DEPARTMENT OF CHEMISTRY
JAHANGIRNAGAR UNIVERSITY
SAVAR, DHAKA-1342

Curriculum/Syllabus for B. Sc. (Honours) Courses for the
SESSIONS: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Courses of study for a Bachelor of Science (Honours) degree in Chemistry shall extend over a period of four academic years and shall be divided into four parts: Part-I, Part-II, Part-III and Part-IV. The Part end examinations shall be held at the end of first year, second year, third year and fourth year, respectively.

A candidate for an Honours degree in Chemistry shall have to take all courses listed totaling fifty one courses covering 136 credits. Of the 51 courses there will be 35 theoretical courses (94 credits), 11 practical courses (30 credits), one industrial training/laboratory project (2 credits) and 4 viva-voce courses (10 credits). The Chem. 370 Course (Computing and Information Technology for Chemistry) will spread over two years (from second to third year).

The Chem. 470 (Industrial Training/Laboratory Project) course will primarily be meant for giving practical training to the students in an appropriate chemical/pharmaceutical industry/research institute. In case a placement of a student in an industry cannot be assured, only then a student will have the option to complete a laboratory project to be offered by the teachers of the department or in an appropriate research institution.

Assignment of credits:

Theoretical Courses: A 1 unit (4-credits) course will involve one tutorial and three lecture hours per week (a total of 55 to 60 lecture hours) and a 0.5 unit (2-credits) course will involve two lecture hours per week (a total of 35 to 40 lecture hours).

Practical Courses: Minimum 9 hours per week for six weeks for a 0.5 unit (2-credits) course and 15 hours per week for 7 weeks for a 1 unit (4-credits) course.

Marks Distribution: Of the total marks in a theoretical or a practical course 70% will be from the written/ practical examination to be held at the end of the course and 20% from tutorials and class tests conducted throughout the course and 10% from class attendance. For assessment of class works (tutorial) a minimum of three tests for a 1 unit course and two tests for a ½ unit course will be taken.

The courses to be taken in the different parts are detailed below:

Part-I

Course No.	**Title of the course**	**Credits**	**Marks**	**Unit**
Chem. 110F	Physical Chemistry I (Elements of Physical Chemistry)	4.0	100	1
Chem. 120F	Inorganic Chemistry I (Introductory Concepts)	4.0	100	1
Chem. 130F	Organic Chemistry I (Fundamentals of Organic Chemistry I)	4.0	100	1
Math. C151H	Calculus and Analytical Geometry	2.0	50	0.5
Math. C152H	Linear Algebra and Numerical methods	2.0	50	0.5
Phys. C161H	Mechanics and Properties of Matter and Waves	2.0	50	0.5
Phys. C162H	Electricity and Magnetism	2.0	50	0.5
Chem. 115LH	Physical Chemistry Practical I	2.0	50	0.5
Chem. 125LH	Qualitative Inorganic Analysis	2.0	50	0.5
Phys. C163LH	Physics Practical	2.0	50	0.5
Chem. 180VH	Viva voce	2.0	50	0.5
	Total	28.0	700	7.0

Part-II

Course No.	Title of the course	Credits	Marks	Unit
Chem. 210F	Physical Chemistry II (Concepts of Physical Chemistry)	4.0	100	1
Chem. 220F	Inorganic Chemistry II (Chemistry of Main Group Elements)	4.0	100	1
Chem. 230F	Organic Chemistry II (Fundamentals of Organic Chemistry II)	4.0	100	1
Chem. 240F	Analytical Chemistry	4.0	100	1
Chem. 245H	Nuclear and Radiochemistry	2.0	50	0.5
Chem. 250F	Industrial Chemistry	4.0	100	1
Math. C252H	Mathematical Methods	2.0	50	0.5
Phys. C261H	Electronics and Optics	2.0	50	0.5
Chem. 215LH	Physical Chemistry Practical II	2.0	50	0.5
Chem. 225LH	Inorganic Preparation and Volumetric Analysis	2.0	50	0.5
Chem. 235LH	Preparative Organic Chemistry	2.0	50	0.5
Chem. 280VH	Viva voce	2.0	50	0.5
	Total	34.0	850	8.5

Part-III

Course No.	Title of the course	Credits	Marks	Unit
Chem. 310F	Physical Chemistry III (Selected Topics in Physical Chemistry)	4.0	100	1
Chem. 312H	Molecular Motion & Reaction Kinetics	2.0	50	0.5
Chem. 320F	Inorganic Chemistry III (Advanced Concepts)	4.0	100	1
Chem. 322H	Inorganic Chemistry IV (Selected Topics)	2.0	50	0.5
Chem. 324H	Molecular Symmetry and Group Theory	2.0	50	0.5
Chem. 330F	Organic Chemistry III (Advanced Organic Chemistry)	4.0	100	1
Chem. 332F	Chemistry of Natural Products	4.0	100	1
Chem. 340F	Chemical Spectroscopy	4.0	100	1
Chem. 350H	Fundamentals of Pharmaceutical Chemistry	2.0	50	0.5
Chem. 315LF	Physical Chemistry Practical III	4.0	100	1
Chem. 335LF	Identification of Organic Compounds	4.0	100	1
Chem. 370LH	Computing and Information Technology for Chemistry	2.0	50	0.5
Chem. 380VH	Viva voce	2.0	50	0.5
	Total	40.0	1000	10.0

Part-IV

Course No.	Title of the course	Credits	Marks	Unit
Chem. 400H	Application of Spectroscopic Methods in Chemical Analysis	2.0	50	0.5
Chem. 410H	Quantum Chemistry and Statistical Thermodynamics	2.0	50	0.5
Chem. 412H	Solid State Chemistry	2.0	50	0.5
Chem. 414H	Polymer Chemistry	2.0	50	0.5
Chem. 420H	Supramolecular Chemistry	2.0	50	0.5
Chem. 422H	Organometallic Chemistry	2.0	50	0.5
Chem. 424H	Environmental Chemistry	2.0	50	0.5
Chem. 430H	Theoretical Organic Chemistry	2.0	50	0.5
Chem. 432H	Advanced Stereochemistry	2.0	50	0.5
Chem. 433H	Topics in Biochemistry	2.0	50	0.5
Chem. 434H	Organic Reagents and Syntheses	2.0	50	0.5
Chem. 425LF	Inorganic Synthesis and Quantitative Analysis	4.0	100	1
Chem. 435LH	Organo-Applied Chemistry Practical	2.0	50	0.5
Chem. 470TH	Industrial Training/ Laboratory Project	2.0	50	0.5
Chem. 480VF	Viva-Voce	4.0	100	1
	Total	34.0	850	8.5

Total Credits: 28 + 34 + 40 + 34 = 136, Total Unit: 7 + 8.5 + 10 + 8.5 = 34, Total Marks: 3400

Session indicates first year admission session.
F = Full Unit, H = Half Unit, LF = Laboratory Full Unit, LH = Laboratory Half Unit, VH = Viva-Voce Half Unit, VF = Viva-Voce Full Unit.

Grading System [Effective from Session 2002-2003]

Marks (%)	Letter Grade	Grade Point
80% and above	A^+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A^-	3.50
65% to less than 70%	B^+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B^-	2.75
50% to less than 55%	C^+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F (Fail)	0
Incomplete	I	0

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 110F 1 Unit, 4 Credits
Physical Chemistry I (Elements of Physical Chemistry) 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- study the chemical principles designed for students pursuing a career in chemistry
- understand the scientific and mathematical principles underlying their chosen discipline
- familiarize the students with states of matter and use of scientific rotation
- impart knowledge on significant figures, accuracy & precision
- understand and explain different laws of physical chemistry
- make students analytic in calculating physico-chemical parameters using standard equations
- increase ability for interpreting the tabulated experimental data for different physical processes.

Course Content

1. Introduction: Classification of matter: substances and mixture, elements and compounds; Three states of matter; Physical and chemical properties of matter: extensive and intensive properties; Measurement: SI units; Handling numbers: scientific notation, significant figures, guidelines for using significant figures; Accuracy and precision; Dimensional analysis in solving problems.

2. Gases: Substances that exist as a gas; Pressure of a gas; Gas laws: Boyle's law, Charles's and Gay-Lussac's law, Avogadro's law; Ideal gas equation; Gas stoichiometry; Dalton's law of partial pressures; Kinetic molecular theory of gases, Applications of the gas laws; Distributions of molecular speeds, Root-mean-square speed; Viscosity of gases, Gas diffusion and effusion; Real gases: molecular interactions, van der Waals equations, Principle of corresponding states, Liquefaction of gases, Critical temperature and pressure, Andrews experiments with CO_2.

3. Thermochemistry: Nature of energy and types of energy; Energy changes in chemical reactions: exothermic and endothermic processes; First law of thermodynamics, work and heat; Enthalpy of chemical reactions, Thermochemical equations; Calorimetry: specific heat and heat capacity, Constant-volume and constant-pressure calorimetry; Standard enthalpy of formation and reaction, Thermochemical laws: Lavoisier and Laplace's law & Hess's law; Heat of solution and dilution.

4. Intermolecular forces and liquids and solids: Kinetic molecular theory of liquids and solids; Intermolecular forces: dipole-dipole forces, ion-dipole forces, dispersion forces, hydrogen bond; Properties of liquids: surface tension, viscosity; Structure and properties of water; Crystal structure: unit cell, packing spheres, coordination number, Simple cube cell, Body-centered cubic cell, Face-centered cubic cell; Types of crystals; Amorphous solids; Phase changes: liquid-vapour equilibrium, liquid-solid equilibrium, and solid-vapour equilibrium.

5. Physical properties of solutions: Types of solutions; Molecular view of solution process; Concentration units: percent by mass, mole fraction, molarity and molality; Effect of temperature on solubility of solids and gases, effect of pressure on solubility of gases; Colligative properties of nonelectrolyte and electrolyte solutions (only concepts); Distribution law.

6. Chemical kinetics: Rate of a reaction; Rate law; Reaction order; First-order, Second-order and Zero-order reactions; preliminary concepts of Collision theory, Arrhenius equation, Reaction

mechanism; Molecularity of a reaction, Rate-determining step; Catalysis: heterogeneous and homogeneous catalysis, enzyme catalysis.

7. Chemical Equilibrium: Equilibrium and equilibrium constant; Homogeneous and heterogeneous equilibria; Multiple equilibria; Relationship between chemical kinetics and chemical equilibrium; Reaction quotient; Factors that affect chemical equilibrium; Le Châtelier's principle; Changes in concentration, volume, pressure and temperature; Effect of catalyst.

8. Electrochemistry: Redox reactions; Galvanic cells; construction of Galvanic cells, notation for Galvanic cells, half reactions; Standard electrode potentials; Spontaneity of redox reactions; Effect of concentration on cell emf: Nernst equation, concentrations cells; pH and buffer solutions; Batteries: dry cell battery, mercury battery, lead storage battery, lithium-ion battery and fuel cells; Corrosion; Electrolysis: electrolysis of molten sodium chloride, water and aqueous sodium chloride solution.

Learning Outcomes

Upon completion of the course, the students should be able to

- use scientific notation in expressing very large and very small numbers
- use dimensional analysis in solving various types of problems
- describe matter in terms of states, properties, and composition
- ability to calculate solution concentrations
- calculate volume, pressure, and temperature of gases based on the ideal gas law
- understand the principles of thermochemical equations and thermodynamics
- explain behaviors of matter using kinetic molecular theory
- identify oxidizing and reducing agents in redox reactions
- distinguish types of intermolecular forces
- predict reaction products for common reactions

Suggested Readings

1. Chemistry, Raymond Chang, 9th edition, Tata McGraw Hill
2. General Chemistry, D. Ebbing, Houghton Mifflin Company, Boston, New York.
3. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co.
4. Principles of Physical Chemistry; Md. Mahbubul Haque & Md. Yousuf Ali, Student publications.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 120F 1 Unit, 4 Credits
Inorganic Chemistry I (Introductory Concepts) 70+20+10 = 100 Marks

Learning Objectives

The objectives of this course are to

- impart knowledge on the elementary concepts of atomic structure, chemical bonding, shapes of molecules
- impart knowledge on periodic properties of the elements, acid base phenomena and redox reactions.
- promote knowledge on the basic concepts of the inorganic chemistry to enter into the field of advanced inorganic chemistry.

Course Content

1. Quantum theory and Electronic structure of the atom: Wave and photonic concept of light, various atom models, Rutherford's atom model, Bohr atom model, Bohr theory of hydrogen atom, de Broglie relation, Uncertainly principle, wave functions, quantum numbers, atomic orbitals, electron configuration (Pauli exclusion principle, building-up principle, Hund's rule, electron spin), effective nuclear charge and shielding.

2. Periodicity of the elements: The periodic table and the classification of elements, electron configurations using periodic table, the periodic properties – atomic radius, ionization energy, electron affinity and electronegativity.

3. The chemical bonds: (a) Ionic bonds: General description, energy involved in ionic bonding, lattice energy and Born-Haber cycle, electron configuration of ions, ionic radii. (b) Covalent bonds: General description, multiple bonds, Lewis formula, octet rule, exception to octet rule, polar covalent bonds, delocalized bonding – resonance, bond length, bond energy. (c) Molecular geometry: Valence shell electron pair repulsion theory, dipole moment and molecular geometry. (d) Valence bond theory: General description, hybrid orbitals, sigma and pi bonds, multiple bonding. (e) Molecular orbital theory: Principles of molecular orbital theory, bond order, molecular orbitals of simple diatomic molecules, molecular orbitals and delocalized bonding. (f) Metallic bond, hydrogen bond, van der Waals forces.

4. Acids and bases: (a) Arrhenius concept, Bronsted-Lowry concept, Lewis concept, acid-base strengths, self-ionization of water and pH. (b) Acid-base equilibria: Salt solutions, solution of a weak acid or base, solutions of a weak acid or base with another solute, common ion effect, buffers, acid-base titration, titration curves.

5. Chemical reactions: Molecular and ionic reactions, precipitation reactions, acid-base reactions, oxidation-reduction reactions, oxidation number, balancing oxidation-reduction equations by half-reaction method, strengths of oxidizing and reducing agents, direction of spontaneity of an oxidation reduction reaction.

Learning Outcomes

Upon completion of this course, the students will be able to

- explain the quantum theory and electronic structure of the atom.
- explain the ionic bonds, covalent bonds, valance bond theory, molecular orbital theory.
- analyze acids and bases using different concepts.
- understand the chemical reactions.

Suggested Readings

1. Chemistry, R. Chang, Maxwell Macmillan.
2. General Chemistry, D. D. Ebbing, A. I. T. B. S. Publisher, Delhi/Houghton Mifflin Company, USA.
3. General Chemistry, Zumdal & Zumdal (Latest edition).

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 130F 1 Unit, 4 Credits
Organic Chemistry I (Fundamentals of Organic Chemistry I) 70+20+10 = 100 Marks

Learning Objectives

Learning objectives of this course are to

- make students understand the fundamental principles of organic chemistry, synthesis and reactivity of important functional groups.
- prepare for further studies of advanced organic courses.
- acquire concepts of constitution, configuration and conformation.
- synthesize simple organic compounds.
- understand basics of reaction mechanism.

Course Content

1. Review and Background: Electronic Structure of Atoms; Covalent Bonds and Shapes of Molecules; The Lewis Model of Bonding; The Octet Rule; Molecular Orbital Theory of Covalent Bonding; Bond Angles and Shapes of Molecules; Polar and Non-polar Molecules; Resonance.

2. Aliphatic hydrocarbon:

2.1. Alkanes and cycloalkanes: Structure; constitutional isomerism; sterioisomerism; cycloalkanes; nomenclature of alkanes and cycloalkanes; Baeyer strain theory, configuration and conformations; cycloalkanes and bicycloalkanes; sources and preparation; Wurtz reaction: its importance and mechanism; physical and chemical properties; Free radicals; mechanism of halogenation and carbene addition; synthetic importance of radical halogenation; Octane number.

2.2. Alkenes: Structure; nomenclature, *cis-trans* isomerism, in cycloalkane, C=C compounds; *E*, *Z* - nomenclature; preparation of alkenes; physical and chemical properties; mechanism of electrophilic addition, Markovnikov's rule, synthetic application of oxidation by O_3, $KMnO_4$, peracids etc.; Polymers of alkenes.

2.3. Dienes: Structure; nomenclature; preparation; reactions; Diels-Alder reaction. polymerization.

2.4. Alkynes: Structure; nomenclature; preparation; reactions, electrophilic addition reactions; important organic synthesis starting from alkynes; chemistry of alkenyl halide and copper reagents.

3. Aromatic Hydrocarbons: Benzene - Source; structure; the concept of aromaticity, Huckel-rule; nomenclature of benzene derivatives; preparation; disubstitution and polysubstitution: orientation; electrophilic substitution with mechanism, alkylation, halogenation nitration, sulfonation etc., acylation.

4. Alkyl and aryl halides: Structure; nomenclature; preparation; physical properties; introduction to substitution and elimination reactions with mechanism (S_N1, S_N2, E1 and E2); Grignard reagent.

5. Alcohol and Phenol: Structure; Nomenclature; Preparation; Physical Properties (acidity and basicity of alcohols and phenols); Important reactions of alcohols and phenols, Substitution, esterification, oxidations, Ring Substitution, Coupling with diazonium salts, Reimer-Tiemann reaction; Phenol-formaldehyde resin of phenol; The Pinacol-Pinacolone rearrangement; Periodic Acid Oxidation of glycols.

6. Ethers, Sulphides and Epoxides: Structure; Nomenclature; Preparation, Williamson-ether synthesis; Physical Properties; Reactions; Ethers as Protecting Groups; Crown Ethers.

7. Heterocyclic compounds: Aromaticity of heterocycles; Sources, Isolation; Reactions and Structure of five membered ring heterocycles, pyrrole, furan and thiophene; Six membered ring heterocycle; Pyridine.

Learning Outcomes

Upon completion of this course students will be able to
- Explain the fundamental of carbon chemistry
- Understand and comprehend the physical and chemical properties of organic molecules taught.
- Outline the synthesis of simple organic molecules.

