

# NATIONAL UNIVERSITY



## Syllabus Department of Chemistry

**Four Year B.Sc Honours Course  
Effective from the  
Session : 2009–2010**

**National University**  
**Subject: Chemistry**  
**Syllabus for Four Year B.Sc Honours Course**  
**Effective from the Session: 2009-2010**

**Year wise courses and marks distribution**

**First year Honours**

Course Code	Course Title	Marks	Credits
	Fundamentals of Physical Chemistry	100	4
	Fundamentals of Organic Chemistry	100	4
	Fundamentals of Inorganic Chemistry	100	4
	Qualitative inorganic analysis, inorganic preparations and elementary crystal chemistry	100	4
	Fundamentals of Mathematics	100	4
	Calculus-I	50	2
	Physics-I (Mechanics, Properties of Matter, Waves & Optics)	100	4
	Physics-II (Heat, Thermodynamics and Radiation)	50	2
	<b>Total =</b>	<b>700</b>	<b>28</b>

**Detailed Syllabus**

**First Year**

**Course Code ..... : Fundamentals of Physical Chemistry                      Marks 100, 4 Credits, 60 Lectures**

- 1. State of Matter:** Microscopic and macroscopic system; properties of molecules; potential and kinetic energy of molecules; Degrees of freedom of motion; translational rotational and vibrational energy of systems; principle of equipartition of energy; State of aggregation of matter.
- 2. Gaseous State:** Properties of gases; The gas laws; ideal and real gases; ideal gas equation; Kinetic theory and its application to ideal gases; Pressure of ideal gases; Boltzmann distribution of molecular energies; Deviation from ideal behaviour; Vander walls equation, Critical constants; Principle of corresponding states; Collision number, Mean free path; Dalton's law of partial pressure.
- 3. Liquids and Solutions:** Physical properties and molecular structure; Surface tension measurement of surface tension, Viscosity, Poiseuille's equation, measurement Viscosity, Molar refractivity and dipole moment, measurement Vapour pressure; Dependence of Vapour pressure on temperature variation, Solution; solubility, solubility product, molecular solution, ionic solution, units of concentration, Raoult's law; Ideal and nonideal solutions; Colligative

properties of solution, Effect of electrolytes on Colligative properties. Henry's law determination of molecular weight by measuring colligative properties.

4. **Chemical Equilibrium:** Equilibrium in chemical reactions and the equilibrium law;  $K_p$ ,  $k_c$ , and  $k_x$  measurements; Degree of dissociation; Effects of temperature, pressure and concentration changes of equilibrium; Principle of Le Chatelier and Braun; Ostwald dilution law; Dissociation of solid; Solubility product; common ion effect,  $p^H$  and buffer solution;
5. **Energetics in Chemistry:** Work and heat; internal energy; The first law of thermodynamics; State function and exact differentials; Enthalpy; Work of expansions reversible and adiabatic expansions; Joule-Thomson effect; Heat capacities at constant pressure and constant volume; Enthalpy changes in various chemical and physical processes; Measurements; Second law of thermodynamics; Spontaneity and reversibility of chemical reactions; Hess's law and its application; Born-Haber cycle; Bond enthalpy.
6. **Electrochemistry:** Oxidation-reduction equilibria, concept of reduction potential, Galvanic cell, electrolytes, non-electronic conduction measurements of electrolytic conductance, application of conductance measurements, transport numbers and their determination.
7. **Rates of Chemical reaction:** Rate of reaction, rate equation, order and rate constant, Measurement of reaction rates, Determination of order and rate constant, Elementary and complex reaction, Molecularity, Effect of temperature on the rate of reaction. Activation energy, Catalysis.

#### Book Recommended:

1. Physical chemistry, PW atkins
2. Physical Chemistry, G W Castellan
3. A text Book of Physical Chemistry, S Glasstone
4. Principles of Physical Chemistry, S H Maroon and C F Pruttons
5. General Chemistry, D Ebbing

Course Code ..... : Fundamentals of Organic Chemistry  
Lectures

Marks 100, 4 Credits, 60

1. **Bonding in Organic Compounds:** Atomic orbitals; Covalent bonds; sigma and pi bonds; Hybridization of orbitals; Shapes of molecules; Classification of organic compounds based on their functional groups, polar and nonpolar molecules; Nomenclature of organic compounds. Formation of carbocations, carbanion, free radicals and their stabilities. Homologous series;
2. **Hydrocarbons and their classification:**  
**Alkanes:** Structure; Nomenclature; Sources; preparation and reaction of alkanes and cycloalkanes; conformation of n butane and cyclohexane, wurtz reaction. Free radical mechanism of halogenation. CFC.
3. **Alkenes:** Structure and orbital picture and sources; Nomenclature; Preparation and reaction of alkenes; Geometrical Isomerism of alkenes; cis-trans and E.Z systems; mechanism of electrophilic addition; Markowikov's and Anti Markowniov's rule, stereo specific reactions cis and trans addition of alkenes. Polymerization of alkenes.

