ATIT 2015 - Syllabus

MATHEMATICS

Sets, Relations and Functions: Sets and their Representations, Union, intersection and complements of sets, and their algebraic properties, Relations, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings.

Complex Numbers: Complex numbers in the form a+ib and their representation in a plane. Argand diagram. Algebra of complex numbers, Modulus and Argument (or amplitude) of a complex number, square root of a complex number. Cube roots of unity, triangle inequality.

Matrices and Determinants: Determinants and matrices of order two and three, properties of determinants, Evaluation of determinants. Area of triangles using determinants, Addition and multiplication of matrices, adjoint and inverse of matrix. Test of consistency and solution of simultaneous linear equations using determinants and matrices.

Quadratic Equations: Quadratic equations in real and complex number system and their solutions. Relation between roots and co-efficients, nature of roots, formation of quadratic equations with given roots; Symmetric functions of roots, equations reducible to quadratic equations – application to practical problems.

Permutations and Combinations: Fundamental principle of counting; Permutation as an arrangement and combination as selection, Meaning of P(n,r) and C(n,r). Simple applications.

Mathematical Induction and its Applications

Binomial Theorem and its Applications: Binomial Theorem for a positive integral index; general term and middle term; Binomial Theorem for any index. Properties of Binomial Co-efficients. Simple applications for approximations.

Sequences and Series: Arithmetic, Geometric and Harmonic progressions. Insertion of Arithmetic Geometric and Harmonic means between two given numbers. Relation between A.M., G.M. and H.M.Special series: Sn, Sn2, Sn3. Arithmetico-Geometric Series, Exponential and Logarithmic series.

Differential Calculus: Polynomials, rational, trigonometric, logarithmic and exponential functions, Inverse functions. Graphs of simple functions. Limits, Continuity; differentiation of the sum, difference, product and quotient of two functions. differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order upto two. Applications of derivatives: Rate of change of quantities, monotonic - increasing and decreasing functions, Maxima and minima of functions of one variable, tangents and normals, Rolle's and Lagrange's Mean Value Theorems.

Integral Calculus: Integral as an anti-derivative. Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities. Integral as limit of a sum. Properties of definite integrals. Evaluation of definite integrals; Determining areas of the regions bounded by simple curves.

Differential Equations: Ordinary differential equations, their order and degree. Formation of differential equations. Solution of differential equations by the method of separation of variables. Solution of homogeneous and linear differential equations.

Two Dimensional Geometry: Recall of Cartesian system of rectangular co-ordinates in a plane, distance formula, area of a triangle, condition for the collinearity of three points and section formula, centroid and in-centre of a triangle, locus and its equation, translation of axes, slope of a line, parallel and perpendicular lines, intercepts of a line on the coordinate axes.

- The straight line and pair of straight lines: Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, distance of a point from a line Equations of internal and external bisectors of angles between two lines, coordinates of centroid, orthocentre and circumcentre of a triangle, equation of family of lines passing through the point of intersection of two lines, homogeneous equation of second degree in x and y, angle between pair of lines through the origin, combined equation of the bisectors of the angles between a pair of lines, condition for the general second degree equation to represent a pair of lines, point of intersection and angle between two lines.
- Circles and Family of Circles : Standard form of equation of a circle, general form of the equation of a circle, its radius and centre, equation of a circle in the parametric form, equation of a circle when the end points of a diameter are given, points of intersection of a line and a circle with the centre at the origin and condition for a line to be tangent to the circle, length of the tangent, equation of the tangent, equation of a family of circles through the intersection of two circles, condition for two intersecting circles to be orthogonal.
- Conic Sections: Sections of cones, equations of conic sections (parabola, ellipse and hyperbola) in standard forms, condition for $y = mx + c$ to be a tangent and point(s) of tangency.

Three Dimensional Geometry: Coordinates of a point in space, distance between two points; Section formula, direction ratios and direction cosines, angle between two intersecting lines. Skew lines, the shortest distance between them and its equation. Equations of a line and a plane in different forms; intersection of a line and a plane, coplanar lines, equation of a sphere, its centre and radius. Diameter form of the equation of a sphere.

