B.Sc. (Honours) Chemistry

Program Learning Outcomes in B.Sc. (Honours) Chemistry

The student graduating with the Degree B.Sc. (Honours) Chemistry, should acquire

1. **Knowledge and Understanding:**
    - The course provides the students with comprehensive understanding of the fundamental concepts of chemistry.
    - In depth knowledge of the core subjects-concept, theories, principles and its applications.
    - Knowledge about the emerging topics and current developments in Chemistry and its related field.
2. **Laboratory Skills and Techniques:**
    - The students gain good practical knowledge and laboratory skills by systematically training them.
    - Through methodical instructions the students experience hands-on training of using basic chemical laboratory instruments.
    - Basic knowledge about preparation of laboratory reagents, solutions and also protocols for their safe disposal.
    - Ability to conduct experiments, analyses of data and interpretation of the results.
3. **Communication Skills:**
    - Students develop good communication skills in writing and speaking through vigorous training of recording experiments, viva-voce and presentations.
    - Ability to listen and convey effectively the knowledge and information acquired to scientific community and society at large.
4. **Competency:**
    - Student develop the ability to think and work independently as well as adaptability to work efficiently in diverse groups.
    - A leadership qualities in student develop through its effective contributions in teamwork based projects by designing and execution of the experiments.
    - The opportunities for critical thinking, reflective thinking and analytical reasoning also add up the overall development of students.

Portable Skills:

- Students developed problem-solving skills to solve different types of chemistry-related problems.
- Attitude to be a life-long learner by consistently updating oneself with current knowledge, skills and technologies.
- Basic IT skills and ability to use relevant software's for making structures, equations and data analysis.

Course outcome in B.Sc. (Honours) Chemistry

SEMESTER I

CHEMISTRY - C I: INORGANIC CHEMISTRY - I
Atomic Structure & Chemical Bonding
Learning Outcomes:
By the end of the course, the students will be able to:

- Understand the quantum mechanical model of an atom using Schrodinger equation, the significance of wave function, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization enthalpy and electronegativity of elements.
- Suggest the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams for homo- & hetero-nuclear diatomic molecules.
- Calculate the lattice energy using Born-Landé and Kapustinskii expression.
- Differentiate between metals, semiconductors and insulators based on the Band theory.
- Gain the theoretical understanding of inter-molecular and intra-molecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.

CHEMISTRY - C II: PHYSICAL CHEMISTRY – I
States of Matter & Ionic Equilibrium
Learning Outcomes:
By the end of the course, students will be able to:

- Gain insight into the physical significance of various properties of gas, liquid and solids and also derive their mathematical expressions.
- Demonstrate understanding of the crystal structure of cubic systems using diffraction pattern.
- Explain the concept of ionization of electrolytes of weak acid and base and hydrolysis of salt.
- Understand various fundamental concepts of pH, buffer solutions, solubility of sparingly soluble salts, acid-base indicators.

SEMESTER II

CHEMISTRY – C III: ORGANIC CHEMISTRY - I
Basics and Hydrocarbons
Learning Objectives:
On completion of the course, the student will be able to:

- Develop a sound understanding of the fundamental concepts of stereochemistry.
- Learning various physical and chemical properties of alkanes, alkenes, alkynes and aromatic hydrocarbons and their general methods of preparation.

- Learn and formulate mechanisms of different organic reaction including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.

CHEMISTRY - C IV: PHYSICAL CHEMISTRY - II

Chemical Thermodynamics and its Applications

Learning Outcomes:

By the end of the course, students will be able to:

- Understand some important concepts like intensive and extensive properties, state and path functions, reversible and irreversible processes.
- Gain deeper understanding of the three laws of thermodynamics.
- Derive the expressions of w, q, ΔU, ΔH, ΔS, ΔG, ΔA for ideal gases under different conditions.
- Apply the thermodynamic concepts to evaluate enthalpy of various reactions and understand its dependence on temperature and pressure.
- Explain the concept of chemical potential and partial molar quantities.
- Derive the thermodynamic relations between the colligative properties and understand their applications in everyday life.

SEMESTER III

CHEMISTRY – C V: INORGANIC CHEMISTRY - II

s- and p-Block Elements

Learning Outcomes:

By the end of the course, the students will be able to:

- Learn the fundamental principles of metallurgy and methods of extraction and purification of metals.
- Gain knowledge of the basic and practical applications of metals and alloys in various fields and their manufacturing processes. Apply the thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals.
- Understand the periodicity in melting point, atomic and ionic radii, electron gain enthalpy, and ionization enthalpy, electronegativity of s and p block elements.
- Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides.
- Understand vital role of sodium, potassium, calcium and magnesium ions in biological systems.

CHEMISTRY – C VI: ORGANIC CHEMISTRY - II

Halogenated Hydrocarbons and Oxygen Containing Functional Groups

Learning Outcomes:

On completion of the course, the student will be able to:

- Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.

- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Propose plausible mechanisms for any relevant reaction.

CHEMISTRY – C VII: PHYSICAL CHEMISTRY – III
Phase Equilibria and Electrochemical Cells
Learning Outcomes:
By the end of the course, students will be able to:

- Have knowledge of concepts like phase, components and degree of freedom in phase equilibrium.
- Derive Phase rule, Clausius-Clapeyron equation, Gibbs-Duhem-Margules equation, Nernst Distribution law and understand their applications.
- Draw the phase diagram for one- component system (water and sulphur) and two-component system involving eutectic, congruent and incongruent melting points.
- Have better understanding of terms, azeotropes, lever rule, partial miscibility of liquids, CST.
- Differentiate between the working of electrolytic cells and galvanic cells and understand the applications of electrolysis in metallurgy and industry.
- Measure the EMF of an electrochemical cell using Nernst equation and its applications.
- Understand concentration cells with and without transference.
- Differentiate between physical adsorption and chemisorption and explain various adsorption isotherms.

