Protein synthesis

Immunology: Innate and adaptive immunity, antigens, antibody, antigen-antibody interactions,immune responses, congenital and acquired immune deficiencies, vaccines.

Genetics: Mendelian principles, Gene: Allele, multiple alleles, mutation types and cause.
Human Physiology: Blood, coagulation, blood groups, Heart, Endocrine glands, Hormones anddiseases.