4. **Dienes:** Structure and orbital picture; Nomenclature; Preparation and reactions of dienes; Diels-alder reaction; Polymerization, conjugated dienes.
5. **Alkynes:** Structure and orbital picture; Nomenclature; Preparation; Reactions of alkynes; Electrophilic addition reaction; Acidity of alkynes.
6. **Alkyl Halides:** Structure; Nomenclature; Preparation and properties of alkyl halides; Mechanism of nucleophilic substitution reaction and elimination reactions; Grignard reagent; its synthesis and application.
7. **Alcohols and ethers:** Structure; Nomenclature; Classification of alcohols, Preparation, reactions of monohydric, dihydric and trihydric alcohols. Reactions of alcohols: dehydration, substitution, oxidation and reduction. Acidity and basicity of alcohols. Hydrogen bonding and boiling point of alcohols.
8. **Ethers and Epoxides:** Nomenclature; Preparation, reactions of ethers; Ethers as protecting groups; Crownethers.
9. **Aldehydes and Ketones:** Nomenclature: Orbital picture of carbonyl group. General methods of Preparation and reactions of aldehydes and ketones; Nucleophilic addition reaction of carbonyl compounds. A brief study of mechanism of Cannizzaro reaction and condensation reactions of carbonyl compounds.
10. **Carboxylic Acids:** Structure and orbital picture; Nomenclature; Acidity, resonance effect and inductive effect on acidity; General methods of preparation and reactions of carboxylic acids, preparation and reactions of hydroxy acids, unsaturated acids, keto-acids; Synthesis using active methylene compounds; Preparation and reactions of carboxylic acid derivatives; esters, acid halides, anhydrides and amides.

#### **Books Recommended:**

1. Organic Chemistry, R.T. Morrison and R.N. Boyd, Sixth Edition
2. Organic Chemistry, I.L. Finar, Vol.I. Longmans, 6<sup>th</sup> Ed.
3. Modern Organic Chemistry, R.W. Griffin Jr, McGraw Hill
4. Principles of Organic Chemistry, J. English, H.G. Cassidy and R.I. Baird. McGraw Hill
5. Basic Principles of Organic Chemistry, J.D. Roberts and M.C. Casserio. W.W. Benjamin Inc.
6. Organic Chemistry, McMurry. Brooks-Cole.

**Course Code ..... : Fundamentals of Inorganic Chemistry**  
**Lectures**

**Marks 100, 4 Credits, 60**

1. **Atomic Structure:** Atomic nucleus, fundamental particles, nuclear forces, nuclear binding energy, nuclear stability, magic numbers, radioactivity, isotopes, atomic mass, mass spectrometry, cathode rays, mass and charge of an electron,  $\alpha$ -particle scattering, Rutherford atom model, Planck's quantum theory, Bohr's theory for hydrogen atom, electromagnetic spectrum, absorption and emission spectra, emission spectrum of atomic hydrogen, dual behaviour of electron, de Broglie's equation, Heisenberg's uncertainty principle, stationary wave, Schrödinger wave equation for hydrogen atom, wave function and its significance, quantum numbers, atomic orbitals, shapes and orientation of s, p and d orbitals, aufbau principle, Pauli exclusion principle, Hund's rule, electronic configurations.

