NEST General Section Syllabus

There is no defined syllabus for the 'General' section of NEST 2010. This section will broadly have three categories of questions.

(a) Questions to test candidate's general ability to comprehend qualitative and quantitative aspects of a given scientific passage.

(b) Questions to test general mathematical skills including graph interpretation, statistics, and other parts of mathematics (algebra, trigonometry, geometry etc) not including calculus.

(c) Questions to test the candidate's general familiarity with (and not a detailed understanding of) the major milestones in mathematics, physics, chemistry, biology and astronomy.

NEST Physics Syllabus

General : Units and dimensions, dimensional analysis; least count, significant figures; Methods of measurement (Direct, Indirect, Null, etc.,) and measurement of length, time, mass, temperature, electrical potential difference, current and resistance.
Design of some simple experiments, Identification of independent, dependent and control variables, Identification of sample size, range and interval; Identification of appropriate measurement techniques and instruments.
Graphical representation, interpretation and analysis of data. Errors in the measurements and error analysis.

Mechanics: Kinematics in one and two dimensions (Cartesian coordinates only), projectiles; Uniform Circular motion; Relative velocity.
Newton's laws of motion; Inertial and uniformly accelerated frames of reference; Static and dynamic friction; Kinetic and potential energy; Work and power; Conservation of linear momentum and mechanical energy.
Systems of particles; Centre of mass and its motion; Impulse; Elastic and inelastic collisions.
Law of gravitation; Gravitational potential and field; Acceleration due to gravity; Motion of planets and satellites in circular orbits; Escape velocity.
Rigid body, moment of inertia, parallel and perpendicular axes theorems, moment of inertia of uniform bodies with simple geometrical shapes; Angular momentum, Torque; Conservation of angular momentum;Dynamics of rigid bodies with fixed axis of rotation; Rolling without slipping of rings, cylinders and spheres.
Equilibrium of rigid bodies; Collision of point masses with rigid bodies.
Linear and angular simple harmonic motions.
Hooke's law, Young's modulus.
Pressure in a fluid; Pascal's law; Buoyancy; Surface energy and surface tension, capillary rise; Viscosity: Stoke's and Poiseuille's law, Terminal velocity, Streamline flow, equation of continuity , Bernoulli's theorem and its applications.

Wave motion (plane waves only), longitudinal and transverse waves, superposition of waves.; Progressive and stationary waves; Vibration of strings and air columns; Resonance; Beats; Speed of sound in gases;Doppler effect (in sound).

Thermal physics: Thermal expansion of solids, liquids and gases; Calorimetry, latent heat; Heat conduction in one dimension; Elementary concepts of convection and radiation; Newton's law of cooling; Ideal gas laws; Specific heats (CV and CP for monoatomic and diatomic gases); Isothermal and adiabatic processes, bulk modulus of gases; Equivalence of heat and work; First and second law of thermodynamics and its applications (only for ideal gases); Entropy. Blackbody radiation: absorptive and emissive powers; Kirchhoff's law; Wien's displacement law, Stefan's law.

Electricity and magnetism: Coulomb's law; Electric field and potential; Electrical potential energy of a system of point charges and of electrical dipoles in a uniform electrostatic field; Electric field lines; Flux of electric field; Gauss's law and its application in simple cases. such as, to find field due to infinitely long straight wire. uniformly charged infinite plane sheet and uniformly charged thin spherical shell.
Capacitance: Parallel plate capacitor with and without dielectrics; Capacitors in series and parallel; Energy stored in a capacitor.
Electric current; Ohm's law ; Series and parallel arrangements of resistances and cells. Kirchhoff's laws and simple applications; Heating effect of current.
Biot Savart's law and Ampere's law; Magnetic field near a current carrying straight wire, along the axis of a circular coil and inside a long straight solenoid; Force on a moving charge and on a current carrying wire in a uniform magnetic field.
Magnetic moment of a current loop; Effect of a uniform magnetic field on a current loop; Moving coil galvanometer, voltmeter, ammeter and their conversions.
Electromagnetic induction: Faraday's law, Lenz's law; Self and mutual inductance; RC,LR and LC circuits with and a.c. Sources.