Suggested Readings

1. Organic Chemistry, R. H. Morrison and R. N. Boyd, Prentice-Hall.
2. Organic Chemistry, W. H. Brown and C. S. Foote, Saunders College Publishing.
3. Organic Chemistry, I. L. Finar, Longmans, Pearson.
4. Advanced Organic Chemistry, T. W. Graham Solomons, John Wiley & Sons, INC.
5. Advanced Organic Chemistry, Jerry March, Wiley Eastern Limited, New Delhi.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Math C151H ½ Unit, 2 Credits
Calculus and Analytical Geometry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to
- impart basic concepts of Calculus and Analytical Geometry
- develop skill solving analytical problems
- enhance knowledge on different principles of mathematics regarding calculus and analytical geometry

Course Content

A. Calculus

1. Basic concepts of set theory, Functions, Limit, Continuity, Differentiability, Derivatives, Techniques of differentiation.
2. Application of the derivatives: Maximum and Minimum values, Taylor's series, Maclaurin's series, Exponential and Trigonometric series.
3. Partial differentiation, Maximum and Minimum values of single variate functions.
4. Indefinite integrals: Techniques of integration, Definite integrals.
5. Application of Integration: Areas of plane curves, Volumes and surface areas of solids of revolutions.

B. Analytical Geometry

6. Plane (2D) Co-ordinate Geometry: Co-ordinate systems and their transformations, Conic sections.
7. Solid (3D) Geometry: Co-ordinate systems and their transformations, The straight line and plane, The sphere.

Learning Outcomes

Upon completion of this course, the students will be able to

- understand the major areas of set theory, functions, limit, continuity, differentiability, derivatives, techniques of differentiation
- describe the application of derivatives and integration
- apply mathematical techniques for solving numerical problem in chemistry

Suggested Reading

1. Calculus with Analytical Geometry, Robert Ellis & Denny Gulick, HBJ.
2. Calculus, Tom. M. Apostol, Wiley International Edition.
3. A text book of Co-ordinate Geometry and Vector Analysis, Khosh Mohammad, The Universal Press.
4. The Chemistry Math Book, Erich Steiner, Oxford University Press.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Math C152H ½ Unit, 2 Credits

Linear Algebra and Numerical methods 35 + 10 + 5 = 50 Marks

Learning objectives of this course are to

- impart concept and techniques of basic linear algebra.
- develop computational proficiency.
- understand the theories and proofs of linear transformations on vector spaces and diagonalization of matrices
- provide elementary knowledge of numerical methods
- enable the students to apply various tools and techniques to solve given problems in mathematical sciences
- impart the basic theories and fundamentals of numerical methods

Course Content

A. Linear Algebra

1. Matrices and Linear equations: Introduction, matrix algebra, types of matrices, elementary row operations of matrices (echelon form and canonical forms of matrices), the rank and inverse of a matrix, system of linear equations.
2. Vector spaces: Introduction, definition and examples of vector spaces, subspaces, linear independence, basis and dimension.
3. Linear transformations on vector spaces: Linear transformation, the matrix of a linear transformation, the kernel and image of a linear transformation, rank and nullity of a linear transformation, applications to linear equations.
4. Diagonalization of matrices: Introduction, eigen values and eigen vectors, diagonalization of matrices and the Cayley-Hamilton theorem.

B. Numerical Methods

1. Interpolation: Concept of interpolation and extrapolation, interpolation with equal intervals, Newton's forward and backward interpolation formula, Gauss's central differences, Gauss's forward and backward interpolation formula.
   Interpolation with unequal intervals: Divided differences, Newton's general divided difference interpolation formula and Lagrange's interpolation formula.
2. Numerical Integration: General quadrature formula for numerical integration, composite rules, trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule and Boole's rule.
3. Solution of Linear Systems (Simultaneous equations): Gauss elimination method, Gauss-Jordan elimination method. Gauss-Jacobi and Gauss-Seidel iterative methods.
4. Solution of first order first degree differential equations: Euler's Method, Heun's method and Runge-Kutta Second order method.

Upon completion of this course students will be able to

- identify matrices and their properties.
- solve system of linear equations by using matrix.
- define and explore vector spaces and related theorem.
- demonstrate understanding of various methods and how these methods are used to obtain the approximate solutions to otherwise intractable mathematical problems.
- apply numerical methods to obtain approximate solutions of the given mathematical and numerical problems.
- derive the numerical methods of various mathematical operations and tasks, such as interpolation, integration, solution of linear system of equations, and the solution of first order first degree differential equations.
- analyze and estimate the accuracy of common numerical methods.

Suggested Readings

1. Elementary Linear Algebra (Ninth edition), Howard Anton.
2. Linear Algebra, S. Lang
3. Linear Algebra, Schaum's Series, Library of Congress cataloging.
4. Elementary Linear Algebra (Sixth edition), Larson, Edwards, Falvo.
5. Numerical Analysis, Richard L. Burden and J. Douglas Faires.
6. Introductory Methods of Numerical Analysis, S. S. Sastry, Asoke K. Gosh, Prentice-Hall.
7. The Chemistry Maths Book, Erich Steiner, Oxford University Press.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Phys. C161H ½ Unit, 2 Credits
Mechanics and Properties of Matter and Waves 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- make students understand the fundamental rules and applications of vector algebra,
- able for further studies of advanced vector analysis,
- acquire fundamental concepts of mechanics, properties of matter and waves,
- solve simple mathematical problems relating mechanics, properties of matter and waves .

Course Content

1. Vector Algebra: Vector and scaler quantities; vector addition and subtraction; scaler and vector products; scaler triple and vector triple products; Gradient, divergence and curl of a vector.

2. Rotational Kinetics: Rotational motion; Rotational quantities as vectors; Rotation with constant angular acceleration; Relation between linear and angular kinematics of a particle in circular motion.

3. Rotational Dynamics: Torque and angular momentum; Kinetic energy of rotation and rotational inertia (moment of inertia); Rotational dynamics of a rigid body; parallel and perpendicular axes theorems; Calculation of moments of inertia; conservation of angular momentum.

4. Gravitation: Keplar's laws; Newton's law; Gravitational attraction of sphere; Mass and density of the earth; Gravitational field; Gravitational potential energy; Escape velocity; Acceleration due to gravity.

5. Surface tension: Molecular theory; Definition of surface tension; Surface energy; Adhesive and cohesive forces; Pressure inside a soap bubble; Contact angle; Capillarity.

6. Waves in Elastic Media: Physical description of a wave; Types of waves; Traveling waves: Equation of a traveling wave; Speed of propagation of waves in a stretched string; Transmission of energy of a traveling wave; The superposition principle; Group velocity and phase velocity.

Learning Outcomes

Upon completion of this course students will be able to
- explain the fundamental of vectors,
- understand and comprehend the physical and mechanical properties of materials,
- outline the simple wave phenomena.

Suggested Readings

1. Vector Analysis, M. Spiegle, McGraw-Hill Book Company, Singapore.
2. Physics, D. Halliday and R. Resovicle.
3. Mechanics Wave motion and Heat, F. W. Sears.
4. Mechanics, Properties of Matter and Waves, U. A. Mofiz.
5. Elements of Properties of Matter, D. S. Mathur, Shyamlal Charitable Trust.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Phys. C162H ½ Unit, 2 Credits
Electricity and Magnetism 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to
- make students understand the fundamental concept of electricity and magnetism
- achieve depth concepts of electric potential, capacitors and capacitance; magnetic induction and inductance.
- analyze mathematical problems regarding electricity and magnetism.

Course Content

1. Electric field: Electric field and field strength; point charge in an electric field; Dipole in an electric field; Electric flux; Gauss's law and some applications.

2. Electric Potential: Electric potential and field strength; Potential due to a point charge; Electric potential energy; Calculation of field strength from electric potential.

3. Capacitors and Dielectrics: Capacitance - its calculation; Parallel plate capacitor with a dielectric; Dielectrics and Gauss's law; Energy stored in an electric field.

4. Current, Electromotive force and Circuits: Current and current density; Resistance, resistivity and conductivity, Ohm's law; Electromotive force; Potential difference; Kirchhoff's laws; Single-loop and multi-loop circuits.

5. Magnetic field and the Ampere's law: Magnetic field and field strength; Magnetic force as a current; Torque on a current loop; The Hall effect; circulating charges; Ampere's law and magnetic field near a long straight wire; Two parallel conductors; Biot-savart law.

6. Magnetic Induction and Inductance: Faraday's law of induction, Lenz's law, Induction and the electric field; Inductance and its calculation; An IR circuit's energy and the magnetic field; Energy density and the magnetic field.

7. Thermoelectricity: Introduction to thermoelectricity; Thermocouple.

Learning Outcomes

Upon completion of this course students will be able to

- explain the fundamental principles of different laws
- solve unseen mathematical problems
- describe electric potential, capacitors and capacitance; magnetic induction and inductance.

Suggested Readings

1. Physics Part II, D. Halliday and R. Resnicks.
2. Concept of Electricity and Magnetism, M. S. Huq, A. K. Rafiqullah and A. K. Roy.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 115LH ½ Unit, 2 Credits
Physical Chemistry Practical I 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- familiarize a student with the basic techniques of chemistry laboratory such as: weighing measuring and transferring liquids, heating, filtering, etc.
- develop skill in separating a pair of immiscible liquids
- prepare a standard solution
- carry out a titration
- perform a calorimetric experiment, etc.

Course Content

Expt. 1 : To calibrate a volumetric glassware: Calibration of a pipette.
Expt. 2 : To determine the volume of a drop of water and to calculate the number of drops in one millilitre of water.
Expt. 3 : To carry out a preliminary acid-base titration.
Expt. 4 : To determine the formula of a hydrate.
Expt. 5 : To determine the relative atomic mass of magnesium and to calculate the molar volume of a gas at STP and evaluation of gas constant R.
Expt. 6 : To determine the molecular weight of a condensable vapour by Dumas method.
Expt. 7 : To determine the integral heat of solution of a solid calorimetrically.

Expt. 8 : To determine the concentration of an unknown acid and the molar mass of an organic acid.
Expt. 9 : To carry out qualitative organic analysis.
Expt.10 : To determine the distribution co-efficient of iodine between water and carbon tetrachloride.
Expt. 11 : To determine the solubility of a given inorganic salt in water at room temperature.
Expt.12 : To determine the density of a solid and a liquid.

N.B. Experiments may be added to or omitted from the above list if necessary.

Learning outcomes

Upon completion of this course, the student will be able to
- compute relative atomic mass
- evaluate molecular mass of a condensable vapour
- determine integral heat of solution calorimetrically
- estimate distribution coefficient of iodine between carbon tetrachloride and water
- analyze elementals in an organic compound.

Suggested Readings

1. Practical Physical Chemistry, Palit, Science Book Agency, Calcutta.
2. Practical Physical Chemistry, Sharma, Vikas Publishing House Pvt. Ltd.
3. Advanced Practical Physical Chemistry, J. B. Yadav.
4. Vogel's Text book of Quantitative Chemical Analysis, J. Bassett, R. C. Dinney, G. H. Jeffery and J. Mendham, Longmen Scientific & Technical.
5. Systematic Identification of Organic Compounds, R. L. Shriner, R. C. Fuson and D. Y. Curtin, John Wiley Sons, Inc. New York, London, Sydney.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 125LH ½ Unit, 2 Credits
Qualitative Inorganic Analysis 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objective of this course is to
- impart knowledge on the identification of different cations and anions by semimicro qualitative analysis.
- promote the students with the knowledge of seven crystal systems

Course Content

1. Identification of inorganic cations and anions in mixture by semi-micro qualitative inorganic analysis.

2. Making models of 7 crystal structures and common molecular structures.

Learning Outcomes

Upon completion of this course the students will be able to
- understand and apply the methods to identify the cations and anions in a mixture.
- understand seven crystal systems

Suggested Readings

1. Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, A. I. Vogel, ELBS Longman, London.
2. Experimental Procedures in Elementary Qualitative Analysis, E. S Gilreath, McGraw-Hill.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Phys. C163LH ½ Unit, 2 Credits
Physics Practical 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- impart skill on various experimental techniques
- learn collecting experimental data
- organize and interpret collected experimental data.

Course Content

1. Experiment with spring:
   (a) To verify Hooke's law for a spring.
   (b) To determine the modulus of rigidity of the material of the spring.
   (c) To observe the harmonic motion of the spring for different loads attached to it.
2. To determine the acceleration due to gravity 'g' by means of a compound pendulum.
3. To determine the frequency of a tuning fork by Melde's experiment.
4. To determine the end correction of a meter bridge and hence to determine the specific resistance of a wire.
5. To determine the internal resistance of a cell.
6. To verify Ohm's law by using a Tangent Galvanometer.
7. To determine the thermal conductivity of a good conductor by Searle's apparatus.
8. To determine the mechanical equivalent of heat 'J' by electrical method.
9. To determine the refractive index of glass of a prism by spectrometer.
10. To determine the radius of curvature of a plane-convex lens and the wavelength of light by Newton's ring method.
11. To study the variation of capacitive and inductive reactances with frequency.
12. To investigate the properties of a series resonance circuit.

Learning Outcomes

Upon completion of this course, the student will be able to

- verify Hooke's law for a spring
- determine the internal the acceleration due to gravity , frequency of a tuning fork , resistance of a cell, refractive index of glass etc.
- verify Ohm's law by using a Tangent Galvanometer.
- investigate the properties of a series resonance circuit
- verify Ohm's law by using a Tangent Galvanometer.

Suggested Readings

1. Practical Physics by Dr. Giasuddin Ahmed & Md. Shahabuddin.
2. Advanced Practical Physics by Giasuddin Ahmed & Fatema Nasreen.
3. A Text Book of Practical Physics by K. Din.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 210F 1 Unit, 4 Credits
Physical Chemistry II (Concepts of Physical Chemistry) 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- familiarize the students with thermodynamic system and surroundings, work, heat and energy
- Impart knowledge on entropy and Gibbs free energy changes for different physical processes
- learn different laws of physical chemistry
- study physico-chemical parameters using standard equations
- enhance ability for interpreting the experimentally collected data for different physical processes.
- teach phenomena involved in physical transformations of pure substances
- impart knowledge on conducting behavior of ions in electrolytic solutions
- have idea on the preparation and function of electro-chemical cells

Course Content

1. First law of thermodynamics: System and surroundings, work, heat and energy, Statement of first law, Expansion work, Heat transactions, Enthalpy, variation of enthalpy with temperature, relation between heat capacities, adiabatic changes; State and path functions, exact and inexact differentials, changes in internal energy, the Joule experiment, changes in internal energy at constant pressure, temperature dependence of the enthalpy, changes in enthalpy at constant volume, Joule-Thomson effect, relation between C_p and C_v.

2. Second and third law of thermodynamics: Direction of spontaneous change: dispersal of energy, entropy, Carnot cycle, Clausius inequality, entropy changes accompanying specific processes, Third law of thermodynamics; Nernst heat theorem; Gibbs free energies and work function or Helmholtz free energies, Gibbs-Helmholtz equation; Maximum work, standard molar Gibbs energies; combination of First and Second Laws: the fundamental equation, properties of the internal energy; Maxwell relations; properties of the Gibbs energy: general considerations, variation of Gibbs energy with temperature and pressure.

3. Physical transformation of pure substances: Phases, stabilities of phases, phase boundaries, phase diagrams of water, carbon dioxide, and helium; Phase stability and phase transitions: thermodynamic criterion of equilibrium, dependence of stability on conditions; Location of phase boundaries: Clapeyron and Clausius-Clapeyron equation; Ehrenfest classification of phase transitions.

4. Simple mixtures: Partial molar quantities, chemical potential, Gibbs-Duhem equation; thermodynamics of mixing, chemical potential of liquids, Raoult's law, Henry's law; Properties of solutions: liquid mixtures, excess functions; Colligative properties, molecular interpretations and thermodynamic derivations; Activities: solvent activity, solute activity.

5. Electrolytic conductance: Conductance and conductivity, Molar conductivity, Limiting molar conductivity, Onsager equation, Kohlrausch las of independent ion migration, Limiting molar conductivity of weak electrolytes, Conductometric titrations, Ostwald's dilution law, Arrhenius theory of electrolytic dissociation, Ion activity and activity coefficient, Dabye-Huckel theory of electrolytic solution and limiting law, Common ion effect, Henderson-Hasselbalch equation, Buffer solutions, Acid-base indicators, Solubility equilibria: solubility product, molar solubility; Common ion effect and solubility; pH and solubility.

6. Electrochemical cells: Electromotive force (emf), Electrolytic cell, Half cell and Cell reactions; Types of electrodes; Electrolyte concentrations cell, Electrode concentration cell, Liquid junction potentials, Derivation and minimization of junction potentials, Cell potential, Nernst equation, EMF of concentrations cells, Cells at equilibrium; Standard potentials; Electrochemical series, Measurement of pH and pK_a, Thermodynamic functions (relations between EMF and free energy; EMF and equilibrium constant); Introduction to cyclic voltammetry (CV) and its applications.

Learning Outcomes

Upon completion of the course the students should be able to

- understand and apply laws of thermodynamics
- derive equations such as Gibbs-Dehum equation, Nernst equation
- understand & explain different laws like Nernst heat theorem, Raoult's law, Hess's law, Kohlrausch's law etc.
- estimate pH, pKa and thermodynamic functions on the basis of the concept of cell emf
- calculate different physico-chemical parameters like changes in internal energy, Gibbs energy, Cp, Cv and cell emf
- illustrate different phenomena such as Joule-Thomson effect, physical transformation of pure substances, thermodynamics of mixing, common ion effect, liquid junction potentials etc.
- analyze given data for conductometric titrations

Suggested Readings

1. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co.
2. Physical Chemistry, N. Levine, McGraw-Hill Book Co.
3. Fundamentals of Physical Chemistry, S. H. Maron, J. B. Lando, Macmillan Publishing Co.
4. Principles of Physical Chemistry, Md. Mahbubul Haque & Md. Yousuf Ali, Student Publications.
5. Elements of Physical Chemistry, S. Glassstone, D. Kews, Macmillan & Co. Ltd.
6. Physical Chemistry, G. W. Castellan, Addision-Wesley Publishing Co.
7. Physical Chemistry, G. M. Barrow, McGraw-Hill Book Co.
8. Physical Chemistry, W. J. Moore, Longmans.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 220F 1 Unit, 4 Credits
Inorganic Chemistry II (Chemistry of Main Group Elements) 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- impart knowledge on the elementary idea about the chemistry of Main group elements.
- promote an understanding of the bonding, structure and properties of the main group elements.

Course Content

1. Hydrogen: general remarks: occurrence, preparation, properties and uses; ortho and para hydrogen, compounds: hydrides, hydrates and clathrates; hydrogen bond; isotopes of hydrogen; Hydrogen as fuel.

2. The Group 1 Elements: General remarks: occurrence, isolation and comparative properties; preparation and properties of compounds, solution of Group-1A metal in liq. NH_3. biological importance of Na^+ and K^+.

3. The Group 2 Elements: General remarks: occurrence, isolation and properties, compounds; Anomalous behavior of Be metal, comparative study of group-1A and group-2A elements. Grignard Reagents: Structure, equilibria in solution and synthetic applications, biological importance of Mg^{2+} and Ca^{2+}.