2. **Periodic Classification:** Periodic law, periodic table, prediction of elements, naming of all elements, elements in groups, periods and blocks, electronic configuration of groups and periods, metals, nonmetals and metalloids, diagonal relationship, periodicity of atomic and molecular properties e.g. ionization energy, electron affinity, electronegativity, effective nuclear charge, atomic/ionic radii, etc., usefulness and limitation of periodic table.
3. **Chemical Bonds:** Chemical bond, types of chemical bonds, ionic bond: energetic of ionic bond formation, properties of ionic compounds, factors influencing the formation of ionic bond, radius ratio rule, lattice energy, Born-Haber cycle, Fajan's rule, covalent bond: sigma and pi bond, polar and non-polar covalent bonds, properties associated with covalent compounds, Lewis formulation, formal charge, valence shell electron pair repulsion (VSEPR) theory and molecular geometry, valence bond theory, hybridization of bond orbitals, molecular orbital theory, bonding and antibonding orbitals and their significance, bond order, stability of molecules, MO diagram of simple diatomic H<sub>2</sub> to Ne<sub>2</sub> molecules, coordination bond, metallic bond, hydrogen bond, van der Waal's forces.
4. **Inorganic Nomenclature:** Prefixes and affixes used in inorganic nomenclature, use of enclosing marks, numbers, letters, and italic letters, names for cations, anions, radicals and heteropolyanions, names of acids, salts, and salt like compounds.
5. **Solids:** Solids, types of solids, characteristics of crystalline and amorphous solids, unit cell, crystal lattice, seven crystal systems, description of NaCl and CsCl, graphite, diamond and ice structures.
6. **Acids and Bases:** Various concepts on acids and bases, conjugate acids and bases, neutralization reactions, acid - base strength, leveling effect, hard and soft acids and bases, hard and soft acids and bases in qualitative analysis.
7. **Types of Reactions:** Oxidation - reduction reactions, oxidizing and reducing agents, assigning oxidation states to bonded atoms, redox half reactions, rules for balancing redox reactions, Ellingham diagram, Latimer diagram, and Frost diagram, standard reduction potential, the electrochemical series, disproportionation reactions, comproportionation reaction, addition reaction, elimination reactions, double decomposition reactions, substitution reactions, metathetical reactions, acid - base reactions, condensation reactions, isomerization reaction, polymerization reactions, nuclear reactions.
8. **Fundamentals of Qualitative Analysis:** Precipitation reactions and solubility product principle, common ion effect, basic radicals (cations) and acid radicals (anions), classification of basic radicals into groups, systematic analysis, semimicro apparatus, dry tests, wet tests - preparation of solutions, separation of cations in groups, effect of pH on precipitations, dissolution of precipitates, confirmatory tests for basic and acid radicals, interfering radicals, detection of cations in presence of the phosphate anion.

**Books Recommended:**

1. General Chemistry, D. D. Ebbing, Houghton Mifflin Co.
2. Chemistry – The Molecular Nature of Matter and Change, M. Silberberg, WCB/McGraw-Hill.
3. General Chemistry, J. B. Russel, International Edition, McGraw-Hill Inc.
4. Modern Inorganic Chemistry, R. D. Madan, S. Chand & Company Ltd.
5. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, and P. L. Gaus, John Wiley & Sons.
6. Principles of Descriptive Inorganic Chemistry, G. Wulfsberg, University Science Books, Mill Valley.

**Course Code ..... : Qualitative inorganic analysis, inorganic preparations and elementary crystal chemistry      Marks 100, 4 Credits, 60 Lectures**

1. **Safety:** The twelve rules of safety, safety in the laboratory.
2. **Purification and Preparation of Inorganic Compounds:**
  - (i) Purification of commercial NaCl by recrystallization and salting out processes,
  - (ii) Preparation of ferrous sulphate  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ , Mohr's salt  $[\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}]$ , potash alum  $[\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$ , chrome alum  $[\text{K}_2\text{SO}_4 \cdot \text{Cr}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$ , sodium carbonate  $\text{Na}_2\text{CO}_3$ .
  - (iii) A cycle of reactions from  $\text{Cu}^0$  through  $\text{Cu}^0$  via copper nitrate, hydroxide, oxide, and sulphate as intermediates in succession.
3. **Model Making:** Seven crystal systems model.
4. **Systematic Semimicro Qualitative Analysis of Inorganic Salts:** Identification of inorganic basic and acid radicals, 5 radicals in a mixture taking at least two from both ion types.

**Books Recommended:**

1. A Text-Book of Macro and Semimicro Qualitative Inorganic Analysis, A. I. Vogel, 4<sup>th</sup> edition, Longmans, Green and Co. Ltd.
2. Semimicro Qualitative Analysis, F. J. Welcher and R. B. Hahn, D. Van Nostrand Co. Inc.
3. Qualitative Analysis, V. Alexeyev, Mir Publishers.

**Course Code ..... : Fundamentals of Mathematics      Marks 100, 4 Credits, 60 Lectures**

**Real Number System:** Field and order properties, Natural numbers, Integers and rational numbers, Absolute value and their properties, Basic inequalities.

**Complex Number System:** Field of Complex numbers, De Moivre's theorem and its applications.

**Theory of equations:** Relations between roots and coefficients, Symmetric functions of roots, Sum of the powers of roots, Synthetic division, Des Cartes' rule of signs, Multiplicity of roots, Transformation of equations.

