Syllabus for M.Phil/Ph.D (Mathematics) Entrance Test - 2018-19

Section I – Analysis:

Finite, countable and uncountable sets, bounded and unbounded sets, Archimedean property, ordered field, completeness of $\mathbb{R}$, sequence and series of functions, uniform convergence, Riemann integrable functions, improper integrals, their convergence and uniform convergence, Fourier series. Partial and directional derivatives, Taylor's series, implicit function theorem, line and surface integrals, Green's theorem, Stoke's theorem. Elements of metric spaces, convergence, continuity, compactness, connectedness, Weierstrass's approximation theorem, completeness, Baire's category theorem, Bolzano-Weirstras's theorem, compact subsets of $\mathbb{R}n$, Heine-Borel theorem, Lebesgue outer measure, Lebsegue measure and Lebsegue integration, Riemann and Lebesgue integrals. Complex numbers, analytic functions, Cauchy-Riemann equations, Riemann sphere and stereographic projection, lines, circles, cross ratio, Mobius transformations, line integrals, Cauchy's theorems, Cauchy's theorem for convex regions, Morera's theorem, Liouville's theorem, Cauchy's integral formula, zerosets of analytic functions, exponential, sine and cosine functions, power series representation, classification of singularities, conformal mapping, contour integration, fundamental theorem of algebra.

Banach spaces, Hahn-Banach theorem, open mapping and closed graph theorem, principle of uniform boundedness, boundedness and continuity of linear transformations, dual spaces, embedding in the second dual, Hilbert spaces, projections, orthonormal bases, Riesz representation theorem, Bessel's inequality, Parseval's identity. Elements of Topological spaces, continuity, convergence, homeomorphism, compactness, connectedness, separation axioms, first and second countability, separability, subspaces, product spaces.

Section II – Algebra:

Space of n-vectors, linear dependence, basis, linear transformations, algebra of matrices, rank of a matrix, determinants, linear equations, characteristic roots and vectors. Vector spaces, subspaces, quotient spaces, linear dependence, basis, dimension, the algebra of linear transformations, kernel, range, isomorphism, linear functional, dual space, matrix representation of a linear transformation, change of bases, reduction of matrices to canonical forms, inner

product spaces, orthogonality, eigenvalues and eigenvectors, projections, triangular form, Jordan form, quadratic forms, reduction of quadratic forms. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic
groups, permutation groups, Cayley's theorem, Symmetric groups, alternating groups, simple groups. conjugate elements and class equations of finite groups, Sylow's theorem, solvable groups, Jordan-Holder theorem, direct products, structure theorem for finite abelian groups. Rings, Ideals, prime and maximal ideals, quotient ring, integral domains, Euclidean domains, principal ideal domains, unique factorization domains, polynomial rings, chain conditions on rings, fields, quotient fields, finite fields, characteristic of field, field extensions, elements of Galois theory, solvability by radicals, ruler and
compass construction.

Section III- Differential Equations and Mechanics:

First order ODE, singular solutions, initial value problems of first order ODE, general theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Lagrange's and Charpit's methods of solving first order PDEs, PDEs of higher order with constant coefficients. Existence and uniqueness of solution dy/ dx f(x , y), =, Green's function, Sturm- Liouville boundary value problems, Cauchy problems and characteristics, classification of second order PDE, separation of variables for heat equation, wave equation and Laplace equation, Equation of continuity in fluid motion, Euler's equations of motion for perfect fluids, two dimensional motion, complex potential, motion of sphere in perfect liquid and motion of liquid past a sphere, vorticity, Navier-Stoke's equations of motion for viscous flows, some exact solutions.

----**

Syllabus for M.Phil/Ph.D (Chemistry) Entrance Test 2018-19

Physical Chemistry

1]. Angular momentum.
2]. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen
3]. atom spectra.
4]. Chemical applications of group theory.
5]. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR.
6]. Chemical thermodynamics.
7]. Phase equilibria.
8]. Statistical thermodynamics.
9]. Chemical equilibria.
10]. Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory.
11]. Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions.
12]. Polymer chemistry. Molecular weights and their determinations. Kinetics of chain polymerization.
13]. Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties
14]. Data analysis.