4. The Group 12 Elements: Zinc, Cadmium and Mercury: General discussion; occurrence, extraction, properties and uses; +1 and +2 oxidation states; divalent and monovalent compounds; toxicity of cadmium and mercury.

5. The Group 13 Elements: General remarks, occurrence, isolation and properties; Structure of boranes and nature of their bonding, Borates, boric acid, Lewis acidity of boron compounds, chemistry of trivalent and monovalent state.

6. The Group 14 Elements: General remarks, occurrence, isolation and properties; Lamellar compounds of graphite, catenation, carbides, oxides of carbon, Xanthates, thiocarbonates, dithiocarbamate allotropic forms and their compounds, inert pair effect, carbon dating.

7. The Group 15 Elements: General remarks, occurrence, isolation and properties, difference of chemical properties of N and P compounds, allotropic forms, binary compounds, oxides, oxoacids, hydrides of nitrogen and phosphorous; hydrazoic acid; amino basic compounds, phosphonitrillic compounds (phosphazen and cyclophosphazen), P-N polymers.

8. The Group 16 Elements: general remarks, occurrence, isolation and properties, structure in the elemental state, allotropic forms, binary compounds, oxoacids, oxohalides, hydrogen peroxide, peracids, ozones and persalts; ozone layer depletion, Singlet oxygen, evolution of oxygen atmosphere and role of life in it, dioxygen as ligand, sulphur catenation, S-N polymers.

9. The Group 17 Elements: General remarks: occurrence, isolation and properties, oxidizing power, bridging halide and their bonding nature, charge-transfer compounds of halogens, oxides, oxo-acids and their salts, halides and halide complexes, positive oxidation states of halogens, interhalogen compounds, pseudohalogen compounds.

10. The Group 18 Elements: The nobel gases; general remarks: occurrence, isolation and properties and uses; structure and bonding in Xenon compounds, Clathrate compounds.

Learning Outcomes

Upon completion of this course, the students will be able to

- acquire knowledge on the elementary ideas about the chemistry of main group elements.
- explain the chemical and physical properties, reactions, structures and applications of different compounds derived from main group elements.

Suggested Readings

1. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P. Gauss, Wiley, John Wiley & Sons.
2. Chemistry of the Elements, N. N. Greenwood & A. Earnshaw, Butterworth-Heinemann.
3. Concise Inorganic Chemistry, J. D. Lee, Chapman & Hall.
4. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, Oxford University Press.
5. Inorganic Chemistry, T. Moeller, Asia Publishing House.
6. Introduction of Modern Inorganic Chemistry, S. Z. Haider, Friends International.
7. Chemistry of Main Group Elements (in bangla), K. Kundu, Bangla Academy, Dhaka.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 230F 1 Unit, 4 Credits
Organic Chemistry II (Fundamentals of Organic Chemistry II) 70 + 20 10 = 100 Marks

Learning Objectives

Learning objectives of this course are to

- understand fundamental ideas about the various classes of organic compounds, their preparations and their physical & chemical properties.
- be familiar with the mechanism of the reactions of compounds containing different functional groups.
- acquire the basic ideas in the field of stereochemistry.
- know the realistic approach to the synthesis of the simple organic drugs.

Course Content

1. Polynuclear aromatic hydrocarbons: Introduction, naphthalene, anthracene and phenanthrene: their sources, structures, syntheses, reactions and derivatives, chemical behavior of the derivatives.

2. Aldehydes and ketones: Nomenclature, general methods of preparation, reactions: nucleophilic addition to carbonyl compounds. A simple study of mechanisms: Reimer-Tiemann reaction, Cannizzaro reaction, Aldol condensation, Perkin reaction, Knoevenagel & Stobbe reaction, Benzoin condensation and Wittig reaction.

3. Carboxylic acids: Nomenclature, acidity, resonance and inductive effect on acidity. General methods of preparation and reactions of carboxylic acids, hydroxy acids, unsaturated acids, keto acids.

4. Derivatives of carboxylic acids: Nomenclature; preparation and reactions of esters, acid halides, anhydrides and amides; nitriles; soap & detergents.

5. Amines: Nomenclature, basicity, preparation of amines, reaction of amines, Hoffmann degradation of quaternary ammonium hydroxides. Aromatic diazonium salts: structure, preparation, introduction of functional groups in aromatic system, coupling reactions. Chemistry of nitro-compounds: aliphatic and aromatic.

6. Stereochemistry: Optical isomerism; polarimetry; cause of optical activity; molecular dissymmetry; molecular models; optical isomerism due to asymmetric carbon atoms: compounds with one asymmetric carbon atom, with two or more equal and unequal asymmetric carbon atoms; racemic modifications: nature and their formation, resolution of racemic modification.

7. Bi-functional compounds: 1,3-dienes; α,ß-unsaturated carbonyl compounds; preparation; electrophilic and nucleophilic addition; Michael addition; Diels-Alder reaction; synthesis using active methylene compounds; hydroxy ketone.

8. Synthesis of some important organic drugs: (a) Sulpha drugs: sulphanilamide, sulphapyridine, sulphathiazol, sulphadiazine, sulphamezathine, sulphaguanidine, prontosil, chloriamin-T; (b) Antimalerials: plasmoquin, mepacrine; (c) Fever sinking drugs: paracetamol, aspirin, phenacetin; (d) Barbiturates: barbituric acid, uramil, alurate, barbital, phenobarbital; (e) Sweetening agent: saccharine, dulcin, aspartame.

9. Heterocyclic compounds: Chemistry and structure of five & six-membered heterocyclic compounds containing two hetero atoms: imidazole, pyrimidine, oxazole and thiazole. Heterocyclic compounds having fused rings: chemistry and structure of indole, benzofuran, benzothiophene, quinoline and isoquinoline.

Learning Outcomes

Upon completion of this course students will be able to

- name simple organic compounds indicated in the course content.
- know the preparation of polynuclear aromatic hydrocarbons, aldehydes & ketones, carboxylic acids & their derivatives, amines & nitro compounds, bi functional compounds, heterocyclic compounds and important organic drugs in different methods.
- understand the physical and chemical properties of the compounds containing different functional groups.
- analyze and compare the reactivity of various functional groups.
- write detailed mechanism of different reactions.
- understand optical isomerism, chairality, symmetry& asymmetry of carbon compounds, enantiomers, diasteoremers, racemic modification and resolution of racemic mixture.

Suggested Readings

1. Organic Chemistry, R.T. Morrison & R. N. Boyd, Printice-Hall International, INC.
2. Organic Chemistry, W. H. Brown and C. S. Foote, Saunders College Publishing.
3. Organic Chemistry, I. L. Finar, Vol. I & II, Longman Group Ltd., Pearson.
4. A guide book to mechanism in organic Chemistry, Peter Sykes 6th edition, Orient Longman Ltd.
5. Advanced Organic Chemistry, J. March, McGraw Hill.
6. Stereochemistry of carbon compounds, E. Eliel, McGraw Hill.
7. An introduction to heterocyclic compounds, Acheson, Academic press.
8. Modern Stereochemistry (in Bangla) by Md. Rabiul Islam, Royal Publications, Dhaka.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 240F 1 Unit, 4 Credits
Analytical Chemistry 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- impart knowledge on sampling and analysis.
- promote knowledge on complexometric titrations and advanced analytical techniques such as atomic absorption, high performance liquid chromatography, ion exchange, colorimetric and spectrophotometric titrations, solvent extraction and chromatographic techniques.

Course Content

1. Errors in analysis: Accuracy, Precision, Mean, Average deviation, Standard deviation; classification of errors; Minimization of errors; Determination of the accuracy of methods of quantitative analysis; significant figures and computations; statistical treatment of analytical data, comparison of results.

2. Sampling in chemical analysis; sampling procedures, sample population, significance of representative sampling.

3. Group separation & precipitation phenomenon: basic principles.

4. Complexometric titrations: Principles, Metal titrants: important complexing reagents in general with particular reference to EDTA, Dithiazone and Diethyldithiocarbamate, Metal indicators, effects of other complexing agents on EDTA titrations, scope of EDTA titration, determination of water hardness.

5. Advanced analytical methods: Some basic concepts of atomic absorption spectroscopy, comparison of AAS, AES and AFS experiments, the origins of spectral transitions; the sodium atom, the magnesium atom. The intensities of emission and absorption spectral lines. The light source, the hollow cathode lamp, limitations of hollow cathode lamps. The monochromator, prisons, diffraction gratings. The detector, flameless atom cells, electrothermal atomization, the Zeeman effect system, the Smith-Hiefte system.

6. Ion-exchange Methods: General considerations, action of ion exchange resins; ion-change equilibria; factors determining the distribution of ions between ion exchange resins and solution, ion exchange capacity; The column operation: experimental techniques; some widely used resins; General remarks on their preparation, determination of their capacity, simple applications in analytical chemistry: Separation of the following mixtures using an anion exchanger (i) Zn and Mg; (ii) Chloride and bromide.

7. Colorimetric and spectrophotometric methods: Principles of colorimetric & spectrophotometric methods, Beer's law, Lambert law, applications and deviation of Beer-Lambert law. Determination of pH of a solution by colorimetric methods, Determination of pK value of an indicator by spectrophotometric method, Spectrophotometric titration, Apparatus for spectrophotometric titration, Determination of equilibrium constant by spectrophotometry and determination of Pb & As.

8. Solvent extraction: General discussion, factors favouring solvent extraction, extracting reagents, some applications: determination of iron by chloride extraction, determination of copper as the diethyldithiocarbamate complex.

9. Chromatographic Methods: Paper chromatography, thin layer chromatography (TLC), gas-liquid chromatography (GLC), high pressure liquid chromatography (HPLC), Column chromatography: General discussion, technique and some applications: (i) Separation of nickel copper from a mixture and R_F values by thin layer chromatography, separation of iron and aluminum by column chromatography using cellulose.

Learning Outcomes

Upon completion of this course, the student will be able to

- understand the concepts of accuracy, precision, mean deviation, standard deviation and significant figures in practical analysis.
- analyze biogeochemical, environmental and chemical samples using instruments and techniques.

Suggested Readings

1. Vogel's Textbook of Quantitative Inorganic Analysis, G. H. Jeffery, J. Bassett, J. Mendham, R. C. Dinney, 5th Ed., Longman Scientific & Technical, UK.
2. Analytical Chemistry, G. D. Christian, John Wiley and Sons, INC.
3. Fundamentals of Analytical Chemistry, D. A. Skoog & D. M. West, Saunders Publishing.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 245H ½ Unit, 2 Credits
Nuclear and Radiochemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to-

- impart knowledge on the different areas of nuclear chemistry, including radioisotopes, nuclear reactions, nuclear reactor, radiation detector etc.
- enhance knowledge on the application of various nuclear and radiochemical techniques in the realm of analytical chemistry.

Course Content

1. The discovery of radioactivity and evolution of atomic theory.

2. Atomic Nucleus: Its Composition, Size and Density, Mass and energy correlation, Mass defect and nuclear binding energy, Stable and unstable nuclei, Factors responsible for the stability (or the instability) of a nucleus, Types of nucleus, Nuclear models.

3. Decay of unstable nuclei (radioisotopes): Laws governing radioactive decay, Half-life and average life, Successive decay and branching decay, Radioactive equilibria.

4. Nuclear reactions: Basic concepts, Potential barrier, Elastic and inelastic scattering, Q-value and threshold energy for nuclear reaction, Quantum mechanical tunneling, Reaction cross section, Excitation function, Reaction mechanism at low and high energy; Types of Nuclear reactions: Radiative capture, Photonuclear reaction, Particle capture-particle emission, Stripping and pick up reaction.

Special nuclear reactions: Evaporation, Spallation, Fission, Fusion, Fragmentation, Transfer reaction.

5. Nuclear fission and nuclear fission reactor: Basic concepts, parameters, components and operations, Mechanism of nuclear fission, Mass yield curve for nuclear fission reaction.

6. Interaction of radiation with matter: Modes of interaction, Heavy charged particle interaction, Beta particle interaction, Gamma ray interaction, Neutron interaction.

7. Radiation detectors: Few definitions of operating characteristics, Gas-filled radiation detectors: Principle of operations of Ionization chamber, Proportional counter and Geiger-Müller Counter; Scintillation detector: Operation principles of NaI (Tl) Scintillation detector, Semiconductor Gamma radiation detector – Ge(Li) and Hyperpure Germanium, Electronic accessories in radiation detection set-up, Non-electronic detection systems, Special neutron detectors

8. Nuclear and radiochemical analytical techniques: Neutron-activation analysis, Isotope dilution analysis, Radiochemical tracer techniques, Radiocarbon dating.

9. Radioparticle generators: Production in nuclear reactors, Production by accelerators, Separation techniques, Radionuclide generators, Cyclotrons, Synchrotrons.

10. Radiation protection and control: Natural and man-made radiation sources, Biological effects of radiation, Safety recommendations and regulations.

Learning Outcomes

Upon completion of this course, the students will be able to-

- differentiate between stable and unstable nuclei.
- understand the decay of unstable nuclei.
- know the different types of nuclear reactions.
- know about the nuclear reactor, components and operations.
- learn the operation principles of different radiation detectors.
- know the safely recommendations and regulations of external and internal radiation.

Suggested Readings

1. Introduction to Nuclear and Radiochemistry, G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller, 3rd edition, John Wiley & Sons, New York.
2. Radiochemistry and Nuclear Methods of analysis, Vol. 116, W. D. Ehmann and D. E. Vance, John Wiley & Sons, New York.
3. Nuclear Chemistry, B. G. Harvey, Prentice-Hall, Inc. N.J. Englewood Cliffs.
4. Essentials of Nuclear Chemistry, H. J. Arnikar, Latest Edition, New age International (p) ltd publisher, New Delhi.
5. Nuclear Energy: An Introduction to the Concepts, Systems and Applications of Nuclear Processes, R. L. Murray, Fifth Edition, Butterworth Heinemann, USA.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 250F 1 Unit, 4 Credits
Industrial Chemistry 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- give a general understanding of classification, properties, uses and industrial manufacturing process of few important materials in Bangladesh
- gain knowledge on analysis and quality control of various industrial products.

Course Content

1. Textiles and dyes industries: Classification; difference between natural and synthetic fibres; properties of synthetic fibres; manufacture of synthetic fibres; methods of spinning; coprammonium rayon, acetate rayon, viscose rayon, nylons, polyesters, dacron; natural fibres (cotton, silk, wool); concept of dyes; classification of dyes, manufacture of dyes.

2. Fertilizer industries: Role of fertilizer in agriculture; classification of fertilizers; manufacture of superphosphate, T.S.P. and urea; production of potash fertilizers, NPK fertilizer and organic fertilizer; and their uses.

3. Sugar and starch industries: Manufacture of cane sugar and beet sugar; refining of sugar; utilization of by-products; manufacture of starch and dextrin and their uses.

4. Cement and lime industries: Types of cements; cement rock benefications; manufacture of Portland cement by wet and dry processes, reactions in kiln; mixing of additive to cement; setting and hardening of cement; testing of cement; method of production of lime; uses of lime.

5. Soaps and detergents: Soap and detergent and their mode of action, advantage and disadvantages; Classification of detergents; biodegradability of surfactants; processing of fats and oils; manufacture of soap and detergent; builders; additives.

6. Pulp and paper industries: Manufacture of pulp (sulphate pulp, sulphite pulp, soda pulp, mechanical pulp); chemicals recovery system; bleaching of pulp; manufacture of paper; reuse of waste paper; manufacturing of paper board.

7. Glass and ceramics industries: Raw materials; classification of glass; method of manufacture; some special glasses; annealing.

8. Caustic chlorine industries: Importance of caustic soda, soda ash, chlorine, bleaching powder, calcium hypo etc. in Bangladesh; method of their production; quality of the products.

9. Fuels: Coal, classification and formation of coal; effect of sulphur and ash in coal; analysis of coal; petroleum; theory of formation; classification of crude petroleum; distillation; thermal and catalytic cracking; reforming; petrochemicals (methanol and ethanol production); gaseous fuels: different types of gaseous fuels and its manufacture; bio-gas.

10. Metallurgy: Ore processing; froath floatation, calcining, roasting; pig iron (raw materials, manufacture, by-product, heat recovery); steel making (Bessemer and open-hearth process, electric furnace process); effect of impurities on steel; stainless steel.

Learning Outcomes

Upon completion of this course, the student will be able to

- describe the properties, classification, uses and the industrial manufacturing methods of textile fibre; dyes, fertilizers; sugar and starch; cement and lime; soap and detergent; pulp and paper; glass and ceramic; and caustic chlorine products.
- explain the refining process of various petroleum products and extraction of iron and steel from ores.
- discuss the ores processing of iron and steel.
- analyze various industrial products.

Suggested Readings

1. The Chemical Process Industries, R. Norris Shreve, McGraw-Hill, International Book Company.
2. Industrial Chemistry, Emil Raymond Riegel, Reinhold publishing Co.
3. Outlines of Chemical Technology, M. Gopala Rao and Marshall Sittig.
4. Industrial Chemistry, B. K. Sharma, Goel Publishing House, Meerut.
5. A Text Book of Chemical Technology, Vol.-I and Vol.-II, G. N. Pandey, Vikas publishing House Pvt. Ltd.
6. Industrial Chemistry and Chemical Technology, A. S. M. N. H. Bhuiyan, Dhaka University.
7. Industrial Chemistry, Part I and Part II, R. K. Das, Kalyani Publishers, New Delhi.
8. Industrial Chemistry, B. N. Chokraborty.
9. A Text book of Metallurgy, A. R. Bailey.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Math C252H ½ Unit, 2 Credits
Mathematical Methods 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- identify an ordinary differential equation and it's order.
- verify whether a given function is a solution of a given ordinary differential equation (as well as verify initial conditions when applicable).
- classify ordinary differential equation into linear and non-linear equation.
- solve first order linear differential equations.
- find solutions of separable differential equations.
- model radioactive decay, compound interest and mixing problem using first order equations.
- find solutions of exact equation.
- find the general solution of second order linear homogeneous equation with constant coefficient.
- compute the Laplace transform and Inverse Laplace transform.
- use the Laplace transform to compute solutions of second order Linear equations.
- find the Fourier series of periodic functions.
- find the Fourier Sine and Cosine series for functions defined on an interval.
- find solutions of the heat equation, wave equation, and the laplace equation subject to the boundary conditions.