Vector Algebra: Vectors and Scalars, addition of vectors, components of a vector in two dimensions and three dimensional space, scalar and vector products, scalar and vector triple product. Application of vectors to plane geometry.

Measures of Central Tendency and Dispersion: Calculation of Mean, median and mode of grouped and ungrouped data. Calculation of standard deviation, variance and mean deviation for grouped and ungrouped data.

Probability: Probability of an event, addition and multiplication theorems of probability and their applications; Conditional probability; Bayes' Theorem, Probability distribution of a random variate; Binomial and Poisson distributions and their properties.

Trigonometry: Trigonometrical identities and equations. Inverse trigonometric functions and their properties. Properties of triangles, including centroid, incentre, circum- centre and orthocentre, solution of triangles. Heights and Distances.

Statics: Introduction, basic concepts and basic laws of mechanics, force, resultant of forces acting at a point, parallelogram law of forces, resolved parts of a force, Equilibrium of a particle under three concurrent forces, triangle law of forces and its converse, Lami's theorem and its converse, Two parallel forces, like and unlike parallel forces, couple and its moment.

Dynamics: Speed and velocity, average speed, instantaneous speed, acceleration and retardation, resultant of two velocities. Motion of a particle along a line, moving with constant acceleration. Motion under gravity. Laws of motion, Projectile motion.

PHYSICS

Units and Measurement: Units for measurement, system of units – S.I., fundamental and derived units. Dimensions and their applications.

Description of Motion in One Dimension: Motion in a straight line, uniform and non-uniform motion, their graphical representation. Uniformly accelerated motion, and its applications.

Description of Motion in Two and Three Dimensions: Scalars and vectors, vector addition, a real number, zero vector and its properties. Resolution of vectors. Scalar and vector products, uniform circular motion and its applications projectile motion.

Laws of Motion: Force and inertia – Newton 's Laws of Motion. Conservation of linear momentum and its applications, rocket propulsion, friction – laws of friction.

Work, Energy and Power: Concept of work, energy and power. Energy – kinetic and potential. Conservation of energy and its applications, Elastic collisions in one and two dimensions. Different forms of energy.

Rotational Motion and Moment of Inertia: Centre of mass of a two-particle system. Centre of mass of a rigid body, general motion of a rigid body, nature of rotational motion, torque, angular momentum, its conservation and applications. Moment of Inertia, parallel and perpendicular axes theorem, expression of moment of inertia for ring, disc and sphere.

Gravitation: Acceleration due to gravity, one and two-dimensional motion under gravity. Universal law of gravitation, variation in the acceleration due to gravity of the earth. Planetary motion, Kepler's laws, artificial satellite – geostationary satellite, gravitational potential energy near the surface of earth, gravitational potential and escape velocity.

Solids and Fluids: Inter-atomic and Inter-molecular forces, states of matter. (A) Solids : Elastic properties, Hook's law, Young's modulus, bulk modulus, modulus of rigidity. (B) Liquids : Cohesion and adhesion. Surface energy and surface tension. Flow of fluids, Bernoulli's theorem and its applications. Viscosity, Stoke's Law, terminal velocity.

Oscillations: Periodic motion, simple harmonic motion and its equation of motion, energy in S.H.M., Oscillations of a spring and simple pendulum.

Waves: Wave motion, speed of a wave, longitudinal and transverse waves, superposition of waves, progressive and standing waves, free and forced Oscillations, resonance, vibration of strings and air-columns, beats, Doppler effect.

Heat and Thermodynamics: Thermal expansion of solids, liquids and gases and their specific heats, Relationship between Cp and Cv for gases, first law of thermodynamics, thermodynamic processes. Second law of thermodynamics, Carnot cycle, efficiency of heat engines.

Transference of Heat: Modes of transference of heat. Thermal conductivity. Black body radiations, Kirchoff's Law, Wien's law, Stefan's law of radiation and Newton 's law of cooling.