Optics: Rectilinear propagation of light; Reflection and refraction at plane and spherical surfaces, Deviation and dispersion of light by a prism; Thin lenses.; Combination of mirrors and thin lenses; Magnification.
Wave nature of light: Huygen's principle, interference limited to Young's double slit experiment.
Elementary idea of diffraction – Rayleigh criterion, Elementary idea of polarization – Brewster's law and the law of Malus.

Modern physics: Atomic nucleus; Alpha, beta and gamma radiations; Law of radioactive decay; Decay constant; Half life and mean life; Binding energy and its calculation; Fission and fusion processes; Energy calculation in these processes.
Photoelectric effect; Bohr's theory of hydrogen like atoms; Characteristic and continuous X rays, Moseley's law; de Broglie wavelength of matter waves. Heisenberg's uncertainty principle.

NEST Chemistry Syllabus

- **Physical chemistry**

Measurements in chemistry: SI units for fundamental quantities, significant figures, significant figures in calculations
General topics: Concept of atoms and molecules; ’s atomic theory; Mole concept; Chemical formulae; Balanced chemical equations; Calculations (based on mole concept) involving common oxidationreduction, neutralisation, and displacement reactions; Concentration in terms of mole fraction, molarity, molality and normality.
Gaseous and liquid states: Absolute scale of temperature, ideal gas equation; Deviation from ideality, van der Waals equation; Kinetic theory of gases, average, root mean square and most probable velocities and their relation with temperature; Law of partial pressures; Vapour pressure; Diffusion of gases.
Atomic structure and chemical bonding: Bohr model, spectrum of hydrogen atom, quantum numbers; Wave□particle duality, de Broglie hypothesis; Uncertainty principle; Qualitative quantum mechanical picture of hydrogen atom, shapes of s, p and d orbitals; Electronic configurations of elements (up to atomic number 36); Aufbau principle; Pauli’s exclusion principle and Hund’s rule; Orbital overlap and covalent bond; Hybridisation involving s, p and d orbitals only; Orbital energy diagrams for homonuclear diatomic species; Hydrogen bond; Polarity in molecules, dipole moment (qualitative aspects only); VSEPR model and shapes of molecules (linear, angular, triangular, square planar, pyramidal, square pyramidal, trigonal bipyramidal, tetrahedral and octahedral).
Energetics: First law of thermodynamics; Internal energy, work and heat, pressure□volume work; Enthalpy, Hess’s law; Heat of reaction, fusion and vapourization; Second law of thermodynamics; Entropy; Free energy; Criterion of spontaneity.
Chemical equilibrium: Law of mass action; Equilibrium constant, Le Chatelier’s principle (effect of concentration, temperature and pressure); Significance of ΔG and ΔG in chemical equilibrium; Solubility product, common ion effect, pH and buffer solutions; Acids and bases (Bronsted and Lewis concepts); Hydrolysis of salts.
Electrochemistry: Electrochemical cells and cell reactions; Standard electrode potentials; Nernst equation and its relation to ΔG; Electrochemical series, emf of galvanic cells; Faraday’s laws of electrolysis; Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch’s law; Concentration cells.
Chemical kinetics: Rates of chemical reactions; Order of reactions; Rate constant; First order reactions; Temperature dependence of rate constant (Arrhenius equation).
Solid state: Classification of solids, crystalline state, seven crystal systems (cell parameters a, b, c, alpha, beta, gamma), close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices; Nearest neighbours, ionic radii, simple ionic compounds, point defects.
Solutions: Raoult’s law; Molecular weight determination from lowering of vapour pressure, elevation of boiling point and depression of freezing point.
Nuclear chemistry: Radioactivity: isotopes and isobars; Properties of alpha, beta and gamma rays; Kinetics of radioactive decay (decay series excluded), carbon dating; Stability of nuclei with respect to protonneutron ratio; Brief discussion on fission and fusion reactions.