Course Content

1. Ordinary differential equations of first order and second order: General principles, Elementary standard types, Linear equations with constant co-efficients.
2. Special functions: Beta and Gamma functions, Legendre and Bessel' functions, Laguree' and Hermite polynomial.
3. Fourier series, Fourier and Laplace transforms.
4. Partial differential equation: Wave equation, Diffusion equation, Laplace equation, Poisson equation, Schroedinger equation, Method of separation of variables, Method of Laplace and Fourier transforms.
5. Probability and statistics: Descriptive statistics, Frequency and probability, Least squares, Sample statistics.

Learning Outcomes

Upon completion of this course, the students will be able to

- a well-developed understanding of the major areas of differential equations including special function.
- an understanding of mathematical formalism as applied to Chemistry.
- apply mathematical techniques to solve numerical problem in Chemistry and Chemical Engineering.

Suggested Readings

1. A First Course in Differential Equations with Modeling Applications, Dennis G. Zill.
2. Differential Equations, Dr. B.D. Sharma.
3. Laplace Transforms, Murray R. Spiegel.
4. The Chemistry Maths Book, Erich Steiner, Oxford University Press.
5. Methods of Applied Mathematics, Titas Publications.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Phys. C261H ½ Unit, 2 Credits
Electronics and Optics 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- provide students a thorough understanding of the elementary concepts of alternating current (AC), direct current, influence of AC through resistor, capacitor and inductor
- impart basic idea of formation and characteristics of PN junction diode, transistor and different types of filter circuits
- enrich the knowledge about the fundamental properties and applications of light.

Course Content

Section-A (Electronics)

1. Alternating current and AC-circuit Analysis: The simple AC generator, Different values of sinusoidal voltage and current, Phase of an AC, Vector representation of an AC, AC through pure resistance, pure capacitance and pure inductance, Alternating current and voltage in a series L-R and in a series R-C circuit, L-R-C circuit, Resonance in an L-R-C circuit, Resonance curve, Transformer.

2. Fundamental Properties of Electronic Devices: Energy band picture of conductor, semi-conductor and insulator, Intrinsic and extrinsic semiconductor, Construction, operation and characteristics of a PN junction, Junction breakdown, Equivalent circuit of a PN junction.

3. Power Rectification and Filter circuit: Half wave rectifiers, Full wave bridge rectifiers, Capacitor filter, L-section filter, Pi-filter, Zener diode, Characteristics of a Zener diode.

4. Transistors: Basic concept of transistors, Transistor terminals and symbols, Construction and operation of transistor, Transistor as an amplifier, CB, CE, CC configuration and their characteristics, Amplification factors, Transistor biasing.

Section-B (Optics)

1. Interference: Huygens principle, Superposition of waves, Coherent source, Conditions for interference to occur, Young's experiment of interference, Analytical treatment of interference, Theory of interference fringes, Newtons's rings experiments.

2. Diffraction: Introduction, Fresnel and Fraunhofer diffraction, Diffraction at a single slit, Diffraction due to double slit, Plane diffraction grating, Dispersive and resolving power of a grating.

3. Polarization: Polarized and Unpolarized light, Polarization of light, Plane of polarization and plane of vibration, Polarization by reflection, Brewster's law, Polarization by refraction, Malus law, Plane polarization, Circular polarization, Optical activity of solution.

Learning Outcomes

Upon completion of this course the students should be able to

- know how to design electronic equipments
- understand and apply the basic concepts of the electronics and optics to enter into the field of advanced electronics and optics.

Suggested Readings

1. Basic Electronics, B. L. Theraja.
2. Principle of Electronics, V. K. Methta.
3. Fundamentals of Optics, F. A. Jenkins and H. F. White.
4. Optics, Subramanyun & Brijlal.
5. Optics, B. K. Mathur.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 215LH ½ Unit, 2 Credits
Physical Chemistry Practical II 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- impart skill on various experimental techniques.
- learn collecting experimental data
- organize and interpret collected experimental data

Course Content

Expt.1 : To determine the molar mass of a volatile substance by victor Mayer's method.

Expt.2 : To determine the equilibrium constant for the reaction $KI + I_2 \leftrightharpoons KI_3$

Expt.3 : To determine the heat of neutralisation of a strong acid and a strong base.

Expt.4 : To determine the heat of solution of a substance from solubility measurement.

Expt.5 : To determine the velocity constant for the hydrolysis of an ester, catalysed by hydrogen ions (Titrimetric method).

Expt.6 : To determine (a) the phase diagram for the phenol-water system and to find out the critical solution temperature and (b) to investigate the effect of added impurities on CST.

Expt.7 : To determine the formula of the silverammine complex.

Expt.8 : To determine the molar mass of a given liquid by steam distillation method.

Expt.9 : To determine the solubility product of $Ca(OH)_2$ in H_2O and to study the effect of added $CaCl_2$ on the solubility of $Ca(OH)_2$.

Expt.10 : To verify of the Hess's law of constant heat summation.

N.B.: Experiments may be added to or omitted from the above list if necessary.

Learning Outcomes

Upon completion of this course, the student will be able to

- determine the molecular mass by using a victor Mayer's apparatus
- calculate the equilibrium constant by titrimetric method
- determine the rate of hydrolysis of an ester by titrimetric method
- estimate the heat of solution from solubility measurement
- find out the formula of a silverammine complex by titrimetric method
- calculate the solubility product and investigate the effect of common ion
- draw a phase diagram of phenol-water system and investigate the effect of added impurities
- carry out steam distillation and
- verify the Hess's law by calorimetric method.

Suggested Readings

1. Practical Physical Chemistry, A. Findlay, Longmans, Green & Company Ltd.
2. Practical Physical Chemistry, Burns and Ruthenbury.
3. Practical Physical Chemistry, Palit, Science Book Agency, Calcutta.
4. Practical Physical Chemistry, Sharma, Vikas Publishing House Pvt. Ltd.
5. Advanced Practical Physical Chemistry, J. B. Yadav.
6. Advanced Physical Chemistry Experiments, J. N. Gurtu & Amit Gurtu.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 225LH ½ Unit, 2 credits
Inorganic Preparation and Quantitative Analysis 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- convey knowledge about the preparation of simple inorganic compounds.
- promote knowledge for the ability to determine the strength of acids or bases by titrimetric methods.
- impart knowledge on oxidation reduction titrations.
- promote knowledge for the ability to determine chloride ion by Volhard's method and determine copper by iodometric method.

Course Content

Preparation of Simple Inorganic Compounds:

i) Preparation of sodium thiosulphate
ii) Preparation of ammonium nickel(II)sulphate.
iii) Preparation of ammonium copper(II)sulphate

Quantitative Analysis

1. Neutralization Titrations:

(i) Standardization of approximately 0.1M NaOH solution against succinic acid
(ii) Standardization of approx. 0.1M HCl by titration with standard 0.1M NaOH (using both methyl orange and methyl red indicator).

2. Oxidation-Reduction Titrations:

(i) Determination of Ferrous iron by oxidation with standard $K_2Cr_2O_7$ solution;
(ii) Determination of Ferric iron with standard $K_2Cr_2O_7$ solution;
(iii) Determination of total iron with standard $K_2Cr_2O_7$ solution;
(iv) Determination of Ferrous iron by oxidation with standard $KMnO_4$ solution;
(v) Determination of ferric ions with standard $KMnO_4$ solution;
(vi) Determination of total iron with standard $KMnO_4$ solution
(vii) Determination of the potency of antacid tablets

3. Iodometric titrations: Determination of copper by iodometric titration
4. Precipitation titrations: Determination of chloride by Volhard's method

Experiments may be added or substracted depending on circumstances

Learning Outcomes

Upon completion of this course the students will be able to

- understand and apply the methods to determine acid, base strengths and different metal ions by redox titrations and iodometric titrations.

Suggested Readings

1. Vogel's Text book of Quantitative Chemical Analysis, J. Bassett, R. C. Dinney, G. H. Jeffery and J. Mendham, Longmen Scientific & Technical.
2. Practical Inorganic Chemistry, G. Pass and H. Sutcliffe, Chapman and Hall.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course Chem. 235H ½ Unit, 2 Credits
Preparative Organic Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- acquaint students with some experimental techniques
- use of required equipments
- carry out one step organic reactions
- prepare dibenzalacetone, aspirin, acetanilide, *p*-nitroacetanilide, , cyclohexanone, benzoic acid and bezylalcohol
- hydrolysis of aspirin and *p*-nitroacetanilide.

Course Content

1. Preparation of aspirin: *O*-Acetylation (esterification) of salicylic acid.
2. Preparation of acetanilide: *N*-acetylation of aniline.
3. Preparation of *p*-nitroacetanilide: Nitration (electrophilic aromatic substitution) of acetanilide.
4. Alkaline hydrolysis of aspirin.
5. Acidic hydrolysis of *p*-nitroacetanilide.
6. Preparation of dibenzalacetone(condensation reaction between benzaldehyde and acetone).
7. Oxidation of cyclohexanol to cyclohexanone.
8. Reduction of 3-nitro acetophenone with Sn/HCl.
9. Preparation of benzyl alcohol and benzoic acid from benzaldehyde (Cannizzaro reaction).

Learning Outcomes

Upon completion of this course students will be able to

- handle the simple apparatus/equipments safely.
- understand practically the preparation of compounds mentioned in the content.
- know how to work up the products.
- check the purity of the products (melting points).

Suggested Readings

1. Organic Experiments, Louis F. Fieser, Kenneth L. Williamson, D. C. Heath & Company Lexington, Massachusetts, Toronto, 4th Edition.
2. Text Book of Practical Organic Chemistry, Vogel's, 5th edition, ELBs with Longman.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 310F 1 Unit, 4 Credits
Physical Chemistry III (Selected Topics in Physical Chemistry) 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- extend student's knowledge on electric & magnetic properties of substances
- understand fundamentals of photochemical reactions and catalysis
- impart knowledge on surface chemistry, colloids and phase diagrams.

Course Content

1. Electric properties of molecules: Polar and non-polar molecules; bond moment and dipole moment; polarization, polarizability; Clausius-Mossotti equation; Debye equation; dependence of polarizability on frequency; measurement of dipole moment; application of dipole moment in elucidation of ionic character, bond angle and geometry of molecules, determination of bond length.

2. Magnetic properties of substances: Magnetic permeability and susceptibility; paramagnetic, diamagnetic and ferromagnetic substances; forces acting on a body in a magnetic field; measurement of magnetic susceptibility; theories of magnetisms; application of magnetic susceptibility measurements.

3. Photochemistry: Dark and photochemical reactions; laws of photochemistry; consequences of light absorption: primary and secondary processes; potential energy curves for primary photochemical processes; quantum efficiency; determination of quantum yield; factor affecting quantum efficiency, reasons for low and high quantum yield; fluorescence; phosphorescence; chemiluminescence; photochemical equilibrium; photosensitization; mechanism and kinetics of photochemical reactions, photochemical chain reactions: hydrogen-chlorine and hydrogen-bromine reactions; non-chain photochemical reactions: dissociation of hydrogen iodide, photolysis of acetaldehyde; lasers and its applications.

4. Catalysis: Types and characteristics of catalysis; theory and kinetics of homogeneous catalysis; function of a catalyst in terms of Gibbs free energy of activation; theory and kinetics of heterogeneous catalysis; effect of temperature on heterogeneous reactions; acid-base catalysis; mechanism and kinetics of acid-base catalysis.

5. Surface chemistry: Adsorption, absorption and sorption; physisorption and chemisorption; adsorption isotherms: Freundlich, Langmuir's and BET isotherms; measurement of surface area of adsorbent; heat of adsorption; Gibbs adsorption equation; surface excess; applications of adsorption; chemisorptions; surface films.

6. Colloids: Colloidal dispersions; classification of colloids; lyophilic and lyophobic colloids; preparation and properties of sols; optical properties: Tyndall effect; Brownian movement; determination of Avogadro's number; stability of sols; electrical properties: electrophoresis, electro-osmosis, streaming and sedimentation potential; origin of charge, electrical double layer, zeta potential; emulsions; gels; micelles; applications of colloids.

7. Phase diagram: Phases, components, and degrees of freedom; Phase rule; two-component systems: vapour pressure diagrams, isopleths, tie line, lever rule, temperature-composition diagrams, distillation of mixtures, azeotropes, liquid-liquid, liquid-solid phase diagrams, phase separation, critical solution temperature, partially miscible liquids, role of added salts; distillation of partially miscible liquids, liquid-solid phase diagram, eutectics, incongruent melting; three-component systems: triangular phase diagrams.

Learning Outcomes

On successful completion of this course, students should be able to

- describe permanent dipoles and induced dipoles, measure dipole moments and apply dipole moments in elucidation of molecular geometry
- identify paramagnetic, diamagnetic and ferromagnetic substances, measure magnetic susceptibility and apply the data for useful purposes
- describe the photochemical laws, primary and secondary photochemical processes, determine quantum yield and interpret the data, describe photochemical chain and non-chain reactions
- discuss the theory of homogeneous and heterogeneous catalysis, acid-base catalysis
- classify colloids, explain optical and electrical properties of colloids, emulsions, gels and micelles
- explain two component and there component phase diagrams.

Suggested Readings

1. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co.
2. Advanced Physical Chemistry, J. N. Gurti and H. Snehi, Pragati Prakashan, Meerut, India.
3. Principles of Physical Chemistry, S. H. Maron and C. F. Prutton, Oxford & IBH Publishing Co.
4. Advanced Physical Chemistry, Gurdeep Raj, GOEL Publishing House, Meerut, India.
5. Elements of Physical Chemistry, S. Glasstone and D. Lewis, Macmillan Education.
6. Advanced Physical Chemistry, D. N. Bajpai, S. Chand Co. Ltd, New Delhi, India.
7. Physical Chemistry, G. M. Barrow, McGraw-Hill Book Company.
8. Physical Chemistry, Daniels and Alberty, John Wiley & Sons, Inc, New York.
9. Modern Photochemistry, N. J. Turro.
10. Surface Chemistry, Reigel, Arft & Jacob.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 312H ½ Unit, 2 Credits
Molecular Motion and Reaction Kinetics 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- promote student knowledge in molecular motion, diffusion thermodynamics, empirical chemical kinetics and rate laws
- study experimental techniques for kinetic measurements
- learn kinetics of complex reactions and molecular reaction dynamics.

Course Content

1. Molecules in motion: (a) Molecular motion of gases: kinetic model of gases; collisions with walls and surfaces; rate of effusion; transport properties of a perfect gas; (b) Molecular and ionic motion in liquids: conductivities of electrolyte solution; mobilities of ions; transport numbers; conductivities and ion-ion interactions; (c) Diffusion: thermodynamic view; diffusion equation; diffusion probabilities.

2. Empirical chemical kinetics: rates of reactions, rate laws and rate constants, reaction order and molecularity, integrated rate laws, zero, first, second and third order reactions with examples, pseudo unimolecular reactions, half-lives, methods of determination of order of a reaction, reaction approaching equilibrium, temperature dependence of reaction rates, Arhenius equation.

3. Accounting for the rate laws: elementary reactions, consecutive elementary reactions; variation of concentration with time, rate-determining step, steady-state approximation, kinetic isotope effect;

unimolecular reactions: Lindemann – Hinshelwood mechanism, activation energy of composite reactions, experimental techniques: classical techniques, discharge flow, resonance fluorescence, laser induced fluorescence, liquid and stopped-flow systems, flash photolysis, shock tubes, relative rate determination.

4. Kinetics of complex reactions: Chain reaction and rate laws of chain reactions, explosions; homogeneous catalysis: features of homogeneous catalysis, enzymes, Michaelis-Menten mechanism, catalytic efficiency of enzymes, mechanism of enzyme inhibition; autocatalysis, autocatalytic mechanisms of oscillating reactions.

5. Molecular reaction dynamics: Collision theory, diffusion-controlled reactions, activated complex theory: Eyring equation, thermodynamic aspects; kinetic salt effect; dynamics of molecular collisions: reactive collisions, potential energy surfaces.

Learning Outcomes

Upon completion of this course, the student should be able to

- understand the kinetic model of gases, rate of effusion, transport properties of a perfect gas, conductivity, mobility and transport numbers of ions, diffusion equation and diffusion probabilities
- achieve knowledge in rate of reactions, rate laws and rate constants, reaction orders and molecularities, methods for the determination of order of a reaction, effects of temperature on reaction rate and Arhenius equation
- understand rate laws for elementary and consecutive elementary reactions, rate- determining step, steady-state approximation, Lindemann-Hinshelwood mechanism, activation energy for composite reactions
- explain various experimental techniques for kinetic measurements such as discharge flow, resonance fluorescence, laser induced fluorescence, stopped-flow system and flash photolysis
- realize chain reaction and its rate laws, explosions, homogeneous catalysis and its applications, enzyme catalysis, Michaelis-Menten mechanism, catalytic efficiency and inhibition mechanisms of enzymes, autocatalytic mechanisms of oscillating reactions
- understand molecular reaction dynamics, collision theory, diffusion-controlled reactions, activated complex theory, Eyring equation and its thermodynamic aspects, dynamics of molecular collisions, reactive collisions and potential energy of surfaces.

Suggested Readings

1. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co., 6^{th} ed.
2. Reaction Kinetics, M. J. Pilling and P. W. Seakins Oxford Science Publications.
3. Chemical Kinetics, K. J. Laidler, McGraw-Hill, New Delhi.
4. Physical Chemistry, N. Levine, McGraw-Hill.
5. Principles of Physical Chemistry; M. M. Huque and M. A. Nawab, Student publications.
6. Elements of Physical Chemistry, S. Glassstone D. Kews, Macmillan & Co. Ltd.
7. Fundamentals of Physical Chemistry, S. H. Maron, J. B. Lando, Macmillan Publishing Co.
8. Physical Chemistry, G. M. Barrow, McGraw-Hill.
9. Physical Chemistry, W. J. Moore, Longmans.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 320F 1 Unit, 4 Credits
Inorganic Chemistry III (Advanced Concepts) 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course is to

- convey knowledge on quantum mechanical interpretation of atomic structure and chemical bonding based on Schrödinger wave equation.
- provide knowledge about valence bond and molecular orbital theories of covalent bonding in the light of wave equation.
- promote knowledge about Pauling's valence bond, Crystal field and molecular orbital theories of coordination compounds.
- impart knowledge on structural, thermodynamic and magnetic properties of coordination compounds.
- convey knowledge on the inorganic reaction mechanism of coordination complexes and redox reactions.
- impart knowledge on magnetic properties of molecules and different techniques on the measurement of magnetic susceptibility.

Course Content

1. Quantum mechanical approach of atomic structure: Nature of wave motion, the Schrödinger wave equation, interpretation of the wave function, solution of the wave equation, Schrödinger equation for hydrogen like atom, separation of variables, the radial and angular functions and probability functions, representation of symmetry orbitals.