Electrostatics: Electric charge – its unit and conservation, Coulomb's law, dielectric constant, electric field, lines of force, field due to dipole and its behaviour in a uniform electric field, electric flux, Gauss's theorem and its applications. Electric potential, potential due to a point charge. Conductors and insulators, distribution of charge on conductors. Capacitance, parallel plate capacitor, combination of capacitors, energy of capacitor.

Current Electricity: Electric current and its unit, sources of energy, cells- primary and secondary, grouping of cells resistance of different materials, temperature dependence, specific resistivity, Ohm's law, Kirchoff's law, series and parallel circuits. Wheatstone Bridge with their applications and potentiometer with their applications.

Thermal and Chemical Effects of Currents: Heating effects of current, electric power, simple concept of thermo-electricity – Seeback effect and thermocouple, Chemical effect of current – Faraday's laws of electrolysis.

Magnetic Effects of Currents: Oersted's experiment, Bio-Savert's law, magnetic field due to straight wire, circular loop and solenoid, force on a moving charge in a uniform magnetic field (Lorentz force), forces and torques on currents in a magnetic field, force between two current carrying wires, moving coil galvanometer and conversion to ammeter and voltmeter.

Magnetostatics: Bar magnet, magnetic field, lines of force, torque on a bar magnet in a magnetic field, earth's magnetic field, para, dia and ferro magnetism, magnetic induction, magnetic susceptibility.

Electromagnetic Induction and Alternating Currents: Induced e.m.f., Faraday's Law, Lenz's Law, Self and Mutual Inductance, alternating currents, impedance and reactance, power In a.c. Circuits with L.C. And R Series Combination, resonant circuits. Transformer and A.C. generator.

Ray Optics: Reflection and refraction of light at plane and curved surfaces, total internal reflection, optical fibre; deviation and dispersion of light by a prism; Lens formula, magnification and resolving power; microscope and telescope.

Wave Optics: Wave nature of light; Interference – Young's double slit experiment. Diffraction - diffraction due to a single slit. Elementary idea of polarization.

Electromagnetic Waves: Electromagnetic waves and their characteristics, Electromagnetic wave spectrum from gamma to radio waves – propagation of EM waves in atmosphere.

Electron and Photons: Charge on an electron, e/m for an electron, photoelectric effect and Einstein's equation of photoelectric effect.

Atoms, Molecules and Nuclei: Alpha - particles scattering experiment, Atomic masses, size of the nucleus; radioactivity; Alpha, beta and gamma particles/ rays and their properties, radioactive decay law, half life and mean life of radio-active nuclei, binding energy, mass energy relationship, nuclear fission and nuclear fusion.

Solids and Semi-conductors Devices: Energy bands in solids, conductors, insulators and semi-conductors, pn junction, diodes, diode as rectifier, transistor action, transistor as an amplifier.

CHEMISTRY

Some Basic Concepts: Measurement in chemistry (Precision, significant figures, SI units, Dimensional analysis). Laws of chemical combination. Atomic Mass, Molecular Mass, mole concept, Molar Mass, determination of Molecular formula. Chemical equation, stoichiometry of Chemical reactions.

States of Matter: Gaseous state, measurable properties of gases, Boyle's Law, Charle's Law and absolute scale of temperature, Avogadro's hypothesis, ideal gas equation, Dalton's law of partial pressures.

Kinetic molecular theory of gases (the microscopic model of gas), deviation form ideal behaviour.

The solid state (classification of solids, X-ray studies of crystal lattices and unit cells, packing of constituent particles in crystals). Imperfection in solids, electrical, magnetic and dielectic properties of solids. Liquid state (Properties of liquids, Vapour pressure, Surface tension, Viscosity).

Atomic Structure: Constituents of the atom (discovery of electron, rutherford model of the atom).

Electronic structure of atoms – nature of light and electromagnetic waves, atomic spectra, bohr's model of hydrogen, shortcomings of the bohr model.

Dual nature of matter and radiation. de-Broglie relation. The uncertainty principle, Quantum Mechanical Model of the atom, Orbitals and Quantum numbers. Shapes of orbitals. Aufbau

principle, Pauli Exclusion Principle, Hund's Rule, Electronic Configuration of atoms.

