# B.Sc. (H) Chemistry

## Learning Outcome

### CHEMISTRY - C I: INORGANIC CHEMISTRY - I

**Atomic Structure & Chemical Bonding**

By the end of the course, the students will be able to: Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization energy and electron affinity of elements. Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). Understand the concept of lattice energy using Born-Landé and Kapustinskii expression. Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory. Understand the importance and application of chemical bonds, inter-molecular and intramolecular 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**

By the end of the course, students will be able to: Derive mathematical expressions for different properties of gas, liquid and solids and understand their physical significance. Explain the crystal structure and calculate related properties of cubic systems. Explain the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt. Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.

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**CHEMISTRY – CIII: ORGANIC CHEMISTRY - I**

**Basics and Hydrocarbons**

On completion of the course, the student will be able to: Understand and explain the different nature and behaviour of organic compounds based on fundamental concepts learnt. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved. Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution. Understand the fundamental concepts of stereochemistry.

**CHEMISTRY - C IV: PHYSICAL CHEMISTRY - II**

**Chemical Thermodynamics and its Applications**

By the end of the course, students will be able to: Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties. Derive the expressions of $\Delta U$, $\Delta H$, $\Delta S$, $\Delta G$, $\Delta A$ for ideal gases under different conditions. Explain the concept of partial molar properties. Explain the thermodynamic basis of colligative properties and applications in surroundings

**CHEMISTRY –GE-2**

**Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I**

By the end of this course, students will be able to: Understand the laws of thermodynamics, thermochemistry and equilibria. Understand concept of pH and its effect on the various

physical and chemical properties of the compounds. Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium. Understand the fundamentals of functional group chemistry through the study of methods of preparation, properties and chemical reactions with underlying mechanism. Use concepts learnt to understand stereochemistry of a reaction and predict the reaction outcome. Design newer synthetic routes for various organic compounds.

**CHEMISTRY - CV: INORGANIC CHEMISTRY - II**

**s- and p-Block Elements**

By the end of the course, the students will be able to: Learn the fundamental principles of metallurgy and understand the importance of recovery of byproducts during extraction. Understand the basic and practical applications in various fields of metals and alloy behavior 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 atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table. 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 and the use of caesium in devising photoelectric cells.

**CHEMISTRY - CVI: ORGANIC CHEMISTRY - II**

**Halogenated Hydrocarbons and Oxygen Containing Functional Groups**

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. To propose plausible mechanisms for any relevant reaction.

**CHEMISTRY - CVII: PHYSICAL CHEMISTRY–III**

**Phase Equilibria and Electrochemical Cells**

By the end of the course, students will be able to: Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation. Learn the working of electrochemical cells, galvanic cell, corrosion and happenings in surroundings related to electrochemistry.

**CHEMISTRY –GE-3**

**Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group**

**Organic Chemistry-II**

By the end of the course, the students will be able to: Explain the concepts of different types of binary solutions-miscible, partially miscible and immiscible along with their applications. Explain the thermodynamic aspects of equilibria between phases and draw phase diagrams of simple one component and two component systems. Explain the factors that affect conductance, migration of ions and application of conductance measurement. Understand different types of galvanic cells, their Nernst equations, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements. Understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses. Design newer synthetic routes for various organic compounds.

**CHEMISTRY –SEC-2**

**Basic Analytical Chemistry**

To handle analytical data. To determine composition and pH of soil, which can be useful in agriculture. Do quantitative analysis of metal ions in water. Separate mixtures using separation techniques. Estimate macro nutrients using Flame photometry.

**CHEMISTRY – CVIII: INORGANIC CHEMISTRY - III**

**Coordination Chemistry**

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 $\Delta o.$, $\Delta t$, 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 - CIX: ORGANIC CHEMISTRY – III**

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

On completion of this course, the students will be able to: Gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups, heterocyclics, polynuclear hydrocarbons, alkaloids and terpenes which includes various methods for synthesis through application of the synthetic organic chemistry concepts learnt so far. Become familiar with their particular properties, chemical reactions, criterion of aromaticity with reference to polynuclear hydrocarbons and heterocyclic compounds, trends in basicity of amines and heterocyclic compounds and their behaviour at different pH. Learn practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids. 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 - CX: PHYSICAL CHEMISTRY–IV**

**Conductance & Chemical Kinetics**

By end of this course, students will be able to: Explain the chemistry of conductance and its variation with dilution, migration of ions in solutions. Learn the applications of conductance measurements. Have understanding of rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic. Have knowledge of the laws of absorption of light energy by molecules and the subsequent photochemical reactions.