2. Detailed study of the covalent bond theories: (a) The nature of the co-valent bonding: wave mechanical principle, valence bond theory (VBT) of hydrogen molecule, hybridization, VBT description using hybrid orbitals, resonance. (b) Molecular orbital theory (MOT) of homo- and hetero-diatomic molecules, HOMO and LUMO, molecular orbitals of polyatomic molecules with σ- and π-bonding, the ligand group orbital approach, comparison of VBT and MOT.

3. The chemistry of transition metals and co-ordination compounds: (a) The transition elements: Electronic configuration, special properties. (b) Elements of coordination Chemistry: Nomenclature for coordination compounds, Werner's theory, electronic interpretation of co-ordination compounds, Pauling's valence bond theory, isomerism stereochemistry of 4-and 6-coordination complexes, the chelate complexes and examples of chelates, Stabilization of unusual oxidation states by complexation Applications of coordination compounds.

4. Advanced treatment of bonding in co-ordination compounds: The crystal field theory and the ligand field theory for octahedral and tetrahedral complexes, tetragonally distorted octahedral complexes and square planer complexes, molecular orbital theory: metal ligand σ-bonding and effect of π-bonding, ligand field stabilization energy, consequence of ligand field splitting: magnetic properties, electronic properties, spectrochemical series, structural and thermodynamic effects of ligand field splitting, the Jahn Teller effect.

5. Reaction mechanism of d-block complexes: (a) Ligand substitution reactions. Substitution in square-planar complexes, the *trans* effect, substitution in octahedral complexes, (b) redox reactions, (c) photochemical reactions.

6. Origin of Magnetism, Ferromagnetism, Ferrimagnetism, Anti-ferromagnetism, Diamagnetism, Pascle's correction, Curie's Law, Curie-Weiss law. Molecular Magnetism, Spin angular moment, Orbital Angular moment, Bohr Magneton, Spin-orbital coupling, Calculation of room temperature magnetic moment, variable temperature magnetic moment, SQUID, spin only magnetic moment,

Van vleck's equation for magnetic susceptibility, intra- and intermolecular ferromagnetism, super exchange, variation of susceptibility with temperature, mathematical formulation for spin exchange in binuclear complexes.

Learning Outcomes

Upon completion of this course the students will be able to

- understand and apply the concepts of bonding theories (e.g. valence bond and molecular orbital theories) and to use these concepts in problem solving matters.
- explain the structural features of coordination compounds.
- apply CFT (crystal field theory) to octahedral, tetrahedral and square planar complexes to explain the electronic, thermodynamic and magnetic properties of complex compounds.
- understand the mechanism of ligand substitution reactions of square planar and octahedral complexes.
- understand the magnetic properties of the molecules.

Suggested Readings

1. Basic Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley & Sons, Inc. New York, USA.
2. Inorganic Chemistry-Principles of Structure and Reactivity, James E. Huhee, E. A. Keiter & R. L. Keiter, 4th Ed., Pearson education.
3. Theoretical Inorganic Chemistry, M. C. Day Jr. and J. Selbin, East-west Press, New Delhi.
4. Atomic structure & Chemical bond including Molecular Spectroscopy, Manas Chanda, Tata McGraw-Hill Publishing Company Ltd.
5. Inorganic Chemistry, 3rd Ed., C. E. Housecroft and A. G. Sharpe, Pearson, USA.
6. Inorganic Chemistry, 3rd Ed., G. L. Miessler and D. A. Tarr, Pearson, India.
7. Inorganic Chemistry, D. F. Shriver and P. W. Atkin, Oxford University Press, UK.
8. Molecular Magnetism, Olivier Kahn, VCH Publishers, NY, USA.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 322H $^1/_2$ Unit, 2 Credits
Inorganic Chemistry IV (Selected Topics) 35 + 10 + 05 = 50 Marks

Learning objectives

The learning objectives of this course are to

- impart knowledge on some aspects of inorganic chemistry, bonding in metals and alloys, non-aqueous solvent system, electron deficient and nonstoichiometric compounds, the polymer chemistry of carbon silicon, boron, phosphorus and nitrogen.
- promote knowledge on bioinorganic chemistry, Lanthanides and actinide chemistry.

Course Content

1. Bonding in metals and alloys: The theory of metals, valence bond approach, the band theory of metals, metallic properties, solid solutions, supper structure and intermetallic compounds.

2. Non-aqueous solvent system: Classification of solvents, properties of ionizing solvents, solubility criteria in ionizing solvents, acid base phenomenon in non-aqueous system. Studies of some typical non-aqueous ionizing solvents such as liquid ammonia, liquid sulphur dioxide, liquid hydrogen sulphide and anhydrous sulphuric acid.

3. Electron deficient and nonstoichiometric compounds: (a) Boron hydrides and their derivatives, properties and studies of their bonding and structures; the borohydrides, (b) Metal carbides; classification, structure, formation and uses.

4. Inorganic polymers: Chain and network polymers, Silicon polymers; Boron nitrogen polymers; Sulphur-Nitrogen polymers; Phosphonitrillic compounds; Fluorocarbons: preparation, structure and uses; Chemistry of fullerenes.

5. Bioinorganic Chemistry: Metalloporphyrins: Chlorophyll, Cytochrome, Hemoglobin and Myoglobin, Vitamin B and B_{12} coenzymes; Iron-sulphur proteins. Nitrogen fixation.

6. Lanthanoids and Actinoids: Occurrence, electronic configuration, position in periodic table, general chemistry, separation techniques, Lanthanide compounds as NMR shift reagents; Actinides: Occurrence, Electronic configurations, oxidation states, General Chemistry, organometallic chemistry of actinides.

Learning Outcomes

Upon completion of this course the students will be able to

- describe selected topics of inorganic chemistry as well as some basic idea about NMR shift reagent.
- understand the bonding and properties of metals.
- know the nature and properties of non-aqueous solvents and bonding in electron deficient compounds
- explain inorganic polymers and the role of metals in living systems.
- study metal containing Biomolecules and their structures.

Suggested Readings

1. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P. Gauss, Wiley, John Wiley & Sons.
2. Chemistry of the Elements, N. N. Greenwood & A. Earnshaw, Butterworth-Heinemann publishing.
3. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Willey & Sons, Inc. New Delhi.
4. Inorganic Chemistry-Principles of Structure and Reactivity, James E. Huhee, E. A. Keiter & R. L. Keiter, 4^{th} Ed., Pearson education.
5. Non-aqueous solvents (Study in Modern Chemistry), T. C. Waddington, Thomas Nelson & Sons. Ltd.
6. An Introduction to Inorganic Chemistry, K. F. Purcell & J. C. Kotz, Saunders College Publishing.
7. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, Oxford University press, UK.
8. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard, J. s. Valentine, University Science Books, CA, USA.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 324H $^1/_2$ Unit, 2 Credits
Molecular Symmetry and Group Theory 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- give the students the idea about the symmetry elements and operations
- to know the applications of symmetry in chemical bonding.
- to know the application of symmetry in vibrational spectroscopy.

Course Content

1. Symmetry elements and operations: Definition of the five symmetry elements (identity, proper rotation axis of order n, plane of symmetry, inversion center and improper axis of order n) and associated symmetry operations.
2. Point Groups: Point group symbol, Systematic classification of molecules into point groups, complete set of symmetry operations of a molecule constitutes a group.

3. Non-degenerate representations: Forming a non-degenerate representation to describe the effect of the symmetry operations of a group on a direction such as x, Reducing a reducible representation to its component irreducible representations.

4. Matrices: Combining two matrices, Setting up a matrix to perform a given transformation, Finding the character of a matrix representing a symmetry operation using any given basis.

5. Degenerate representations: Finding the characters of a set of representations generated by using a set of degenerate vectors as a basis.

6. Applications to chemical bonding: Finding sets of hybrid orbitals with given directional properties, Determining orbitals suitable for π-bonding in a molecule, Finding the symmetries of LCAO molecular orbitals, Constructing simple MO correlation diagrams.

7. Applications to molecular vibration: Finding the symmetry species of the normal modes of vibration of a molecule of a given symmetry, Finding the number of infrared and Raman active vibrations in a molecule, Finding the number of active vibrations in a characteristic region of the infrared or Raman spectrum of a molecule

8. Linear combinations: Finding the combinations of bond stretching vibrations which form the bond stretching vibrational modes of a molecule, Finding the symmetry adapted linear combinations of orbitals suitable for combining with the atomic orbitals of a central atom to form molecular orbitals, finding the form of the wave functions of hybrid orbitals, Normalizing any of the above functions, Confirming the orthogonality of normalized functions

Learning Outcomes

Upon completion of this course, the students will be able to

- understand the symmetry elements, operation and point group of simple molecules.
- understand the applications of symmetry in chemical bonding and vibrational spectroscopy.

Suggested Readings

1. Molecular Symmetry and Group Theory, Alan Vincent, John Wiley & Sons Ltd.
2. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P. Gauss, Wiley, John Wiley & Sons.
3. Concepts and Models of Inorganic Chemistry, B. E. Douglas, D.H. McDaniel, J. J. Alexander, 3rd ed, John Wiley and Sons, Ltd. NY, USA.
4. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, Oxford University Press.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 330F 1 Unit, 4 Credits
Organic Chemistry III (Advanced Organic Chemistry) 70 + 20 + 10 = 100 Marks

Learning Objectives

Learning objectives of this course are to

- impart knowledge on analysis of IR, MS, UV, and NMR spectral data to elucidate structures of simple organic compounds.
- provide in-depth knowledge of the cis-trans isomerism and their interconversion, conformational analysis, relative and absolute configuration and their application.
- understand the role of identification of products and intermediates in the elucidation of reaction mechanisms.
- lay a rock-solid foundation in understanding of all major types of organic reaction mechanisms viz., substitution, elimination, addition.

Course Content

1. Spectroscopy in analysis of organic compounds: A brief introduction and applications of IR, UV, NMR and Mass spectrometry in structural elucidation of simple organic compounds.

2. Stereochemistry: *cis-trans* isomerism in C=C & C=N, cycloalkane; interconversion of *cis-trans* isomers, physical properties; Determination of configuration by chemical and physical methods; conformation of acyclic molecules; physical and spectral properties of diastereoisomers and conformers, conformation and reactivity.

Configuration: relative and absolute configuration, notation: R/S, D/L configuration determination; chemical interconversion, chemical correlation methods.

3. Organic Reaction Mechanisms: Classes of reaction mechanism; methods for determining reaction mechanisms: Isolation of Products, Trapping and detection of Intermediates, Isotope tracing, Kinetics and stereochemical evidence.

4. Broad concept of the mechanism of the following classes of organic reactions:
(a) Nucleophilic substitution reactions in aliphatic system: S_N1 and S_N2, S_Ni reactions-kinetics, Effect of solvent, Effect of structure, Effect of attacking reagents and leaving groups, stereochemistry, neighboring group participation, steric effect; allylic rearrangement. Aromatic Nucleophilic substitution reactions;
(b) Elimination reactions: E1, E2 and E1cB mechanisms; orientation in elimination reactions; competition between elimination and substitution; intramolecular (cis) elimination;
(c) Addition Reactions: Addition to carbon-carbon multiple bonds: addition of halogens; addition of hydrogen halides; peroxide initiated addition of hydrogen bromide; hydration of olefins. Mechanism & stereochemistry of nucleophilic additions, Diel's -Alder reactions, hydroxylation-cis and trans.

5. Name Reactions: Wolf-Kishner reduction, Clemmensen reduction, Meerwein-Ponndorf-Verley reduction, Oppenauer oxidation, Baeyer-Villiger oxidation, reduction with metal hydrides, $LiAlH_4$, $NaBH_4$.

Learning Outcomes

Upon completion of this course students will be able to

- analyse IR, MS, UV, and NMR spectral data to elucidate structures of simple organic compounds.
- acquire the skills for correct conformational and configurational assignment and understand cis-trans isomerisms.

- describe the methods of determining reaction mechanism and explain the role of identification of products and intermediates in the elucidation of mechanisms.
- write a detailed mechanism with supporting evidence of substitution, elimination and addition reaction.
- propose rational and logical mechanism(s) for any organic reaction run under the conventional conditions.
- formulate reasoned opinions in the mechanistic side of organic reactions.

Suggested Readings

1. A Guide Book to Mechanism in Organic Chemistry, P. Sykes, Orient Longman Ltd.
2. Advanced Organic Chemistry, J. March, McGraw Hill.
3. Organic Chemistry, I. L. Finar, Longman, Vol. 1 and 2, ELBS, Longman.
4. Stereochemistry of Carbon Compounds, E. Eliel, McGraw Hill.
5. Organic Chemistry, Morrison & Boyd, Prentice-Hall of India Pvt. Ltd.
6. Spectroscopic Methods in Organic Chemistry, Fourth Ed. D. H. Williams & Ian Fleming, Tata McGraw-Hill Publishing Company Ltd.
7. Spectroscopy of Organic Compounds, P. S. Kalsi, Wiley Eastern Limited, India.
8. Organic Spectroscopy, W. Kemp, ELBS with Macmillan.
9. Modern NMR Spectroscopy (in Bangla) by M. Rabiul Islam and Mirza Aminul Huq, Ashrafia Boighar, Dhaka.
10. Modern Mass Spectroscopy (in Bangla) by Mirza Aminul Huq and M. Rabiul Islam, Bangla Academy, Dhaka.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 332F 1 Unit, 4 Credits
Chemistry of Natural Products 70 + 20 + 10 = 100 Marks

Learning Objectives

Learning objectives of this course are to

- acquaint the students with the fundamental ideas of natural products chemistry.
- understand extraction, isolation and structural elucidation of terpenoids, carbohydrates, α-amino acids, purines & nucleic acids, alkaloids, steroids and antibiotics.
- explain the physical properties of terpenoids, carbohydrates, α-amino acids & proteins, purines & nucleic acids, alkaloids, steroids and antibiotics.

Course Content

1. Natural products: Definition, occurrence & importance of some natural products.

2. Terpenoids: Definition, classification; essential oils, isoprene rule, isolation and purification and general methods of determining structures of terpenoids. Detailed studies of (i) acyclic monoterpenoids like myrcene, citral; (ii) monocyclic monoterpenoids like limonene; (iii) sesquiterpenoids like farnesol. Biosynthesis of monoterpenoids.

3. Carbohydrates: Definition, classification; Monosaccharides: Structure, configuration, conformation and reactions of glucose; Disaccharides: Structures and conformations of sucrose and maltose; Polysaccharides: Preliminary ideas of starch and cellulose.

4. Amino acids and proteins: Structure, classification, synthesis, physical and chemical properties of α-amino acids; analysis of α-amino acids; Peptides: Structure and synthesis; Proteins: General nature and structure (primary and secondary).

5. Purines and nucleic acids: Introduction; structure and synthesis of important derivatives of purine bases like adenine and guanine; structural elucidation of uric acid, nucleosides, nucleotides and nucleic acids; replication of DNA.

6. Alkaloids: Occurrence, classification, extraction and purification of alkaloids; general methods of determining structure; structural elucidation of ephedrine, atropine and morphine.

7. (a) Lipids: Definition, general classification, glycolipids, phospholipids, fats and oils, saponification number, iodine value; preliminary ideas of LDL and HDL.

(b) Steroids: Definition, Diels' hydrocarbon, chemistry of cholesterol: Functional group, angular methyl group and ring size determination. Preliminary ideas of steroidal glycosides: cardiotonic glycosides, saponins.

8. Antibiotics: Definition, structural elucidation of penicillins and chloramphenicol by synthetic and degradative methods.

Learning Outcomes

Upon completion of this course students will be able to

- describe the fundamentals of natural products chemistry.
- explain extraction, isolation, structural elucidation of terpenoids, carbohydrates, α-amino acids, purines & nucleic acids, alkaloids, steroids and antibiotics.
- discuss the chemistry of some important natural products like terpenoids, carbohydrates, α-amino acids & proteins, purines & nucleic acids, alkaloids, steroids and antibiotics.

Suggested Readings

1. Organic Chemistry by I. L. Finar, Longmans, Vol. 2, ELBS, Longman, Pearson.
2. Natural Product Chemistry, K. B. G. Torssell, J. Wiley and sons New York.
3. Selected Organic Synthesis, I. Fleming, J. Wiley and Sons, New York.
4. An Introduction to the Alkaloids, G. A. Wawan, Blackwell.
5. Mono & Sesqui-terpenes, P. de Mayo, Inter Science.
6. Chemistry of the Alkaloids, S. W. Pelletier, von Nostrand Renihold.
7. Natural Products Chemistry, P. S. Kalsi, Kalyani Publishers, New Delhi.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 340F 1 Unit, 4 Credits
Chemical Spectroscopy 70 + 20 + 10 = 100 Marks

Learning Objectives

Learning objectives of this course are to

- realize the interaction between electromagnetic radiation and matter
- achieve knowledge on the fundamental principles of spectroscopic techniques.
- prepare students for advanced studies involving spectroscopic analysis of organic compounds.
- attain concepts of absorption, emission and chemical shift.
- understand basics of vibrational, rotational and other types of transitions.

Course Content

1. Interaction of electromagnetic radiation with atoms and molecules: Electromagnetic radiation, quantization of energy, absorption and emission of radiation, regions of spectrum, representation of spectra, basic elements of practical spectroscopy, signal-to-noise: resolving power, line width, intensity of spectral transitions, removal of line broadening.

2. Microwave Spectroscopy: Observational methods for the absorption of radiation by rotating molecules, rotation of molecules, rotational spectra; rotation of diatomic molecule, rotational spectra and bond length of diatomic molecule, rotation of polyatomic molecules, the Stark effect, techniques and instrumentation, microwave oven.

3. Vibrational Spectroscopy: Vibrating diatomic molecule, diatomic vibrating rotator; vibration-rotation spectrum of carbon monoxide, breakdown of the Born-Oppenheimer approximation: interaction of rotations and vibrations; vibrations of polyatomic molecules.

4. Raman Spectroscopy: Quantum theory of Raman effect, classical theory of Raman effect, pure rotational Raman spectra; vibrational Raman spectra; structure determination from Raman and infrared spectroscopy, techniques and instrumentation.

5. Electronic Spectroscopy of Atoms: Hydrogen atom spectrum, electronic angular momentum, fine structure of hydrogen atom spectrum; Many-electron atoms: spectrum of Lithium and other hydrogen-like species; Angular momentum of many-electron atoms, term symbols, spectrum of Helium and alkaline earths; atomic absorption spectroscopy.

6. Electronic spectroscopy of molecules: Electronic spectra of diatomic molecules; vibration coarse structure, Frank-Condon principle; dissociation energy and dissociation products; rotational fine structure of electronic – vibration transition, electronic angular momentum in diatomic molecules, spectrum of hydrogen molecule, chemical analysis by electronic spectroscopy; re-emission of energy by excited molecules: fluorescence and phosphorescence; circular dichroism (CD) spectroscopy.