SEMESTER IV

CHEMISTRY – C VIII: INORGANIC CHEMISTRY - III
Coordination Chemistry
Learning Outcomes:
By the end of the course, the students will be able to:

- Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds.
- Discuss the various types of isomerism possible in such compounds and understand the types of isomerism possible in a metal complex.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δo, Δt, pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory.
- Understand the important properties of transition metals like variable oxidation states, colour, magnetic and catalytic properties and use Latimer diagrams to predict and identify species which are reducing, oxidizing and tend to disproportionate and calculate skip step potentials.

- Understand reaction mechanisms of coordination compounds and differentiate between kinetic and thermodynamic stability.

CHEMISTRY – C IX: ORGANIC CHEMISTRY - III

Nitrogen containing functional groups, Polynuclear Hydrocarbons, Heterocyclic Chemistry, Alkaloids and Terpenes.

Learning Outcomes:

On completion of this course, the students will be able to:

- Understand thouroughly the chemistry of compounds having nitrogen containing functional groups, heterocyclic, polynuclear hydrocarbons, alkaloids and terpenes which includes various methods for synthesis through application of the synthetic organic chemistry concepts learnt so far.
- Acquainted with important properties, chemical reactions, aromaticity of polynuclear hydrocarbons and heterocyclic compounds, basicity of amines and heterocyclic compounds and their behavior at different pH
- Elucidate structure of organic compounds with specific examples of terpenes and alkaloids by practical approach.
- Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods.
- Understand the applications of these compounds including their medicinal applications through their reaction chemistry.

CHEMISTRY – C X: PHYSICAL CHEMISTRY - IV

Conductance & Chemical Kinetics

Learning Outcomes:

By the end of this course, students will be able to:

- Explain the variation of conductance with dilution for weak and strong electrolytes using Arrhenius theory and Debye Huckel Onsager theory.
- Learn the applications of conductance measurements.
- Determine transference number using Hittorf and Moving Boundary methods.
- Explain order, molecularity, rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.
- Derive differential and integrated form of rate expressions up to second order reactions.
- Have deep understanding of the laws of photochemistry and terms, quantum yield, quenching, photostationary states, chemiluminescence.

SEMESTER V

CHEMISTRY – C XI: ORGANIC CHEMISTRY - IV

Biomolecules

Learning Outcomes:

On completion of this course, the students will be able to:

- Learn the synthesis, properties and reactions of nucleic acids, amino acids and peptides.

- Demonstrate how structure of biomolecules determines their reactivity and biological functions.
- Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation.
- Understand the primary, secondary and tertiary structures of proteins and denaturation.
- Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.
- Develop a sound understanding of the structure of Pharmaceutical Compounds and understand the importance of different classes of drugs and their applications for treatment of various diseases.

CHEMISTRY – C XII: PHYSICAL CHEMISTRY - V

Quantum Chemistry & Spectroscopy

Learning Outcomes:

By the end of this course, students will be able to:

- Learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
- Develop an understanding of postulates of quantum mechanics, quantum mechanical operators, quantization, probability distribution, uncertainty principle.
- Solve quantum mechanically the various systems like a particle in a box, harmonic oscillator, rigid rotator and hydrogen atom.
- Learn approximate method (Variation Method) and its applications.
- Understand the valence bond and molecular orbital theory to solve H_2 molecule.
- Have knowledge of the applications of quantization to spectroscopy.
- Gain insight into the basic principles of rotational, vibrational, electronic, Raman, NMR, ESR spectroscopy to interpret the spectra for structure elucidation.

SEMESTER VI

CHEMISTRY – C XIII: INORGANIC CHEMISTRY - IV

Organometallic Chemistry & Bio-inorganic Chemistry

Learning Outcomes:

By the end of the course, the students will be able to:

- Gain insights into the basic principles of qualitative inorganic analysis.
- Apply 18-electron rule to account for the stability of metal carbonyls and related species.
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of the metal alkyls tetrameric methyl lithium and dimerictrialkyl aluminium and explain the concept of multicenter bonding in these compounds.
- Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and describe the active sites and action cycles of the metalloenzymes carbonic anhydrase and carboxypeptidase.

- Understand the sources and consequences of excess and deficiency of trace metals.
- Explain the use of chelating agents in medicine and, specifically, the role of cisplatin in cancer therapy.
- Understand the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin.
- Explain catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler-Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

CHEMISTRY – C XIV: ORGANIC CHEMISTRY - V

Spectroscopy and Applied Organic Chemistry

Learning Outcomes:

On completion of this course, the students will be able to:

- Learn about basic principles of UV, IR and NMR spectroscopic techniques to interpret the spectra to determine structure and stereochemistry of known and unknown compounds.
- Have better knowledge of the chemistry of natural and synthetic polymers including fabrics and rubbers.
- Learn about the chemistry of biodegradable and conducting polymers and assess the need of biodegradable polymers with emphasis on basic principles.
- Understand the theory of colour and constitution as well as the chemistry of dyeing.
- Know applications of various types of dyes including those in foods and textiles.

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