- **Inorganic Chemistry**

Study of different groups in periodic table
Group 1A (Preparation, properties and reactions of alkali metals, with emphasis on chemistry of Na and K their compounds oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates)

Group 2A (preparation, properties and reactions alkaline earth metals with emphasis on Mg and Ca their compounds such as oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates)
Group 3A(chemistry of Boron and its compounds – diborane)
Group 8A (preparation, properties and reactions inert gases with emphasis on chemistry of Xenon)
Group 7A(halogen chemistry with special emphasis on chemistry of chlorine)
Study of nonmetals – C, S, N, P (especially oxides and oxyacids compounds of these elements, in addition phosphines for P, ammonia for N) and O (peroxide and ozone), Si (silicones and silicates) (allotropes of C, S,
N should be covered)
Transition elements (3d series): Definition, general characteristics, variable oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin only magnetic moment;
Coordination compounds: nomenclature of mononuclear coordination compounds, cis trans and ionisation isomerisms, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral)
Metals and metallurgy: General methods involving chemical principles, General operation stages involved in metallurgical operation, Metallurgy of p block element (emphasis on Al), Metallurgy of Fe triad (Fe, Co, And Ni with more emphasis on Fe metallurgy), Metallurgy of coinage metals (Cu, Ag with more emphasis on Cu)

- **Organic Chemistry**

Concepts: Hybridisation of carbon; Sigma and pi bonds; Shapes of simple organic molecules; Structural and geometrical isomerism; Optical isomerism of compounds containing up to two asymmetric centres, (R,S and E,Z nomenclature excluded); IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono functional and bi functional compounds); Conformations of ethane and butane (Newman projections); Resonance and hyperconjugation; Keto enol tautomerism; Determination of empirical and molecular formulae of simple compounds (only combustion method); Hydrogen bonds: definition and their effects on physical properties of alcohols and carboxylic acids; Inductive and resonance effects on acidity and basicity of organic acids and bases; Polarity and inductive effects in alkyl halides; Reactive intermediates produced during homolytic and heterolytic bond cleavage; Formation, structure and stability of carbocations, carbanions and free radicals.
Preparation, properties and reactions of alkanes: Homologous series, physical properties of alkanes (melting points, boiling points and density); Combustion and halogenation of alkanes; Preparation of alkanes by Wurtz reaction and decarboxylation

reactions. Preparation, properties and reactions of alkenes and alkynes: Physical properties of alkenes and alkynes (boiling points, density and dipole moments); Acidity of alkynes; Acid catalysed hydration of alkenes and alkynes (excluding the stereochemistry of addition and elimination); Reactions of alkenes with KMnO4 and ozone; Reduction of alkenes and alkynes; Preparation of alkenes and alkynes by elimination reactions; Electrophilic addition reactions of alkenes with X2, HX, HOX and H2O (X=halogen); Addition reactions of alkynes; Metal acetylides.
Reactions of benzene: Structure and aromaticity; Electrophilic substitution reactions: halogenation, nitration, sulphonation, Friedel□Crafts alkylation and acylation; Effect of o□, m□ and p□directing groups in monosubstituted benzenes.
Phenols: Acidity, electrophilic substitution reactions (halogenation, nitration and sulphonation); Reimer□ Tieman reaction, Kolbe reaction.
Characteristic reactions of the following (including those mentioned above): Alkyl halides: rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions; Alcohols: esterification, dehydration and oxidation, reaction with sodium, phosphorus halides, ZnCl2/concentrated HCl, conversion of alcohols into aldehydes and ketones; Ethers:Preparation by Williamson's Synthesis; Aldehydes and Ketones: oxidation, reduction, oxime and hydrazone formation; aldol condensation, Perkin reaction; Cannizzaro reaction; haloform reaction and nucleophilic addition reactions (Grignard addition); Carboxylic acids: formation of esters, acid chlorides and amides, ester hydrolysis; Amines: basicity of substituted anilines and aliphatic amines, preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines, Sandmeyer and related reactions of diazonium salts; carbylamine reaction; Haloarenes: nucleophilic aromatic substitution in haloarenes and substituted haloarenes (excluding Benzyne mechanism and Cine substitution).
Carbohydrates: Classification; mono□ and di□saccharides (glucose and sucrose); Oxidation, reduction, glycoside formation and hydrolysis of sucrose.
Amino acids and peptides: General structure (only primary structure for peptides) and physical properties, some examples for separation of amino acid mixture using physical properties.