7. Spin Resonance Spectroscopy: Spin and an applied magnetic field, interaction between spin and magnetic field, population of energy levels, lamor precession, relaxation times, sampling and instrumentation, ^{1}H nuclear magnetic resonance spectroscopy; chemical shift and factors affecting chemical shift, chemical analysis by NMR techniques, electron spin resonance spectroscopy: introduction, the position of ESR absorptions, the fine structure of ESR absorptions, hyperfine structure, double resonance in ESR, techniques of ESR spectroscopy; Mössbauer spectroscopy: instruction; techniques and applications.

Learning Outcomes

Upon completion of the course, students should be able to

- know absorption and emission of radiation, region of spectrum and quantization of energy
- calculate bond length of diatomic molecule, rotational constant (B), ratio of population in different energy states and resonance frequency
- understand the interaction of radiation with atoms/ molecules and between spin and magnetic field
- identify the molecules which will show microwave rotational spectrum, IR, NMR, ESR, CD and Mössbauer spectroscopy
- describe the allowed selection rule and transition between vibrational, rotational, electronic energy levels for atom/molecules
- state and explain different rules/ principles regarding Chemical Spectrocopy
- apply microwave, IR, Raman, electronic and spin resonance spectroscopy for chemical analysis

Suggested Readings

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. Mccash, Tata McGraw-Hill.
2. Introduction to Molecular Spectroscopy, G. M. Barrow.
3. Modern Spectroscopy, J. Michael Hollas, Willey.
4. Spectroscopy (Atomic and Molecular), G. Chatwal & Shan Anand.
5. Molecular Spectroscopy, P. S. Sindhu, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

6. Introduction to Spectroscopy, F. P. Larkins.
7. Basic Principles of Spectroscopy, R. Chang.
8. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman, G. S. Kriz
9. Physical Chemistry, P. W. Atkins.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 350H ` $^1/_2$ Unit, 2 Credits
Fundamentals of Pharmaceutical Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- introduce students to general pharmaceutical process used for manufacturing drugs.
- understand function of drugs, their classifications, synthesis, routes of administration and interaction in biosystem.
- describe the formulation of pharmaceutical products and advantages/disadvantages associated with the process.
- analyze drugs using different chemical, chromatographic and spectroscopic methods.
- introduce with the regulatory body and their principles.

Course Content

1. Introduction: Pharmaceutical raw materials, Classification of raw materials (API & excipients), Pharmaceutical preformulation, Stability studies, Pharmaceutical testing, Pharmacopoeias: basic concept, objectives & monograph.

2. Pharmacology: Definition and groups of drugs, Classification of drugs, Source of drugs, Routes of administration, Pharmacodynamics: principle and mechanism of drug action, Pharmacokinetics: definition and brief idea about factors in pharmacokinetics (absorption, distribution, metabolism and excretion), Prodrugs.

3. Pharmaceutics: (a) Tablets: Definition, Component of tablets, Formulation of different type of tablets, Granulation technology, Tablet manufacturing process, Tablet defects, Coating, Evaluation of tablets; (b) Capsules: Definition, Types of capsules, Advantage and disadvantage, Materials for production of hard gelatin capsules and method of capsule filling, Soft gelatin capsule manufacturing process, Evaluation of capsules; (c) Ophthalmic preparation: Requirements, Formulation, Types of ophthalmic preparation, Containers.

4. Chemotherapy of microbial diseases: (a) Sulfonamides, trimethoprim-sulphamethoxazole: synthesis, mode of action, SAR; (b) Penicillin and cephalosporin: mode of action and SAR; (c) Drugs used in tuberculosis and leprosy: basic concept; (d) Antifungal agents: synthesis and mode of action (amphotericin b, fluconazole); (e) Chemotherapy of neoplastic diseases: general consideration, classification, side effects.

5. Pharmaceutical analysis: (a) Significance of quantitative analysis in pharmaceutical quality assurance, Quality assurance and quality control, Theory and basic concepts of cGMP, ISO 9000, ISO 9001 and TQM, Pharmaceutical procurement; (b) Titrimetric analysis: Acid-base titration, Oxidation-reduction titration, Iodimetry and iodometry - application in pharmaceutical analysis; (c) Non-aqueous titration: principle and application (assay of methyldopa); (d) Instrumental analysis: UV, IR, HPLC: application in drug analysis (paracetamol, vitamin C, ciprofloxacin); (e) Microbiological assay: principle and application (specific examples).

Learning Outcomes

Upon completion of this course students will be able to

- acquire preliminary knowledge about the pharmaceutical process.

- realize the functions & way of drugs synthesis and the effects on living systems.
- formulate pharmaceutical products considering advantages and disadvantages associated with the process.
- analyze drugs by physical and chemical methods using modern instruments.
- learn how to proceed in pharmaceutical regulations.

Suggested Readings

1. The Theory and Practice of Industrial Pharmacy, L. Lachman, 3rd Indian edition, Varghese Publishing House, Bombay.
2. Basic and Clinical Pharmacology, B. G. Katzsung, 9th edition, Mcgraw Hill, N.Y.
3. Vogel's Quantitative Chemical Analysis, 6th edition, Prentice Hall.
4. Burger's Medicinal Chemistry & Drug Discovery, ed. Donald J. Abraham, John Wiley & Sons. Inc.
5. Foye's Principles of Medicinal Chemistry, David A. Williams and Thomas L. Lemke, Lippincott Williams & Wilkins.
6. Pharmaceutical Drug Analysis, 3rd edition, Ashutosh Kar, New Age International Pvt. Ltd.
7. General Principles of Pharmacology, 5th edition, Mir Mesbahuddin and Md. Rabiul Islam, Bengal Library, Dhaka.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 315LF 1 Unit, 4 Credits
Physical Chemistry Practical III 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- learn principle of different physico-chemical techniques and collect experimental data
- organize collected experimental data
- impart skill on various experimental techniques
- analyze and interpret experimentally collected data.

Course Content

Expt. 1 : To determine the molecular weight of a solute by ebullioscopic method.
Expt. 2 : Study of the adsorption of acetic acid on charcoal and examine the validity of Freundlich's adsorption isotherm and Langmuirs adsorption isotherm.
Expt. 3 : To study the liquid-liquid miscibility of three liquid system and to determine the position of one tie line.
Expt. 4 : Phase diagram for two component system: The pure components only crystallize from the solution.
Expt. 5 : To draw the phase diagram for two-component system with continuous solid solution formation.
Expt. 6 : To determine the partial molal volume of solutions (Alcohol-Water system).
Expt. 7 : To find (a) the specific rotation of sucrose (b) concentration of an unknown sucrose solution (c) Intrinsic rotation (d) Influence of solvent on the rotation of sucrose solution by polarimetric method.
Expt. 8 : To determine the percentage of d-sucrose and d-tartaric acid in a given solutions polarimetrically.
Expt. 9 : To determine the specific reaction rate of the inversion of sucrose in presence of an acid by polarimetric method.
Expt.10 : To determine (a) the absorption curve of coloured substances in solution, (b) the validity of Beer-Lambert law, and (c) the strength of an unknown solution.

Expt.11 : To determine the concentration of potassium dichromate and potassium permanganate solution in a mixture by spectrophotometric method.
Expt.12 : To determine (a) the cell constant of a conductance cell, (b) the solubility of a sparingly soluble salt, and (c) the effect of salt on the solubility by conductometric method.
Expt.13 : To determine the specific reaction rate of base catalysed hydrolysis of an ester by conductometric method.
Expt.14 : To find out the equivalent conductance at infinite dilution and the dissociation constant of a weak electrolyte.
Expt.15 : Conductometric titration of (a) strong and (b) weak acids and to draw their neutralisation curves.
Expt.16 : Potentiometric titration of (a) strong and (b) weak acids and to draw their neutralisation curves.
Expt.17 : To determine the Fe^{2+} ion concentration in a given solution by potentiometric titration and to determine the value of $E^{o}_{Fe^{2+}/Fe^{3+}}$
Expt.18 : To determine the standard electrode potential of zinc and copper.

N.B.: Experiments may be added to or omitted from the above list if necessary.

Learning Outcomes

Upon completion of this course, the student will be able to
- determine the molecular weight of a solid using cryoscopic method
- determine the partial molar volume of ethanol
- determine the specific rotation of sucrose, reaction rate of the hydrolysis of an ester by NaOH and $E^{\circ}_{Fe2+/Fe3+}$
- estimate the concentration of $K_2Cr_2O_7$ and $KMnO_4$ in a solution mixture by spectrophotometric method
- verify the validity of Beer's law and determine the strength of an unknown solution spectrophotometrically
- calculate the solubility of a sparingly soluble salt conductometrically
- draw a phase diagram of partially miscible three component system and neutralization curves for conductometric titration of acid against base.

Suggested Readings

1. Advanced Physical Chemistry Experiments, J. N. Gurtu & Amit Gurtu
2. Practical Physical Chemistry, A. Findlay, Longmans, Green & Co. Ltd.
3. Practical Physical Chemistry, Palit, Science Book Agency.
4. Practical Physical Chemistry, Sharma, Vikas Publishing House, Calcutta.
5. Advanced Practical Physical Chemistry, J. B. Yadav.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 335LF 1 Unit, 4 Credits
Identification of Organic Compounds by 70 + 20 + 10 = 100 Marks
Chemical and Spectroscopic Methods

Learning Objectives

Learning objectives of this course are to
- identify organic compounds by physical and chemical methods.
- analyze spectral data to identify organic compounds using spectroscopic methods.

Course Content

1. Physical appearance
2. Elemental analysis
3. Solubility Test
4. Functional group analysis by chemical and spectroscopic (IR, ^{1}HNMR) methods
5. Preparation of derivatives
6. Literature survey
7. Determination of Physical Constants (m.p, b.p. & mixed m.p determination).
8. Naming of the identified compounds and elucidating their structures by chemical as well as by spectroscopic methods.

Learning Outcomes

Upon completion of this course students will be able to

- find the elements in organic compounds
- determine the functional groups.
- analyze spectral data and finding from chemical and physical observation to elucidate structure of organic compounds.

Suggested Readings

1. Hand book of Organic Analysis, Qualitative and Quantitative, H. T. Clarke, B. Haynes, E. C. Brick, G. C. Shone, Edward Arnold, 5th Edition.
2. Systematic Identification of Organic Compounds, R. L. Shriner, R. C. Fuson and D. Y. Curtin, John Wiley Sons, Inc. New York, London, Sydney, 5th Edition.
3. Text Book of Practical Organic Chemistry, Vogel's 5th Edition, ELBS with Longman.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 370LH ½ Unit, 2 Credits
Computing and information technology for chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- impart skill on various IT based computer programmes
- analyze and interpret data using computer software

Course Content

Students will complete Part A, Part B and Part C of the course in 1st, 2nd and 3rd years respectively.

Part A

1. a) Introduction to Windows and MS-DOS.
   b) Introduction to Microsoft Word. Writing chemistry texts involving chemical formulae, superscripts, subscripts, symbols.

Part B

2. a) Advanced word processing-Tabs, tables, use of the equation editor in chemistry.
   b) Two-dimensional chemical structure drawing using Chem-Window.
   c) Microsoft Excel/Origin-Chemical spreadsheets (use of the function wizard, formulae) and graphs in chemistry (line graphs and scatter plots).

Part C

3. a) Databases using Access.
   b) Use of PowerPoint.
   c) Molecular Structure Drawing using Chemwin 2D and 3D.
   d) Use of Internet.

During the progress of the course, use of new software will be encouraged depending on availability.

Learning Outcomes

Upon completion of this course, the student will be able to

- use MS word and MS excel, origin, chem. Draw softwares
- prepare salary sheet using excel programme
- draw chemical structures
- prepare power-point presentation
- draw figure using excel and origin softwares.

Suggested Readings

1. Microsoft Office, 97/2000, Mahbubur Rahman, Cistech publications, 38/3 Bangla Bazar, Dhaka.
2. SAMS Teach Yorself Microsoft Office 2000 in 21 days, Laurie Ulrich, Techmedia, New Delhi-2.
3. Windows 98, Bruce A. Hallberg & Joe Casad, Techmedia, 20 Ansari Road, New Delhi-2.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-21

Course No. Chem. 400H $^1/_2$ Unit, 2 Credits
Application of Spectroscopic Methods in Chemical Analysis 35 + 10 + 5 = Marks

Learning Objectives

Learning objectives of this course are to

- develop the basic ideas of the effects of different types of electromagnetic radiations on molecules.
- analyze UV-Visible, IR and NMR spectral data to elucidate the structure of compounds
- use mass spectral data and fragmentation pattern to determine the molecular weight and structure.

Course Content

1. Ultraviolet and Visible spectroscopy (UV-Vis spectroscopy): Introduction, Beer's law, Energy level and electronic transitions (n-π^*, π-π^*, n-σ^*, σ-σ^*), Modern instrumentation – design and working principle, Chromophores, Auxochromes, Conjugation, Choice of solvent and solvent effects, Effect of polarity on various type of bands, Woodward-Fieser rule for calculating λ-max of alkenes, carbonyl compounds, benzene and its derivatives, Applications of UV-Visible spectroscopy (qualitative and quantitative analysis).

2. Infrared Spectroscopy (IR) and Raman Spectroscopy: (a) IR Spectroscopy: Fundamentals of IR, FTIR theory and applications, Types of vibrations, Characteristics regions of the spectrum, The parameters determining the position and intensity of bands, Experimental technique, Characteristic absorption bands and functional groups, Influence of substituent, ring size, hydrogen bonding, conjugation and vibrational coupling on frequency. (b) Raman spectroscopy: Stokes and anti-stokes lines, theories of Raman spectra, Rotation and vibration Raman spectra, Advantages of Raman spectra & its application.

3. Nuclear Magnetic Resonance (NMR) Spectroscopy: (a) ^{1}H NMR Spectroscopy: Fundamental theory, Instrumentation, Solvents, Chemical shift and factors affecting chemical shift, Spin-spin splitting, Complex spin-spin splitting – First order, Non-first order spectra, Vicinal coupling, Coupling constant and factors influencing the value of coupling constant, Proton exchange reactions; Variable temperature spectra, Simplification of complex spectra-LSR & spin decoupling, New techniques in FT-NMR, NOE difference spectra . Introduction to 2D NMR: NOESY, COSY, HETCOR. (b) ^{13}C NMR spectroscopy: Operating frequency, ^{1}H decoupling; Off resonance decoupling, Broad band and gated-DEPT, Special pulse techniques. (c) ^{31}P NMR spectroscopy: Basic principles and applications.

4. Mass Spectrometry: Basic principles and instrumentation, ion formation and types, fragmentation processes and fragmentation pattern, Detection of the presence of the isotopes-recognition of molecular ion peak, meta-stable ions, McLaffery rearrangement, nitrogen rule, mass spectra of different classes of organic compounds.

5. Structural elucidation by combined UV, IR, NMR and Mass spectra.

Learning Outcomes

Upon completion of this course students will be able to

- interpret an IR spectrum to find the nature of bonds present in a molecule.
- use IR spectrum to identify geometric isomers and monitor chemical reactions.
- analyze the UV-Visible spectrum to find the type of chromophores and purity of drugs.
- interpret different types of NMR spectra specially ^{1}H, ^{13}C and 2D to determine the structure of a molecule.

- apply mass spectral data to find the molecular mass and structure.
- identify unknown molecules using a combination of all the spectroscopic techniques.

Suggested Readings

1. Spectroscopic methods in Organic Chemistry, Fourth Ed., D. H. Williams & Ian Fleming, Tata McGraw-Hill Publishing Company Ltd.
2. Spectroscopy, D. L. Pavia, G. M. Lampman, G. S. Kriz, Ceugage Learning India Private Ltd.
3. Spectroscopy of Organic Compounds, 6th edition, P. S. Kalsi, Wiley Eastern Limited.
4. NMR and Chemistry, J. W. Akitt, Springer.
5. Structure Elucidation, Modern NMR-H. Duddeck, W. Dietrich, Springer-Verlag New York.
6. Organic Spectroscopy, W. Kemp, ELBS with Macmillan.
7. Organic Spectroscopy, V. R. Dani, Tata McGraw-Hill Publishing Company Ltd.
8. Modern NMR Spectroscopy (in Bangla) by M. Rabiul Islam and Mirza Aminul Huq, Ashrafia Boighar, Dhaka.
9. Modern Mass Spectroscopy (in Bangla) by Mirza Aminul Huq and M. Rabiul Islam, Bangla Academy, Dhaka.
10. Spectroscopic Identification of Organic Compounds, 6th edition, Robert M. Silverstein and Francis X. Webster, John Wiley & Sons. Inc.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 410H ½ Unit, 2 Credits
Quantum Chemistry and Statistical Thermodynamics 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- introduce some of the principles and postulates of quantum mechanics
- demonstrate applications of quantum mechanics
- illustrate failure of classical mechanics
- upgrade student knowledge in development of quantum mechanics
- familiarize various approximate methods and their applications
- learn probability distribution of particles, partition function and quantum statistics.

Course Content

A: Quantum Chemistry

1. Development of quantum mechanics: Failure of classical mechanics; black body radiation; photoelectric effect; Campton effect; de-Broglie's concept of dual nature of electron; Heisenberg's uncertainly principle; Schrodinger wave equations; eigen values and eigen functions; normalization; orthogonality; operators; postulates of quantum mechanics.

2. Application of quantum mechanics: particle in a one-dimensional box; electron in a ring; particle in a three-dimensional box, simple harmonic oscillator; wave functions of the harmonic oscillator; application of Schrodinger equation to the hydrogen atom; separation of variables, significance of $\varnothing(\varphi)$, $T(\theta)$ and $R(r)$ equation, quantum numbers and total energy of an orbital, space wave functions and radial distribution curves.

3. Approximate methods: Perturbation Method, Variation Method and self consistent Field Method; Application of approximate methods for calculating energies of helium atom, hydrogen molecule ion and hydrogen molecule.

B: Statistical Thermodynamics

1. Probability distribution of particles: Probability and thermodynamic probability; probability distribution of particles in energy states; most probable distribution; derivation of Maxwell-Boltzmann distribution law.

2. Partition functions: Definition and physical significance of partition function; separation of partition functions; translational, rotational, vibrational, electronic, and total partition function; relationship between partition functions and thermodynamic functions; molar partition functions; application of partition function to monoatomic and diatomic molecules; statistical expression for equilibrium constant; equipartition of energy.