**CHEMISTRY –GE-4**

**Chemistry of s- and p-Block Elements, States of Matter and Chemical Kinetics**

By the end of the course, the students will be able to: Understand the chemistry and applications of s- and p-block elements. Derive ideal gas law from kinetic theory of gases and explain why the real gases deviate from ideal behaviour. Explain Maxwell-Boltzmann distribution, critical constants and viscosity of gases. Explain the properties of liquids

especially surface tension and viscosity. Explain symmetry elements, crystal structure specially NaCl, KCl and CsCl . Define rate of reactions and the factors that affect the rates of reaction. Understand the concept of rate laws e.g., order, molecularity, half-life and their determination. Learn about various theories of reaction rates and how these account for experimental observations.

**CHEMISTRY –SEC-7**

**Analytical Clinical Biochemistry**

By the end of the course, the students will be able to: Understand and establish how the structure of biomolecules determines their reactivity and biological uses. Understand the basic principles of drug-receptor interaction and structure activity relation (SAR). Gain an insight into concept of heredity through biological processes like replication, transcription and translation. Demonstrate an understanding of the biochemistry of diseases. Understand the application of chemistry in biological systems.

**CHEMISTRY - CXI: ORGANIC CHEMISTRY - IV**

**Biomolecules**

On completion of this course, the students will be able to: Understand and 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. Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.

**CHEMISTRY - CXII: PHYSICAL CHEMISTRY–V**

**Quantum Chemistry & Spectroscopy**

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 quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy. Interpret various types of spectra and know about their application in structure elucidation.

**CHEMISTRY –DSE-2**

**Inorganic Materials of Industrial Importance**

By the end of the course, the students will be able to: Learn the composition and applications of the different kinds of glass. Understand glazing of ceramics and the factors affecting their porosity. Give the composition of cement and discuss the mechanism of setting of cement. Explain the suitability of fertilizers for different kinds of crops and soil. Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings. Explain the principle, working and applications of different batteries. List and explain the properties of engineering materials for mechanical construction used in day-to-day life. Explain the synthesis and properties of nano-dimensional materials, various semiconductor and superconductor oxides.

**CHEMISTRY –DSE-8**

**Green Chemistry**

By the end of the course, the students will be able to: Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances. Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentage yield. Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"· Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, importance led reactions in various green solvents. Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus, the students are able to realise that chemistry can be used to solve rather than cause environmental problems. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real-world cases also motivate them to practice green chemistry. These days customers are demanding to know about a product: Is it green? Does it contribute to global warming? Was it made from non-depletable resources? Students have many career opportunities as " green" is the path to success.

**CHEMISTRY - CXIII: INORGANIC CHEMISTRY - IV**

**Organometallic Chemistry & Bio-inorganic Chemistry**

By the end of the course, the students will be able to: Understand and explain the basic principles of qualitative inorganic analysis. Apply 18-electron rule to rationalize 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 dimeric trialkyl aluminium and explain the concept of multicentre bonding in these compounds. Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and understand and describe the active sites and action cycles of the metalloenzymes carbonic anhydrase and carboxypeptidase. Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity and antidotes. Explain the use of chelating agents in medicine and, specifically, the role of cisplatin in cancer therapy and explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin. Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

**CHEMISTRY - CXIV: ORGANIC CHEMISTRY - V**

**Spectroscopy and Applied Organic Chemistry**

On completion of this course, the students will be able to: Gain insight into the basic principles of UV, IR and NMR spectroscopic techniques. Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds. Develop a sound understanding of the structure of Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases. Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers. Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles. Learn about 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.