NEST Biology Syllabus

- **Cell Biology**:

Cell theory Cell as a unit of life. Tools and techniques of cell studies □ Microscopy (use of microscope and calibration). .Elements of microscope. Biomembranes □Transport mechanism, cellular respiration. Cell organelles: their structure and functions. Discovery and structure of DNA, processes of replication, transcription and translation, principles of the basic techniques in molecular biology.

- **Zoology:**

Anatomy and Physiology: (i) Digestive System: Modes of nutrition; Structure of alimentary canal and associated glands, digestive enzymes and their role in digestion, absorption of Products of digestion, peristalsis, balanced diet. (ii) Respiratory System: Gaseous exchange in animals; Structure of respiratory organs, mechanism of breathing, gaseous transport, tissue respiration. (iii) Circulatory System: Open and closed systems; Functions of blood and 1ymph. Microscopic structure of blood and blood vessels. Structures and working of heart, distribution of arteries and veins, circulation of blood coagulation, blood groups. (iv) Excretory System: Elimination of nitrogenous waste, osmoconformers and osmoregulators; structure and function of kidney tubules, arrangement of excretory organs. (v) Nervous System: General account of brain, spinal cord and nerves. Reflex actions (simple and conditioned), sense organs (eye and ear). Reproductive System: Sexual and asexual reproduction; General arrangement of reproductive organs.
Developmental Biology: Basic features of development in animals. Types of eggs, fertilization, cleavage, blastula.
Diversity of Animal Life: Principles of Classification, binomial nomenclature. General classification of animal phyla upto classes (invertebrates) and upto sub□classes/order (vertebrates), with detailed study of the types as indicated: (i) Protozoa: Amoeba, Entamoeba, Paramecium, Plasmodium, Parasitic trypanosomes.
(ii) Porifera {iii) Coelenterata: Hydra. (iv) Platyhelminthes: Taenia and Fasciola (v) Aschelminthes: Ascaris (vi) Annelida: Pheretima and Nereis (vii) Arthropoda: Crustaceans and Insects (viii) Mollusca (ix) Echinodermata. (x) Chordata: General characters of fishes, amphibians, reptiles, birds and mammals.
Genetics and Evolution (Fundamentals only): Human genetics □Human chromosomes, sex□determination, sex□linked inheritance. Evidences and theories of organic evolution.
Ecology: Physical and biological factors influencing organisms. Food chains, pyramids of numbers and biomass, biological equilibrium. Interspecific associations.

- **Botany**

Anatomy and Physiology of Plants: Meristems □Plant growth and development. Internal and external regulators of growth and development in plants, internal structure of root, stem, secondary growth and leaves; Xylem and Phloem□their cell elements and functions: Internal structure of dicot and monocot leaves; photosynthesis, history, importance, factors and mechanism, stomatal mechanism, transpiration and respiration. Comparative study of dicot and monocot anatomy. Absorption and cell□water relations, transport of water and minerals, tropic and turgor movements. Significance of life□cycles with special reference to alternation of generations as exemplified in Funaria, Selaginella and Pinus (No structural details).
Systematics: Principles of classical and new systematics. Binomial nomenclature. Familiarity with taxa.
Humans and Environment: Soil, rainfall and temperature with reference to natural resources. Our natural resources □their uses and abuses. Environmental pollution and preventive measures.
Genetics: Organisation of the heredity material in chromosomes. Equational division, Reduction division,