Solutions: Types of solutions, Units of concentration, Vapour-pressure of solutions and Raoult's law. Colligative properties. Determination of molecular mass. Non-ideal solutions and abnormal molecular masses. Volumetric analysis-concentration unit.

Chemical Energetics and Thermodynamics: Energy changes during a chemical reaction, Internal energy and Enthalpy, Internal energy and Enthalpy changes, Origin of Enthalpy change in a reaction, Hess's Law of constant heat summation, numericals based on these concepts. Enthalpies of reactions(Enthalpy of neutralization, Enthalpy of combustion, Enthalpy of fusion and vaporization).

Sources of energy (conservation of energy sources and identification of alternative sources, pollution associated with consumption of fuels. The sun as the primary source).

First law of thermodynamics; Relation between Internal energy and Enthalpy, application of first law of thermodynamics.

Second law of thermodynamics: Entropy, Gibbs energy, Spontaneity of a chemical reaction, Gibbs energy change and chemical equilibrium, Gibbs energy available for useful work.

Chemical Equilibrium: Equilibria involving physical changes (solid-liquid, liquid-gas equilibrium involving dissolution of solids in liquids, gases in liquids, general characteristics of equilibrium involving physical processes).

Equilibria involving chemical systems (the law of chemical equilibrium, the magnitude of the equilibrium constant, numerical problems).

Effect of changing conditions of systems at equilibrium (change of concentration, change of temperature, effect of catalyst-Le Chateliar's principle).

Equilibria involving ions — ionization of electrolytes, weak and strong electrolytes, acid-base equilibrium, various concepts of acids and bases, ionization of water, pH scale, solubility product, numericals based on these concepts.

Redox Reactions and Electrochemistry: Oxidation and reduction as an electron transfer concept. Redox reactions in aqueous solutions-electrochemical cells. EMF of a galvanic cell. Dependence of EMF on concentration and temperature (NERNST equation and numerical problems based on it). Electrolysis, Oxidation number (rules for assigning oxidation number, redox reactions in terms of oxidation number, nomenclature). Balancing of oxidation-reduction equations.

Electrolytic conduction. Molar conductivity, Kohlrausch's Law and its applications, Voltaic cell, Electrode potential and Electromotive force, Gibb's energy change and cell potential. Electrode potential and products of electrolysis, Fuel cells, corrosion and its prevention.

Rates of Chemical Reactions and Chemical Kinetics: Rate of reaction, Instantaneous rate of reaction and order of reaction. Factors affecting rates of reactions - factors affecting rate of collisions encountered between the reactant molecules, effect of temperature on the reaction rate, concept of activation energy, catalyst. Effect of light on rates of reactions. Elementary reactions as steps to more complex reactions. How fast are chemical reactions?

Rate law expression. Order of a reaction (with suitable examples). Units of rates and specific rate constants. Order of reaction and effect of concentration (study will be confined to first order only). Temperature dependence of rate constant – Fast reactions (only elementary idea). Mechanism of reaction (only elementary idea). Photochemical reactions.

Surface Chemistry: Surfaces: Adsorption – Physical and chemical adsorption, adsorption isotherms Colloids – Preparation and general properties, Emulsions, Micelles Catalysis: Homogeneous and heterogeneous, structure of catalyst, Enzymes, Zeolites.

Chemical Families – Periodic Properties: Modern periodic law, Types of elements – Representative elements (s & p block), Transition elements –d-block elements, inner transition elements – f-block elements). Periodic trends in properties – ionization enthalpy, electron gain enthalpy, atomic radii, valence, periodicity in properties of compounds).

Chemical Bonding and Molecular Structure: Chemical bonds and Lewis structure, shapes of molecules (VSEPR theory). Quantum theory of the covalent bond, hydrogen and some other simple molecules, carbon compounds, hybridization, Boron and Beryllium compounds.

Coordinate covalent bond, ionic bond as an extreme case of polar covalent bond, ionic character of molecules and polar molecules. Bonding in solid state ionic, molecular and covalent solids, metals). Hydrogen bond, Resonance.