**CHEMISTRY –DSE-3**

**Applications of Computers in Chemistry**

By the end of the course, the students will be able to: Have knowledge of most commonly used commands and library functions used in QBASIC programming. Develop algorithm to

solve problems and write corresponding programs in BASIC for performing calculations involved in laboratory experiments and research work. Use various spreadsheet software to perform theoretical calculations and plot graphs.

**CHEMISTRY –DSE-9**

**Industrial Chemicals and Environment**

By the end of this course students will be able to understand: The different toxic gases and their toxicity hazards. Safe design systems for large scale production of industrial gases. Manufacturing processes, handling and storage of inorganic chemicals. Hazardous effects of the inorganic chemicals on human beings and vegetation. The requirement of ultra-pure metals for the semiconducting technologies. Composition of air, various air pollutants, effects and control measures of air pollutants. Different sources of water, water quality parameters, impacts of water pollution, water treatment. Different industrial effluents and their treatment methods. Different sources of energy. Generation of nuclear waste and its disposal. Use of biocatalyst in chemical industries.

# Program: B.Sc (P) Life Sciences & B.Sc (P) Physical Science with Chemistry

## Course Papers outcomes of LOCF

**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons**

Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). To understand and explain the differential behavior of organic compounds based on fundamental concepts learnt and formulate the mechanism of organic reactions.

**Chemical Energetics, Equilibria and Functional Group Organic Chemistry-I**

To understand the laws of thermodynamics, thermochemistry and equilibria, concept of pH and its effect on the various physical and chemical properties of the compounds. To

understand the fundamentals of functional group chemistry through the study of methods of preparation, properties and chemical reactions with underlying mechanism and use concepts learnt to understand stereochemistry of a reaction and predict the reaction outcome.

**Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group**

**Organic Chemistry-II**

Explain the concepts of different types of binary solutions-miscible, partially miscible and immiscible along with their applications, the thermodynamic aspects of equilibria between phases. To understand different types of galvanic cells, their Nernst equations, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements also to understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.

**Chemistry of s- and p-Block Elements, States of Matter and Chemical Kinetics**

To understand the chemistry and applications of s- and p-block elements. Derive ideal gas law from kinetic theory of gases and explain why the real gases deviate from ideal behaviour. Explain the properties of liquids especially surface tension and viscosity. Explain symmetry elements, crystal structure specially NaCl, KCl and CsCl. To define rate of reactions and the factors that affect the rates of reaction and learn about various theories of reaction rates and how these account for experimental observations

**Discipline Specific Elective Courses**

**Chemistry of d-Block Elements, Quantum Chemistry and Spectroscopy (DSE)**

To understand chemistry of d and f block elements, Latimer diagrams, properties of coordination compounds and VBT and CFT for bonding in coordination compounds. To understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions. To understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra and explain Lambert-Beer's law, quantum efficiency and photochemical processes.

**Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy (DSE)**

To understand the chemistry and applications of 3d and to get a general idea of toxicity of metal ions through the study of $Hg^{2+}$ and $Cd^{2+}$ in the physiological system. To understand

the fundamentals of functional group chemistry, polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism and gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.

**Skill Enhancement Courses**

**Basic Analytical Chemistry**

To handle analytical data. To determine composition and pH of soil, which can be useful in agriculture. Do quantitative analysis of metal ions in water. Separate mixtures using separation techniques. Estimate macro nutrients using Flame photometry.

**Analytical Clinical Biochemistry**

To understand and establish how the structure of biomolecules determines their reactivity and biological uses. To understand the basic principles of drug-receptor interaction and structure activity relation (SAR) and gain an insight into concept of heredity through biological processes like replication, transcription and translation.

**Chemistry of Cosmetics and Perfumes**

To learn basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products, use of safe, economic and body-friendly cosmetics. To prepare new innovative formulations.

**IT Skills for Chemists**

To become familiar with the use of computers. Use software for tabulating data, plotting graphs and charts, carry out statistical analysis of the data and solve chemistry problems and simulate graphs. To prepare documents that will incorporate chemical structure, chemical equations, mathematical expressions from chemistry.