3. Quantum statistics: Maxwell-Boltzmann statistics; Bose-Einstein statistics; Fermi-Dirac statistics; electron gas in metals; specific heat of solids; Einstein and Debye theory of specific heat.

Learning Outcomes

Upon completion of this course, the student should be able to

- understand the failure of classical mechanics, black body radiation, photoelectric and Compton effects, Heisenberg's uncertainty principle, Schrodinger wave equations, eigen values and eigen functions, and postulates of quantum mechanics
- achieve knowledge in particle in a one- and three-dimensional box, wave functions of the harmonic oscillators, applications of Schrodinger wave equation, quantum numbers and total energy of an orbital
- understand various approximate methods such as, perturbation, variation and self consistent field methods, applications of various approximate methods for calculating energies of helium atom, hydrogen molecular ion and hydrogen molecule
- realize probability distribution of particles in various energy states, most probable distribution, relation between probability and thermodynamics, Maxwell-Boltzmann distribution law
- understand partition functions and its physical significances, relation between partition functions and thermodynamic functions, statistical expression for equilibrium constant
- compare and contrast Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics
- differentiate between Einstein and Debye theories of specific heat.
- analyze the values of partition function, equilibrium constant, specific heat of solids etc.

Suggested Readings

1. Theoretical Chemistry, S. Glasstones.
2. Quantum Chemistry, M. R. Awode, S. Chand & Co. Ltd., New Delhi.
3. Advanced Physical Chemistry, Gurdeep Raj, GOEL Publishing House, Meerul, India.
4. Advanced Concepts in Physical Chemistry, E. D. Kaufmann.
5. Introduction to Quantum Mechanics, L. Pauling and E. B. Wilsion.
6. Quantum Chemistry, Eyring and E. C. Kemble.
7. Introduction to Statistical Mechanics, G. S. Rushbrook.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 412H ½ Unit, 2 Credits
Solid State Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- develop and extend student's knowledge on solid state chemistry and its application
- promote student knowledge on several topics of solid state chemistry such as classification of solids, chemical crystallography and crystal structure of ionic materials
- Impart knowledge on band theory of solids, defects and non-stochiometry, thermal and electrical conductivity

Course Contents

1. Classification of Solids: Crystalline solids, amorphous solids, distinction between crystalline and amorphous solids; Molecular crystals, covalent crystals, ionic crystals, metallic crystals; Hydrogen bonding in crystals; Born-Haber cycle.

2. Chemical Crystallography: Structure of crystals: lattice and unit cell, lattice planes, crystal system, bravais lattice; Close packed systems: hexagonal and cubic close packing, tetrahedral and octahedral sites in close packed arrangements, radius ratio and coordination number; Symmetry: symmetry elements, point group, space group; polymorphism, isomorphism, allotropy; Miller indices; X-ray diffraction: powder method; single crystal X-ray diffraction, electron and neutron diffraction; Bragg`s law.

3. The crystal structure of ionic materials: Rock Salt NaCl; Niccolite/Nickel Arsenide NiAs; Zinc Blende/Sphalerite, ZnS; Wurtzite, ZnS; Caesium Chloride, CsCl; Fluorite, CcF_2; Rutile TiO_2; Cadmium Iodide, CdI_2; Cadmium Chloride, $CdCl_2$.

4. Band theory of Solids: Conductors, semiconductors and insulators.

5. Defects and non-stoichiometry: (a) Lattice defects: inherent thermodynamic defects, Schottky and Frenkel defects, equilibrium concentration of Schottky and Frenkel defects; Thermodynamic of Schottky and Frenkel defects; (b) Other imperfections: point-defects, line defects, plane defects, edge and screw dislocations, Seeback effect and Hall effect, colour centre; (c) Nonstoichiometry: Nonstoichiometry in alkali metal halides, transition metal oxides and sulphides; (d) Impurity: foreign impurity atoms or ions, doping or impurity in a semiconducting elements.

6. Thermal and Electrical conductivity: Thermal conductivity, electrical conductivity, solid electrolytes, ionic conductivity, super conductivity.

Learning Outcomes

Upon completion of the course, the students should be able to

- classify solids and crystals
- explain bonding and lattice energy of ionic crystals
- describe the principle types of solid state symmetry including point group symmetry elements, symmetry in extended, and how this relates to the crystallographic space groups
- describe the principles of atomic scale diffraction by x-rays, neutrons, and electrons and how it relates to practical aspects of crystallography**.**
- understand crystal structure of ionic materials and band theory of solids.
- identify point defects and their causes, thermodynamics of point defect formation and various dopants on defect formation.

- analyze the thermal and electrical conductivity of solid-state materials as well as the behaviour of conductor, semiconductor. super conductor etc.

Suggested Readings

1. Solid State Chemistry and its applications, Anthony West, Wiley.
2. Chemistry of Solids, A. K. Galway.
3. New Direction in Solid-State Chemistry, C.N.R Rao, J. Gopalakrishman.
4. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co.
5. Chemistry of the Defect Solid State, Methuen, London, by A. L. G. Rees.
6. The Chemistry of Imperfect Crystals, North Holland Amsterdam, by F. A. Krager.
7. Chemistry of the Solid State, W. E. Garnes, Bulterworths, London.
8. The Defect Solid State, T. I. Gray, D. E. Rose, W. G. Lawrece, R. R. Jennings, Interscience. N. Y.
9. Principles of the Solid State, H. V. Keer, Wiley Eastern Ltd.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 414H ½ Unit, 2 Credits
Polymer Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objective of this course is to

- Provide a general idea of polymeric compounds, their molecular weight distribution, properties in solution, preparation methods and mechanical properties.

Course Content

1. Polymer Structure: Definition of polymer, difference between polymers and macromolecule. Classification of polymers; degree of polymerization, nomenclature and tacticity; basic structure of polymers (linear and branched polymers; moderately cross linked polymer); molecular forces and chemical bonding in polymers.

2. Polymer solutions: Criteria for polymer solubility; size and shapes of polymers in solution; thermodynamics of polymer solution; Flory-Huggins theory, fractionation of polymers by solubility.

3. Molecular weight and size of polymers: Number average, molecular weight average, Z-average and viscosity, average molecular weight; distribution of molecular weight; determination of molecular weight by end group analysis, osmotic pressure measurement, light scattering, viscosity measurement and ultra-centrifugation.

4. Polymerization: Types of polymerization; (a) step-reaction (condensation) polymerization: mechanism and kinetics of stepwise polymerization, statistics and molecular weight control; (b) Radical chain (addition) polymerization: mechanism-initiation, propagation, termination, kinetics and thermodynamics of radical polymerization, degree of polymerization and chain transfer, ceiling temperature; (c) Ionic polymerization: Similarities and contrasts in ionic polymerization, mechanism and kinetics of cationic and anionic polymerization, living polymers.

5. Preparation with mechanism, properties and uses: Polyethylene, polystyrene, phenol-formaldehyde resins, melamine-formaldehyde resins, urea-formaldehyde resins, epoxy resins, polyester, PVC, polyamide.

6. Rheology and mechanical properties of polymers: Flow behavior of polymers: Newtonian and non-Newtonian flow; Elasticity, viscoelasticity (viscoelastic properties of polymers); The glass transition temperature (Tg); The mechanical properties of crystalline polymers: crystallinity, the crystalline melting point etc.

Learning Outcomes

Upon completion of this course, the student will be able to

- describe the definition, classification, configuration and conformation, nomenclature of polymers
- explain the molecular weight and distribution of molecular weight
- measure molecular weight by different methods
- describe the solubility, size and shape and thermodynamics of polymer solutions
- understand the different polymerization processes, kinetics and thermodynamics
- discuss the preparation, properties and uses of some important polymers
- explain the flow behaviour and mechanical properties of polymers.
- analyze values of different properties of polymers.
- develop concept for preparing new polymers.

Suggested Readings

1. Textbook of Polymer Science, Padmal L. Nayak, S. Lenka.
2. Polymer Science, V. R. Gowarker, N. V. Viswanathan and Jayadev Sreadhar.
3. Introduction to Polymer Chemistry (International Student Editions), R. B. Seymour.
4. Polymer Chemistry, M. G. Arora, M. Singh.
5. Text Book of Polymer Science (Willey), Fred W. Billmeyer.
6. Introductory Polymer Chemistry, G. S. Misra, Wiley Eastern Limited, India.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 420H ½ Unit, 2 Credits
Supramolecular Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- provide the basic concepts of supramolecular chemistry, supramolecular designing and their applications.
- impart knowledge on liquid crystals and precursors for optoelectronic materials.

Course Content

1. Basics of Supramolecular chemistry: (a) Definition and development of Supramolecular Chemistry (b) Host-Guest concept, Molecular materials to supramolecular structures (c) Molecular receptors, lock and key analogy, Chelate effect (d) Spherical recognition (e) Tetrahedral recognition by macrotricyclic cryptands, Preorganization and complimentarity, Thermodynamic and Kinetic selectivity of supramolecular motifs, Nature of supramolecular interactions.

2. Host-Guest Chemistry: Cation binding Hosts: (a) Bipyridine, synthesis, binding modes (b) Crown Ethers, synthesis, Podands, Lariat ethers, (c) Cryptands (d) Catenanes, catenands, Catenates, corands, Spherands. Ionophores, solubility property of crown ethers, Application, selectivity of for complexation by crown ethers, binding constants, role of metal ion in cyclization, High dilution synthesis, Schiff base reactions in designing macrocyclic ligands.

Anion binding Hosts: Anion receptors, Anion Host design, anion hosts to cation Host conversion with change of pH, Tetrahedral receptors, shape selectivity, Organometallic receptors, Coordination interactions.

3. Bioinorganic and bioorganic model compounds: (a) Fe and Cu type compounds (b) Selective complexation of topologically complementary organic molecules (c) cyclodextrins, Porphyrins, tetrapyrrole Macrocycles

4. Clathrate Inclusion compounds: (a) Definition of clathrates (b) Different types of clathrate hosts (c) Modern concepts for the construction of clathrate hosts.

5. Self Processes: (a) Self-Assembly (b) Self Organization (c) Self-Assembly of Double-Helical and Triple-Helical metal complexes, The Helicates, Molecular Boxes (d) Replication, Self-Replication; (e) Template synthesis, self-assembling coordination complexes, Rotaxanes.

6. Surfactants, Micelles, and Vesicles: (a) Effect of surfactants on interfaces (b) Micelles, Layers, vesicles and other ordered aggregates; Liquid crystalline materials.

7. Liquid Crystals: The thermotropic liquid crystals, Lyotropic Liquid crystals, Mesophase characterization, structural features. Metal complexes as liquid crystals: monodentate ligands, bidentate ligands, polydentate ligands.

Learning Outcomes

Upon completion of this course the students will be able to

- know the basic definitions and concepts of supramolecular chemistry.
- understand the fundamental interactions and their applications in complexation of compounds.
- explain the new trends in designing supramolecular complexes and devices.
- understand the self assembly processes.
- understand about surfactants, Micelles, Vesicles.
- understand the properties of liquid crystals and their uses in optoelectronic devices.

Suggested Readings

1. Supramolecular Chemistry, F. Vogtle, John Wiley and Sons.
2. Supramolecular Chemistry: Concepts and Perspective, J. M. Lehn, Wiley-VCH Verlag GmbH.
3. Supramolecular Chemistry, Jonathan W. Steed, Jerryl. Atwood John Wiley and Sons, Ltd, 2000, England, UK.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 422H ½ Unit, 2 Credits
Organometallic Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- impart knowledge on synthesis, structures and bonding of some main group and transition metal organometallic compounds and low-valent transition metal clusters.
- convey knowledge on bonding, structures and reactions of different classes of organometallics.
- provide knowledge on synthesis, structures and bonding of low-valent transition metal clusters.
- promote knowledge on the fundamental organometallic reactions, such as insertion, oxidative-addition, reductive-elimination, and how these key reactions operate in various important catalytic processes.

Course Content

1. General introduction: The types of organometallics most frequently encountered; Difference between main groups and transition metal organometallic compounds.

2. Main group organometallic compounds: Classification, general methods of preparation, organometallics of Groups 13(IIIA), 14(IVA) and 15(V) and their application in organic synthesis.

3. Transition metal organometallic compounds: Classification of organic ligands, the 18-electron rule and its basis, applications and exceptions.

4. Metal carbonyls, metal nitrosyls and metal phosphines: Synthesis, structures, bonding properties and reactions.

5. Synthesis, bonding, structures and properties (including fluxional behavior) of the following types of transition metal organometallic compounds: (a) Compounds with 1-electron ligands: σ-alkyl, aryl and hydride complexes, (b) Compounds with 2-electron ligands: alkene compounds, (c) Compounds with 3-electron ligands: η^3-allyl complexes, (d) Compounds with 4-electron ligands: Tricarbonyliron complexes of dienes and alkynes, (e) Compounds with 5-electron donor ligands: cyclopentadienyl complexes.

6. Metal clusters: (a) Definition of cluster compounds, (b) various types of metal cluster compounds, (c) Synthesis and structure of trimetallic dodecacarbonyls of osmium, ruthenium, iron and their reactions with molecular hydrogen, monophosphines phosphites and diphosphines and nitriles.

7. (a) Organometallic reactions and catalysis: Oxidative addition, reductive elimination and insertion reactions, (b) Ligand dissociation and substitution, nucleophilic displacement, (c) Hydride elimination and hydride abstraction, (d) Catalytic reactions of transition metal organometallics: hydroformylation reactions, homogeneous hydrogenation by Wilkinson's catalyst, olefin metathesis, Ziegler-Natta catalyzed polymerisation of ethylene and propylene, water gas shift reaction, Fischer-Tropsch synthesis.

Learning Outcomes

Upon completion of this course the students will be able to

- can recognize organometallic compounds and differentiate them from classical coordination complexes.
- understand the electron counting rules to predict the structure of various organometallic compounds.
- understand metal and ligand bonding (M-L; M = Metal, L = ligand *e.g.* CO, NO, phosphine) observed in various organometallic complexes
- can define low-valent transition metal clusters and predict their reactivity towards simple ligands such as phosphine, organonitriles etc.
- understand various types of reactions shown by organometallic compounds and clusters.
- know the catalytic mechanisms involved in various industrially important organic synthesis

Suggested Readings

1. Inorganic Chemistry, G. L. Miessler and D. A. Tarr, 5th ed., Prentice Hall.
2. Organometallics 1: Complexes with transition metal carbon σ-bonds, M. Bochmann, Oxford Science Publications, Macmillan.
3. Organometallics 2: Complexes with transition metal-carbon π-bonds, M. Bochmann, Oxford Science Publications, Macmillan.
4. The Chemistry of Metal Cluster Complexes, D. F. Shriver, H. D. Kaesz, R. D. Adams, VCH Publishers, NY, USA.
5. An Introduction to Organometallic Chemistry, A. W. Parkins and R. C. Pollar, MacMillan Publishers, London, UK.
6. Principles of Organometallic Chemistry, G. E. Coates, M. L. H. Green, P. Powell and K. Wade, Springer Publishing.
7. Organometallic Compounds, Vol. 1 & 2, G. E. Coates, M. L. H. Green and K. Wade, Methuen & Company Ltd.
8. Transition Metal Clusters, B. F. G. Johnson (ed.), John Wiley & Sons.
9. Principles of Organometallic Chemistry, P. Powell, Chapman and Hall, New York.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 424H ½ Unit, 2 Credits
Environmental Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- promote knowledge of fundamental chemical processes related to environmental problems and utilization of this knowledge for mitigation of these problems.

Course Content

1. Chemistry of the Air Environment: Composition of the atmosphere, Types of the pollutants and their sources, Environmental effects of the oxides of carbon, nitrogen, sulphur, hydrocarbons and ozone; Metallic particulates in the atmosphere; The automobiles as polluter; Acid Rain, Environmental radioactivity.

2. Green House Effect (Global Warming): Sources and sinks, Green House Potential of different gases, Sea level rise and other adverse impacts on environment, Global and Bangladesh perspective, Remedial measures to be taken for offsetting the green house effect.

3. Ozone Layer Depletion: CFCs and their role, Chemical formulae of CFCs from numbers Chemistry of ozone depletion in stratosphere, ODP, Implications of ozone depletion, Remedial measures, Montreal Treaty and other International treaties for protecting the ozone layer.

4. Chemistry of the Water Environment: Sources of water pollution, Classes of polluted water, Water quality parameters and standards. Mobilization of Arsenic in ground water, Arsenic and human health, Bangladesh scenario. Oceanic dumping, Effects of pollution on the oceans. Sewerage and its effects, Sewerage treatment.

5. Pesticides: Kinds of pesticides, Classifications, Toxicity, MLD, LD_{50} and pT, Behavior of pesticides in soil, Organochlorine compounds, Organophosphates and Carbamates, Effects of the pesticides on environment; Hazards to human life. Integrated Pest Management (IPM), Environment Friendly Insecticides and Pesticides.

6. Agricultural Environmental Chemistry: Composition of soil, acid-base and ion exchange reaction in soil, sink and pathway of nitrogen in soil, micronutrient in soil, fertilizers and its pollution, green and sustainable agriculture.

7. Waste Treatment: General understanding of wastes in Society; Wastes in various industries; Carriers of wastes - Solid, water and other liquids and Gas, General principles of waste treatment; Effluent treatment plant for Textile and Tannery.

Solid wastes: Municipal and industrial; Waste utilization; Recycling Strategy: Principles and practice; Economics of recycling.

8. Green Chemistry: Definition, Twelve principles of Green Chemistry, Green Chemistry for solving the problems for sustainable development, few examples of green reaction.

Learning Outcomes

Upon completion of this course the students will be able to

- know the chemistry of air environment, different types of pollutant and their sources.
- understand of the basic principle of the greenhouse effect, the sources and sinks of the family of greenhouse gases and there implication for climate change.
- understand the chemistry of the stratospheric ozone layer and the ozone depletion processes.
- understand the source of water pollution and measuring technique of DO, BOD, COD.

- know different types of fertilizers, insecticides and pesticides, their impact on the environment.
- know different types of wastes, the waste treatment methods, waste utilization, and waste recycling.
- understand the principles of green chemistry.