Inorganic Chemistry

1]. Chemical periodicity
2]. Structure and bonding in homo- and hetero nuclear molecules, including shapes of molecules.
3]. Concepts of acids and bases.

4]. Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure.

5]. Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reaction mechanisms.

6]. Inner transition elements – spectral and magnetic properties, analytical applications.

7]. Organo metallic compounds - synthesis, bonding and structure, and reactivity. Organo metallics in homogenous catalysis.

8]. Cages and metal clusters.

9]. Analytical chemistry- separation techniques. Spectroscopic electro- and thermo analytical methods.

10]. Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation.

11]. Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopic techniques.

12]. Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Organic Chemistry

1]. IUPAC nomenclature of organic compounds.

2]. Principles of stereochemistry, conformational analysis, isomerism and chirality.

3]. Reactive intermediates and organic reaction mechanisms.

4]. Concepts of aromaticity.

5]. Pericyclic reactions.

6]. Named reactions.

7]. Transformations and rearrangements.

8]. Principles and applications of organic photochemistry. Free radical reactions.

9]. Reactions involving nucleophotic carbon intermediates.

10]. Oxidation and reduction of functional groups.

11]. Common reagents (organic, inorganic and organometallic) in organic synthesis.

12]. Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids and lipids.

13]. Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Protecting groups.

14]. Chemistry of aromatic and aliphatic heterocyclic compounds.

15]. Physical characterisation of organic compounds by IR, UV-, MS, and NMR.

Interdisciplinary topics

1]. Chemistry in nanoscience and technology.

2]. Catalysis and green chemistry.

3]. Medicinal chemistry.

4]. Environmental chemistry.

----**

Syllabus for M.Phil/Ph.D (PHYSICS) Entrance Test 2018-19

Unit-1:

Calculus of single and multiple variables, partial derivatives, Jacobian, imperfect and perfect differentials, Taylor expansion. Vector algebra, Vector Calculus, Multiple integrals, Divergence theorem, Green's theorem, Stokes' theorem. First order equations and linear second order differential equations with constant coefficients. Matrices and determinants, Algebra of complex numbers.

Elements Complex analysis, Limit and continuity, Cauchy's Riemann equations, Complex integrations, Cauchy's theorem for simply and multiply connected regions, Cauchy's integral formula, Taylor and Laurent series, Poles and singularities, Cauchy's residue theorem and its application to evaluation of definite integrals.

Unit-II:

Electricity and Magnetism: Coulomb's Law, Gauss's law, Energy of a charge distribution, Laplace's and Poisson's equations, Conductors, Method of images, Field and Potential due to dipole. Polarization in a dielectric, vectors D, P and E, linear dielectrics, force on dielectrics. Line, surface and volume currents and current densities, electrical conductivity and Ohm's law, equation of continuity, energy dissipation. Motion of charged particles in electric and magnetic fields. Biot-Savart and Ampere's law, divergence and curl of B and the differential form of Ampere's law, vector potential, Magnetic dipoles, magnetization in materials, H, B and M, Dia-, para- and ferro-magnetism. Electromagnetic induction, motional e.m.f and Faraday's law, inductance and energy in magnetic field, the displacement current, Maxwell's equations, Ising Model, Anti Ferromagnetism , Two Sub Lattice Model, Ferrimagnetism, Ferrites.

Unit-III:

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A &

B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

Unit-IV:

Bravais lattices. Reciprocal lattice, Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. 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. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals

Unit-V:

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

Unit-VI:

Introduction to Nano Physics: Definition, Length scale, Importance of Nano-scale and technology, History of Nantechnology, Benefits and challenges in molecular manufacturing. Molecular assembler concept, Understanding advanced capabilities. Vision and objective of Nano-technology, Nanotechnology in different field, Automobile, Electronics, Nano-biotechnology, Materials, Medicine.

____**