Molecules: Molecular orbital. Theory – bond order and magnetic properties of H2, O2, N2, F2 on the basis of MOT. Hybridisation involving s, p and d orbitals (including shapes of simple organic molecules), Dipole moment and structure of molecules.

Chemistry of Non-Metals – I: Hydrogen (unique position in periodic table, occurrence, isotopes, properties, reactions and uses), Hydrides – molecular, soline and interstitial Oxygen (occurrence, preparation, properties and reactions, uses), simple oxides; ozone. Water and hydrogen peroxide, structure of water molecule and its aggregates, physical and chemical properties of water, hard and soft water, water softening, hydrogen peroxide – preparation, properties, structure and uses. Nitrogen – Preparation, properties, uses, compounds of Nitrogen – Ammonia, Oxides of Nitrogen, Nitric Acid – preparation, properties and uses.

Chemistry of Non-Metals – II: Boron – occurrence, isolation, physical and chemical properties, borax and boric acid, uses of boron and its compounds. Carbon, inorganic compounds of carbon – oxides, halides, carbides, elemental carbon. Silicon – occurrence, preparation and properties, oxides and oxyacids of phosphorus, chemical fertililzers. Sulphur – occurrence and extraction, properties and reactions, oxides, Sulphuric acid – preparation, properties and uses, sodium thiosulphate. Halogens – occurrence, preparation, properties, hydrogen halides, uses of halogens. Noble gases – discovery, occurrence and isolation, physical properties, chemistry of noble gases and their uses.

Chemistry of Lighter Metals: Sodium and Potassium – occurrence and extraction, properties and uses. Important compounds – NaCl, Na2CO3, NaHCO3, NaOH, KCl, KOH. Magnesium and calcium – occurrence and extraction, properties and uses. Important compounds MgCl2, MgSO4, CaO, Ca(OH)2, CaCO3, CaSO4, plaster of paris, Bleaching Powder. Aluminium – occurrence, extraction, properties and uses, compounds – AlCl3, alums. Cement. Biological role of Sodium, Potassium, Magnesium and Calcium.

Heavy Metals: Iron – Occurrence and extraction, compounds of iron, oxides, halides, sulphides, sulphate, alloy and steel. Copper and silver – occurrence and extraction, properties and uses, compounds – sulphides, halides and sulphates, photography. Zinc and Mercury – occurrence and extraction, properties and uses, compounds – oxides, halides; sulphides and sulphates Tin and Lead – occurrence and extraction, properties and uses, compounds – oxides, sulphides, halides.

Chemistry of Representative Elements: Periodic properties – Trends in groups and periods (a) Oxides-nature (b) Halides-melting points (c) Carbonates and sulphates – solubility. The chemistry of s and p block elements, electronic configuration, general characteristic properties and oxidation states of the

following:- Group 1 elements – Alkali metals Group 2 elements – Alkaline earth metals Group 13 elements – Boron family Group 14 elements – Carbon family Group 15 elements – Nitrogen family Group 16 elements – Oxygen family Group 17 elements – Halogen family Group 18 elements – Noble gases and Hydrogen.

Transition Metals including Lanthanides: Electronic configuration: General characteristic properties, oxidation states of transition metals. First row transition metals and general properties of their compounds-oxides, halides and sulphides. General properties of second and third row transition elements (Groupwise discussion). Preparation and reactions, properties and uses of Potassium dichromate and Potassium permanganate.

Inner Transition Elements: General discussion with special reference to oxidation states and lanthanide contraction.

Coordination Chemistry and Organo Metallics: Coordination compounds, Nomenclature: Isomerism in coordination compounds; Bonding in coordination compounds, Werner's coordination theory. Applications of coordination compounds.

Nuclear Chemistry: Nature of radiations from radioactive substances. Nuclear reactions; Radioactive disintegration series; Artificial transmutation of elements; Nuclear fission and Nuclear fusion: Isotopes and their applications: Radio carbon-dating.

Purification and Characterization of Organic Compounds: Purification (crystallization, sublimation, distillation, differential extraction, chromatography). Qualitative analysis, detection of nitrogen, sulphur, phosphorus and halogens. Quantitative analysis – estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus (basic principles only) Determination of molecular mass – Silver salt method, cholroplatinate salt method, Calculation of empirical formula and molecular formula. Numerical problems in organic quantitative analysis, modern methods of structure elucidation.