Suggested Readings

1. Environmental Chemistry, S. Manahan, Lewis Publisher.
2. Environmental Chemistry, R. W. Raiswell, Science.
3. Environmental Chemistry, Moore & Moore, Academic Press.
4. Green Chemistry, S. E. Manahan, Chem. Char Research, Inc publishers.
5. A Textbook of Environmental Chemistry, S. S. Dara.
6. Environmental Chemistry, B. K. Sharma.
7. Environmental Chemistry with green chemistry. Asim K. Das. Books and allied (p) Ltd. Kolkata, India.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course Chem. 430H ½ Unit, 2 Credits
Theoretical Organic Chemistry 35 + 10 + 5 = 50 Marks

Learning objectives

Learning objectives of this course are to

- acquaint the students with theoretical organic chemistry
- make students understand organic acids and bases
- provide quantitative explanation of reactions with reference to Hammett and Taft equation, Yukuwa-Isuno equation, uses of Hammett plots.
- lay a rock solid foundation in photochemical reaction, orbital symmetry controlled reaction, free radical and rearrangement reactions

Course Content

1. Acids and bases: Effect of structure on the strength of acids and bases; effect of solvents on the strength of acids and bases; Hammett's acidity function; Grunwald-acidity scale. Acid-base catalysis: Mechanism of acid and base catalysis, specific and general acid catalysis; specific and general base catalysis: Bronsted catalysis Law; hard and soft acids and bases.

2. Structure and reactivity: Quantitative treatment; The Hammett-equation (kinetic and thermodynamic aspects), significance of substituent constant (σ_x) and reaction constant (ρ), modification of substituent constant (σ_x, σ_x^+, σ_x^-), Yukuwa-Tsuno equation, Taft equation, solvent effect, uses of Hammett plots; spectroscopic correlations, thermodynamic implications.

3. Free radical reaction: Long lived and short lived free radicals: production and detection of free radicals; configuration of free radicals; type of free radical reactions and general characteristics; Homolysis and free radical displacements: Free radical halogenations, iodine exchange reactions, Sandmeyer reaction, additions and rearrangements of free radicals, polymerisation; Homolytic elimination and cyclizations.

4. Rearrangement reactions: Electron deficient skeletal rearrangements; mechanism and energy diagram of 1, 2-shift, non-classical carbonium ion, detection and stereochemistry of rearrangement, migration to nitrogen: Hofmann, Lossens, Curtius, Schmidt and Beckmann rearrangements; electron rich (anion) rearrangements: Stevens and Favorskii rearrangements.

5. Orbital symmetry controlled reactions: Analysis of electrocyclic, cycloaddition and sigmatropic reactions. Anionic oxy-cope reactions; Cope and Claisen rearrangements.

6. Photochemistry; Theory of photochemistry, electronic transitions, photosensitization by energy transfer, photoadditon, photoreduction, substitution reactions, fragmentation and rearrangement, photochemical reactions of conjugated aromatic and heterocyclic systems.

Learning Outcomes

Upon completion of this course students will be able to

- discuss theoretical organic chemistry
- describe different factors that influence the acidity and basicity of organic chemistry
- understand the acid-base catalysis.
- explain chemical reactivity, Hammett equation and Taft equation, Yukuwa-Isuno equation, uses of Hammett plots.
- analyze pericyclic/ non-ionic reactions.
- describe the photochemical excitation, photochemical process and different types of photochemical reactions.
- explain the definition of free radicals, generation and detection of free radicals, different types of free radical reactions.
- understand the classical and non classical carbocations and molecular rearrangements.

Suggested Readings

1. Advanced Organic Chemistry; Part A: Structure and Mechanism; Part B: Reactions and Synthesis, Francis A, Carey and Richard J. Sundberg, Plenum Press, New York and London.
2. Mechanism and Theory in Organic Chemistry, Thomas H. Lowry and Kathleen S. Richardson, Harper Collins Publishers, Inc., New York.
3. Organic Synthesis, Michael B. Smith, McGraw-Hill, Inc., New York.
4. A Guide Book to Mechanism in Organic Chemistry, P. Sykes Orient Longman Ltd.
5 Advanced Organic Chemistry, J. March, McGraw Hill, Wiley Eastern.
6. Physical Organic Chemistry, J. Hine, McGraw Hill.
7. Structure and Mechanism in Organic Chemistry, C. K. Ingold, CBS Publishers & Distributors.
8. Free Radical Chemistry, D. C. Nonhebed and J. C. Walton, C.U.P.
9. Molecular Rearrangements, P de Mayo, Inter Science.
10. Photochemistry; A visual Approach, Jan Xopecky VCH Publishers Inc. New York.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 432H ½ Unit, 2 Credits
Advanced Stereochemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- provide the fundamental concepts to the shapes of molecules, symmetry and streogenicity/ chairality, etc.
- extend the ideas to analyze the conformational properties of some important biopolymers.
- make them understand the basics of stereochemistry, physical properties of isomers and concepts of configuration and conformation.
- know assignment of (R) - and (S) - descriptions to streogenic centers in chiral molecules.
- provide in dept knowledge on conformational analyses of fused and bridged ring compounds, proteins, nucleic acid and carbohydrates.

Course Content

1. Chiral and prochiral molecules, pro-R, Pro-S, homotopic and heterotopic ligands and faces. Enantiotopic ligands (HCN addition), diastereotopic ligands and faces. enzymatic oxidation-reduction, prostereoisomerism in biochemical reactions (citric acid cycle), stereochemistry of molecule synthetase reaction.

2. Configuration and conformation of cyclic compounds; Three, four, five and six-membered ring conformational analysis and di- and poly-substituted cyclohexanes, inositols, conformation and physical properties, reactivity in cyclohexane and cyclohexanones derivatives, Winstein Eliel equation, Curtin-Hammet principle.

3. Conformational analysis of biopolymers: (a) Conformation of carbohydrates: Anomeric effect, conformation of glycosides, starch, cellulose and effect of conformation on physical properties; (b) Conformation of proteins and nucleic acids.

4. Chirality in molecules devoid of chiral centres: atropisomerism, biphenyls, allenes, cyclic allenes, molecules with planar chirality, cyclophanes, annulenes; chromatographic resolution, kinetic resolution and enzymatic resolution of racemic mixture.

5. Introduction and basic principles of optical rotatory dispersion curve, circular dichroisom, octant rule, α-haloketone rule and their application.

6. Fused rings & bridged rings: (a) Norboranes – bridged rings (b) strained carbocycles – bredt's rule (c) Fused rings: Decalins, Hydrindanes, Steroid nucleus, bridged alkaloids.

Learning Outcomes

Upon completion of this course students will be able to

- describe the principle of stereochemistry.
- interpret streochemically the pattern of reactivity on the basis of mechanistic reasoning.
- demonstrate and analyze stereochemistry of some selected organic molecules in the biological system, viz carbohydrates, protein, and nucleic acids.
- explain the conformation of fused and bridged ring compounds

Suggested Readings

1. Stereochemistry of carbon compounds, El. Eliel, John Wiley & Sons.
2. Stereochemistry-Kagan, Edward Arnold.
3. Introduction to stereochemistry-Mislow, Benjamin.
3. Stereochemistry, conformation and Mechanism, P. S. Kalsi, Wiley Eastern Ltd.
5. Organic chemistry, Morrison and Boyd, Pearson.
6. Organic Chemistry, I. L. Finar, Vol. 2, ELBS, Longman, Pearson.
7. Modern Stereochemistry (in Bangla), M R Islam, The Royal Publishers, Dhaka.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 433H ½ Unit, 2 Credit
Topics in Biochemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- expose student to the general biochemistry of enzymes, hormones and vitamins which embraces the sources, biochemical functions and the diseases associated with the deficiency of these elements.
- provide the knowledge on biochemical pathway of carbohydrates, proteins, lipids metabolism and protein biosynthesis including the related biochemical reactions.
- provide thorough idea about the digestive system for the digestion and absorption of protein, fat and carbohydrate.

Course Content

1. Biochemical aspects of Enzymes: Characterization and classification; coenzyme and prosthetic group; chemical kinetics, michaelis-menten equation, factors affecting the enzymatic reaction, brief treatment on enzymatic reaction mechanism, substrate specificity of enzymes, catalytic efficiency of enzymes, enzyme inhibition: reversible and irreversible, regulatory enzymes, allosteric enzymes, covalent modification.

2. Digestive system, digestion and absorption of protein, fat and carbohydrate.

3. Vitamins: Physiological action and sources of vitamin A.D.E.K. and Thiamine, Riboflavin, Niacin, Pantothenic acid, Folic Acid and Ascorbic acid.

4. Metabolism: (a) Carbohydrate: Glycolytic pathway: glycolysis and its regulation, feeder pathways, fate of pyruvate , TCA cycle and its regulation, oxidative phosphorylation, (b) Lipid: Beta oxidation of even, odd, saturated and unsaturated fatty acid, biosynthesis of fatty acid. (c) Protein: Transamination, deamination, decarboxylation, transport of ammonia in the blood stream, glucose-alanine cycle, urea cycle, link between TCA and urea cycle. (d) Protein biosynthesis; different types of RNA; simple treatment on protein biosynthesis, genetic code.

5. Hormones: Classification of hormones, insulin, thyroxine and glucocorticoids: Structure, biochemical aspects and deficiency.

Learning Outcomes

Upon completion of this course students will be able to

- understand structures of bio-molecules which includes fundamental building blocks, biopolymers, macromolecular conformations, membranes and supramolecular architecture.
- explain the biochemical functions, importance and diseases associated with the deficiency of these bio-molecules in biological system.
- describe the biochemical reactions that take place during the metabolism which includes kinetics and mechanisms of biological catalysis; biosynthetic pathways and strategies.

Suggested Readings

1. Biochemistry, Lehninger, Kalyani Publishers.
2. Biochemistry, Styer, W. H. Freeman & Company.
3. Out lines of Biochemistry, Cohn & Stumpt, Wiley Eastern Ltd.
4. Cell physiology, L. Howland, Collier Macmillan Ltd.
5. Harper's Biochemistry, Robert K. Murray, Daryl K. Granner, Appleton & Lange.
6. Biochemistry, U. Satyanarayana, New Central Book Agency (p) Ltd.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 434 ½ unit, 2 Credits
Organic reagents and Syntheses 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- develop a knowledge base of synthetic organic reactions.
- provide in-depth understanding of structure reactivity principles in a variety of chemical structures.
- make the students understand designing strategies of complex molecular constructions.

Course Content

1. Oxidation: Oxidations with Chromium and Manganese compounds: Oxidation of alcohols, aldehydes, and carbon-carbon double bonds, carbon-hydrogen bonds in hydrocarbons; (ii) oxidation with selenium dioxide: oxidation of aldehydes/ketones, 1,4-diketones and olefins; (iii) Oxidation with lead tetra acetate: oxidative cleavage of 1,2-diols, α-hydroxy ketones, 1,2-diketones, α-hydroxy acids; (iv) oxidation with periodic acid: oxidative cleavage of 1,2-diols, 1-amino-2-hydroxy compounds, α-hydroxy ketones and 1,2-diketones; (v) oxidation with per acids: oxidation of olefins, carbonyl compounds, amines, sulfides, and allylic C-H bonds.

2. Reduction: (i) Catalytic hydrogenation and dehydrogenation: Catalysts and solvents, Reduction of different functional groups, Heterogeneous and Homogeneous catalytic hydrogenation, Mechanism and stereochemistry of catalytic hydrogenation, Dehydrogenation reactions; (ii) Metal Hydride reductions: Nucleophilic and electrophilic reducing agents, reduction of aldehyde and ketones, The stereochemistry of ketone reductions, reduction of other functional groups; (iii) Dissolving metal reductions: reduction of carbonyl functions, and reduction of conjugated systems, reduction of disubstituted alkynes and nitro alkane.

3. Interconversion of functional groups: (a) Interconversion of functional groups-Transformation of alcohols, phenols, halogenocompounds, nitro compounds, acids and acid derivatives, (b) Protective groups: The strategy, protection of alcohols, diols, carboxylic acids, amino groups, carbonyl groups and their applications in organic synthesis.

4. Formation of carbon-carbon bonds: The principles, Enols and enolate anions, reactions of organometallic compounds, Grignard reagents, Organocopper reagents, Reformatsky reaction; Enamines, Stereoselective Enolate reactions, Michael reaction, Robinson Annelation; The use of stabilised carbanions and related nucleophiles, Formation of carbon-hetero atom bonds, Umpolung, Wittig reaction, Ylides; Heck reaction, Suzuki reaction, Stille coupling, and Sonogashira coupling.

5. Combinatorial chemistry: Introduction, Principles of combinatorial chemistry, Methods and Techniques of combinatorial synthesis, Solution-phase synthesis, Solid-phase synthesis of peptides,

6. Strategy in Synthesis: The disconnection approach to synthesis, concept of a target molecule, synthon, reagent, and synthetic equivalent; Synthesis of monofunctional and difunctional compounds: (a) One-group disconnection: Disconnection of simple alcohols-compounds derived from alcohols, disconnection of simple olefins, ketones, (b) (i) Two group disconnections: 1,3-Dioxygenated skeletons (ii) The 1,2-Dioxygenation skeletons.

Learning Outcomes

Upon completion of this course students will be able to

- predict either the product or reactant from a given structure on the basis of the knowledge obtained from the study of the reactions covered e.g. C-C, C=C and C-X bond formations and eliminations, oxidations, reductions and protecting group transformations.
- design a retrosynthetic analysis using the disconnection approach.
- convert retrosynthetic analysis to a forward multistep synthesis.

Suggested Readings:

1. Guide book to organic Synthesis, R.K. Mackie and D. M. Smith, ELBS/Longman, Great Britain.
2. Some modern methods of organic Synthesis, W. Carruthers, Cambridge University Press, UK.
3. Modern Synthetic Reactions, H. O. House, W. A. Benjamin, USA.
4. Organic Synthesis, Michael B. Smith, McGraw-Hill, Inc., New York.
5. Designing Organic Synthesis Stuart Warren, John Wiley & Sons, New York.
6. Combinatorial Chemistry: Synthesis, Analysis, Screening, Guenther Jung, Wiley-VCH, New York.
7. Advanced organic Chemistry, Reactions, Mechanisms and structure, Jerry March, John Wiley & Sons. New York.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 425LF 1 Unit, 4 Credits
Inorganic Chemistry Practical 70 + 20 + 10 = 100 Marks

Learning Objectives

The learning objectives of this course are to

- impart knowledge about the preparation of Coordination complexes.
- convey knowledge on complexomatric titrations using EDTA.
- promote knowledge on quantitative analysis of metal ions and anions using volumetric and gravimetric methods.

Course Content

Experiments may be added to or omitted from the list depending on circumstances.

1. Inorganic Synthesis

1.1 The preparation of tris(thiourea)copper(I) sulfate.
1.2 The preparation of potassium trioxalatochromate(III).
1.3 The preparation of *cis*- and *trans*- potassium dioxalatodiaquachromate(III).
1.4 The preparation of hexamminecobalt(III) chloride
1.5 The preparation of tris(acetylacetonato)manganese (III) and comparison of its IR spectra with that of ligand.
1.6 The preparation of ferrous oxalate, FeC_2O_4 and conversion to potassium trioxalateferrate(III) $K_3Fe(C_2O_4)_3.3H_2O$.
1.7 Preparations of linkage isomers chloropenta(amine)cobalt(III) chloride $[CoCl(NH_3)_5Cl_2]$, Nitropentaamminecobalt(III) chloride $[Co(NO_2)(NH_3)_5]Cl_2$ and Nitritopentaamminecobalt(III) chloride $[Co(ONO)(NH_3)_5]Cl_2$ and IR investigations.
1.8 Preparation of $K_2[Co(NCS)_4]$, $Co[Hg(SCN)_4]$ and structural investigation by IR spectroscopy.
1.9 The preparation of tris(ethylenediamine)chromium(III) sulphate.
1.10 Preparation of $[Mn_2(CO)_9MeCN]^-$ from $[Mn_2(CO)_{10}]$ and comparison of IR spectra.
1.11 Preparation of Al^{3+} and Cu^{2+} complexes with acetylacetone and comparison by IR spectra.

2. Complexometric Titrations Using EDTA.

2.1 Determination of zinc by direct titration using Eriochrome-Black T as indicator.
2.2 Determination of nickel by direct titration using murexide as indicator.
2.3 Determination of calcium by substitution titration using Eriochrome-Black T as indicator.
2.4 Determination of aluminum by back titration using Eriochrome-Black T as indicator.
2.5 Determination of total hardness of water (temporary and permanent) using Eriochrome Black - T as indicator.

3. Quantative Analysis.

3.1 Determination of lead as lead chromate.
3.2 Determination of sulfate as barium sulfate.
3.3 Determination of nickel as nickeldimethylglyoximate.

3.4 Determination of iron as Fe_2O_3.
3.5 Determination of copper as $Cu_2(CNS)_2$.
3.6 Quantitative separation and estimation of copper volumetrically and nickel gravimetrically in a mixture.
3.7 Determination of Ca^{2+} and Mg^{2+} in a mixture.
3.8 Quantitative separation and estimation of iron volumetrically and calcium gravimetrically in a mixture.

4. Charge Determinations By Ion-Exchange.

4.1 Determination of the charge of the complex ion in potassium trioxalatochromate(III) by ion-exchange method.

Learning Outcomes

Upon completion of this course, the student will be able to

- synthesize coordination compounds.
- analyze metal ions by complexometric titration.
- determine metal ions and anions volumetrically and gravimetrically.

Suggested Readings

1. Vogel's Textbook of Quantitative Chemical Analysis, G.H. Jeffery, J. Bassett, J. Mendham & R.C. Denny, Longman and ELBS.
2. Practical Inorganic Chemistry, Preparations, reactions and instrumental methods, G. Pass and H. Sutcliffe, Chapman and Hall, New York.
3. Inorganic Experiments, Ed., J.D. Woollins, VCH Verlagsgesellschaft mbh, Weinheim.

SESSION: 2017-2018, 2018-2019, 2019-2020, 2020-2021

Course No. Chem. 435LH ½ Unit, 2 Credits
Organo-Applied Chemistry Practical 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- expose students to basic concepts and techniques related to quantitative chemical analysis.
- provide experimental knowledge on assay of tablets such as vitamin C and aspirin.
- lay foundation on quantitative analysis of different types of functional groups.
- give working experience to determine saponification number of oil.

Course Content

Name of the experiments:

1. Assay of L-Ascorbic acid.
2. Assay of Vitamin C-tablets.
3. Assay of Aspirin.
4. Assay of Aspirin tablets.
5. Quantitative estimations of OH / NH_2 groups.
6. Quantitative estimations of an acid.
7. Determination of saponification number of edible oils (soybean oil, coconut oil, rice bran oil)
8. Determination of iodine value of soybean oils.

Learning Outcomes

Upon completion of this course students will be able to

- assay tablets like vitamin C, aspirin.
- demonstrate pharmaceutical and titrimetric methods for drug analysis.
- know the process how to estimate functional groups.
- determine and calculate saponification number for soybean oil.
- understand and apply various analytical techniques to chemical analysis.

Suggested Readings

1. Text Book of Practical Organic Chemistry, Vogel's, 5th edition, ELBs with Longman.
2. Laboratory Manual.