**Matrices and Determinants:**, Notion of matrix. Types of matrices. Algebra of matrices. Determinant function and its properties. Minors, Cofactors, expansion and evaluation of determinants. Elementary row and column operations and row-reduced echelon matrices. Invertible matrices. Diagonal, triangular and symmetric matrices.

**System of Linear Equations:** System of linear equations (homogeneous and non-homogeneous ) and their solutions. Gaussian elimination, Application of matrices and determinants for solving system of linear equations. Applications of system of equations in real life problems.

**Vector Spaces:** : Euclidean  $n$ -space. Real vector spaces. Subspaces. Linear combination of vectors. Linear dependence of vectors. Basis and dimension. Linear transformations. Matrix representation of linear transformation. Kernel and image. Eigenvalues and eigenvectors.

**Two-dimensional Geometry:** Transformation of coordinates, Pair of straight lines (homogeneous second degree equations, general second degree equations representing pair of straight lines, angle between pair of straight lines, bisectors of angle between pair of straight lines), General equations of second degree (reduction to standard forms, identifications, properties and tracing of conics).

**Three-dimensional Geometry:** Three-dimensional coordinates, Distance, Direction cosines and direction ratios. Planes and straight lines. Vectors in plane and space. Algebra of vectors. Scalar and vector product. Vector equations of straight lines and planes.

Evaluation: Final examination (Theory, 4 hours): 100 marks.

Ten questions will be set, of which any six are to be answered.

**Books Recommended :**

1. S. Bernard & J M Child- *Higher algebra*.
2. Howard Anton & Chris Rorres – *Elementary Linear Algebra with Application*.
3. Khosh Mohammad- *Analytic Geometry and Vector Analysis*.
4. Md. Abdur Rahman – *Linear Algebra*.

**Course Code ..... : Calculus-I      Marks 50, 2 Credits, 30 Lectures**

**Functions & their graphs :** Polynomial and rational functions, logarithmic and exponential functions, trigonometric functions & their inverses, hyperbolic functions & their inverses, combinations of such functions.

**Limit and continuity:** Definitions and basic theorems on limit and continuity. Limit at infinity & infinite limits, Computation of limits.

**Differentiation:** Tangent lines and rates of change. Definition of derivative. One-sided derivatives. Rules of differentiation . Successive differentiation. Leibnitz's theorem. Related rates. Linear approximations and differentials.

**Applications of Differentiation:** Mean value theorem. Maximum and minimum values of functions. Concavity and points of inflection. Optimization problems.

**Integration:** Antiderivatives and indefinite integrals. Techniques of integration. Definite integration using antiderivatives. Fundamental theorems of calculus. Basic properties of integration. Integration by reduction.

**Applications of Integration:** Arc length. Plane areas. Surfaces of revolution. Volumes of solids of revolution. Volumes by cylindrical shells. Volumes by cross sections.

**Approximation and Series:** Taylor polynomials and series. Convergence of series. Taylor's series. Taylor's theorem and remainders. Differentiation and integration of series.

Evaluation: Final exam (Theory, 3 hours): 50 marks.

Six questions will be set, of which any four are to be answered.

**Books Recommended:**

1. Howard Anton -*Calculus (7<sup>th</sup> and forward editions)*.
2. E.W. Swokowski - *Calculus with Analytic Geometry*.
3. Md. A Matin & B Chakraborty, - *Differential Calculus*.