Some Basic Principles: Classification of Organic Compounds. Tetravalency of Carbon. Homologous series. Functional groups– –C = C –, – C C – and groups containing halogen, oxygen, nitrogen and sulphur. General introduction to naming organic compounds – Common names and IUPAC nomenclature of alphatic, aromatic and Cyclic Compounds. Illustration with examples of Compounds having not more than three same or different functional groups/atoms. Isomerism – Structural and stereoisomerism (geometrical and optical). Chirality – Isomerism in Compounds having one and two chiral Centres. Enantiomers, diastereoisomers, racemic forms, racemisation & resolution. Covalent bond fission – Homolytic and Heterolytic: free radicals carbocations and carbanions. Stability of Carbocations and free-radicals. Electrophiles and Nucleophiles. Electron displacement in a covalent bond – inductive effect, electromeric effect, resonance. Common types of organic reactions – Substitution, addition, elimination and rearrangement reactions. Illustrations with examples.

Hydrocarbons: Classification. Sources of hydrocarbons: Alkanes - General methods of preparation (from unsatmated hydrocarbons, alkylhalides, aldehydes, ketones and carburoxylic acids). Physical properties and reactions (Substitution, oxidation and miscellaneous). Conformations of alkanes(ethane, popane butane) and cyclohexane, sawhorse and Newman projections)– mechanism of halogaration of alkanes. Alkanes and Alkynes - General methods of preparation physical properties, Chemical reactions – Mechanism of electrophilic addition reactions in alkenes – Markowni Koff's Rule, peroxide effect. Acidic character of alkynes. Polymerisation of alkenes. Aromatic hydrocarbons - Benzene and its homologues, Isomerism, Chemical reactions of bonzene. Structure of bonzene, resonance. Directive influence of substituents. Petroleum - HydroCarbons from Petroleum, Cracking and reforming, quality of gasoline – Octane number, gasoline additives.

Organic Compounds Containing Halogens: (Haloalkanes and Haloarenes), Methods of preparation, physical properties and reactions, Preparation, properties and uses of Chloroform and Iodoform.

Organic Compounds Containing Oxygen: General methods of preparation, correlation of physical properties with their structures, chemical properties and uses of Alchols, polyhydric alcohols, Ethers, aldehydes, ketones, carboxylic acids and their derivatives, Phenol, Benzaldehyde and Benzoic acid – their important methods of preparation and reactions. Acidity of carboxylic acids and phenol effect of substituents on the acidity of carboxylic acids.

Organic Compounds Containing Nitrogen: (Cyanides, isocyanides, nitrocompounds and amines) Nomenclature and classification of amines, cyanides, isocyanides, nitrocompounds and their methods of preparation; correlation of their physical properties with structure, chemical reactions and uses – Basicity of amines.

Synthetic and Natural Polymers: Classification of Polymers, natural and synthetic polymers (with stress on their general methods of preparation) and important uses of the following: Teflon, PVC, Polystyrene, Nylon-66, Terylene, Bakelite.

Bio Molecules and Biological Processes: The Cell and Energy Cycle, Carbohydrates: Monosaccharides, Disaccharides, Polysaccharides, Amino Acids and Peptides – Structure and classification. Proteins and Enzymes – Structure of Proteins, Role of enzymes. Nucleic Acids – DNA and RNA, Biological functions of Nucleic Acids – Protein synthesis and replication, Lipids – Structure, membranes and their functions.

Chemistry in Action: Dyes, Chemicals in medicines (antipyretic, analgesic, antibiotics & tranquilisers), Rocket propellants. (Structural formulae non-evaluative)

Environmental Chemistry: Environmental pollutants; soil, water and air pollution; major atmospheric pollutants; acid rain, Ozone and its reactions causing ozone layer depletion, effects of the depletion of ozone layer, industrial air pollution.

ENGLISH

Reading Comprehension, Diction, Formation of Effective Sentences, Sentence Completion, Vocabulary, Common Errors.