Mitosis and Meiosis compared and contrasted, significance of meiosis. Mendel's laws of inheritance: Discovery of linkage, sex□linked inheritance. Crossing□over, stage at which crossing□over occurs: Neurospora genetics, Mutation, discovery, types of Mutation and Mutations in diploids. Role of mutations in evolution, Elaboration of Mendel's laws of inheritance: Monohybrid or Dihybrid crosses

NEST Mathematics Syllabus

- **Algebra:**

Algebra of complex numbers, addition, multiplication, conjugation, polar representation, properties of modulus and principal argument, triangle inequality, cube roots of unity, geometric interpretations.
Quadratic equations with real coefficients, relations between roots and coefficients, formation of quadratic equations with given roots, symmetric functions of roots.
Arithmetic, geometric and harmonic progressions, arithmetic, geometric and harmonic means, sums of finite arithmetic and geometric progressions, infinite geometric series, sums of squares and cubes of the first n natural numbers.
Logarithms and their properties.
Permutations and combinations, Binomial theorem for a positive integral index, properties of binomial coefficients.
Matrices as a rectangular array of real numbers, equality of matrices, addition, multiplication by a scalar and product of matrices, transpose of a matrix, determinant of a square matrix of order up to three, inverse of a square matrix of order up to three, properties of these matrix operations, diagonal, symmetric and skew□symmetric matrices and their properties, solutions of simultaneous linear equations in two or three variables.
Addition and multiplication rules of probability, conditional probability, Bayes Theorem, independence of events, computation of probability of events using permutations and combinations.

- **Trigonometry:**

Trigonometric functions, their periodicity and graphs, addition and subtraction formulae, formulae involving multiple and sub□multiple angles, general solution of trigonometric equations.
Relations between sides and angles of a triangle, sine rule, cosine rule, half□angle formula and the area of a triangle, inverse trigonometric functions (principal value only).
Analytical geometry:

- **Two dimensions:**

Cartesian coordinates, distance between two points, section formulae, shift of origin.
Equation of a straight line in various forms, angle between two lines, distance of a point from a line; Lines through the point of intersection of two given lines, equation of the bisector of the angle between two lines, concurrency of lines; Centroid, orthocentre,

incentre and circumcentre of a triangle. Equation of a circle in various forms, equations of tangent, normal and chord.
Parametric equations of a circle, intersection of a circle with a straight line or a circle, equation of a circle through the points of intersection of two circles and those of a circle and a straight line. Equations of a parabola, ellipse and hyperbola in standard form, their foci, directrices and eccentricity, parametric equations, equations of tangent and normal. Locus Problems.

- **Three dimensions:**

Direction cosines and direction ratios, equation of a straight line in space, equation of a plane, distance of a point from a plane.

- **Differential calculus:**

Real valued functions of a real variable, into, onto and one□to□one functions, sum, difference, product and quotient of two functions, composite functions, absolute value, polynomial, rational, trigonometric, exponential and logarithmic functions. Limit and continuity of a function, limit and continuity of the sum, difference, product and quotient of two functions, L'Hospital rule of evaluation of limits of functions. Even and odd functions, inverse of a function, continuity of composite functions, intermediate value property of continuous functions. Derivative of a function, derivative of the sum, difference, product and quotient of two functions, chain rule, derivatives of polynomial, rational, trigonometric, inverse trigonometric, exponential and logarithmic functions.
Derivatives of implicit functions, derivatives up to order two, geometrical interpretation of the derivative, tangents and normals, increasing and decreasing functions, maximum and minimum values of a function, Rolle's Theorem and Lagrange's Mean Value Theorem.

- **Integral calculus:**

Integration as the inverse process of differentiation, indefinite integrals of standard functions, definite integrals and their properties, Fundamental Theorem of Integral Calculus.
Integration by parts, integration by the methods of substitution and partial fractions, application of definite integrals to the determination of areas involving simple curves. Formation of ordinary differential equations, solution of homogeneous differential equations, separation of variables method, linear first order differential equations.

- **Vectors:**

Addition of vectors, scalar multiplication, dot and cross products, scalar triple products and their geometrical interpretations.