**Course Code ..... : Physics-I (Mechanics, Properties of Matter, Waves & Optics)    Marks 100, 4 Credits, 60 Lectures**

- 1. Vector Analysis:** Vectors and scalars, Addition and multiplication of vectors, Triple scalar & vector products, Derivatives of vectors, Gradient, divergence and curl-their physical significance, Theorems of Gauss, Green & Stoke's.
- 2. Work, Energy and Power:** Work energy theorem, Conservation of energy and linear momentum, Conservative and non-conservative forces and systems, Conservation of energy and momentum, Centre of mass, Collision problems.
- 3. Rotational Motions:** Rotational variables, Rotation with constant angular acceleration, Relation between linear and angular kinematics, Torque on a particle, Angular momentum of a particle, kinetic energy of rotation and moment of inertia. Combined translational and rotational motion of a rigid body, Conservation of angular momentum.
- 4. Gravitation:** Centre of gravity of extended bodies, Gravitational field and potential their calculations, Determination of gravitation constant and gravity, Compound and kater's pendulums, Motion of planets and satellites, Escape velocity.
- 5. Elasticity:** Moduli of elasticity, poisson's ratio, Relations between elastic constants and their determination, Cantilever.
- 6. Surface Tension:** Surface tension as a molecular phenomenon, Surface tension and surface energy, Capillary rise or fall of liquids, Pressure on a curved membrane due to surface tension, Determination of surface tension of water, mercury and soap solution, Effect of temperature.
- 7. Fluid Dynamics:** Viscosity and coefficient of viscosity, Poiseulle's equation, Determination of the coefficient of viscosity of liquid by Stoke's method, Bernoulli's theorem and its applications, Toricelli's theorem, Venturimeter.
- 8. Waves:** Mechanical waves, types of waves, travelling waves. The superposition principle. Wave speed, Power and intensity in wave motion. Interference of waves, Standing Waves and resonance.
- 9. Oscillatory Motions:** Simple harmonic motion, Combination of harmonic motions, Damped harmonic motion, Forced oscillations and resonance.
- 10. Geometrical Optics:** Fermat's Principles, Theory of equivalent lenses, Defect of images, Optical instrument, Dispersion rainbow.
- 11. Nature and Propagation of light:** Properties of light, Wave theory and Huygene's Principle, Theories of light.
- 12. Interference:** Young's experiment: Bi-prism, Newton's ring.
- 13. Diffraction:** Fresnels and Fraunhofer types, Diffraction through single slit and double slit, diffraction grating, Dispersive and resolving powers of gratings.
- 14. Polarization:** Plane, Elliptical and circular Polarizations, Optical, Rotatory dispersion, Polarimeters.

**Books Recommended:**

- |  |   |                               |
|--|---|-------------------------------|
| 1. Spiegel, M.R.                               | : | Vector Analysis               |
| 2. R.S. Halliday, R. Resnick, and J.Walker     | : | Fundamentals of Physics       |
| 3. Halliday, D and Resnick, R.                 | : | Physics                       |
| 4. Sears, F.W., Zimansky, M.W. and Young, H.D. | : | University Physics            |
| 5. Mathur, D.S.                                | : | Properties of Matter          |
| 6. Newman, F.W. and Serale, V.H.L              | : | General Properties of Matter. |
| 7. A text Book of Light                        | : | Choudhury, Saha & Pramanik    |
| 8. Fundamantals of Optics                      | : | F.A. Jenking & H.E. White     |
| 9. A Text Book of Light                        | : | K.G. Mazumder                 |
| 10. Principles of Optics                       | : | B.K. Mathur                   |

**Course Code ..... : Physics-II (Heat, Thermodynamics and Radiation) Marks 50, 2 Credits, 30 Lectures**

1. **Thermometry:** Temperature, Concepts of thermal equilibrium, measurement of low and high temperature: Gas thermometers, Resistance thermometer, Thermocouple, Pyrometry, International temperature scale.
2. **Calorimetry:** Specific heats of solids, liquids and gases by method of mixture with radiation corrections: Newton's Law of cooling, Variations of specific heats, Atomic and molecular heats.
3. **Transmission of Heat:** Thermal conductivity, Determination of thermal conductivities of good and bad conductors.
4. **Thermodynamic Systems:** Concept of internal energy: The first law of thermodynamics, Work and specific heats, Isothermal and adiabatic processes.
5. **The second law of thermodynamics:** Reversible and irreversible processes: Carnot cycle, Efficiency of reversible engines, Absolute thermodynamic temperature scale, Change of phase: Clausius and Clapeyron equation, Porous plug experiment.
6. **Entropy:** Entropy of an ideal gas, Temperature-entropy diagram, Increase of entropy.
7. **Thermodynamic Functions:** The Maxwell's relations, Specific heat equations.
8. **Radiation:** Concept of black body radiation, Kirchhoff's law, Stefan-Boltzmann law, Wien's displacement Law, Rayleigh-Jean's law, Planck's Radiation law, Pyrometers, Temperature of the sun.

**Books Recommended:**

- |   |   |                           |
|---|---|---------------------------|
| 1. R.S. Halliday, R. Resnick, and J.Walker          | : | Fundamentals of Physics   |
| 2. Halliday, D and Resnick, R.                      | : | Physics                   |
| 3. A Text Book of Heat                              | : | T. Hossain                |
| 4. Principles of Heat, Thermodynamics and Radiation | : | M.A. Haque                |
| 5. Text Book of Heat, Thermodynamics and Radiation  | : | M. Ishaque & A.M.Z. Islam |
| 6. Text Book of Heat , Thermodynamics and Radiation | : | Z.I. Bhuiyan & S. Rahman  |
| 7. Heat and Thermodynamics                          | : | N. Uddin & A Kalam        |
| 8. Tap O Tapagati Bijnan                            | : | M.A. Jabbar               |
| 9. Heat & Thermodynamics                            | : | M.W. Zemansky             |