Program Specific Outcomes and Course Outcomes in CHEMISTRY under CBCS

Outcomes of Core Course (HONOURS) in CHEMISTRY

The core course in Chemistry prepares students to make use the knowledge as future professionals and researchers. Theoretical knowledge along with laboratory works associated with each course makes the program almost complete and enjoying.

- The main objective of this program is to train the students to use the knowledge of Chemistry for professional use and future employability.
- Students are exposed to diverse branches of Chemistry.
- Quantum Chemistry along with other Inorganic Chemistry topics like periodic properties of elements and related experimental works in laboratory helps in building a solid base.
- Concepts of Physical Chemistry complements in better understanding of rates, equilibria and energy parameters associated with chemical processes. Physical Chemistry experiments involving codutometry, pHmetry, potentiometry and spectrophotometry train the students to use these techniques for a variety of applications.
- Students are acquainted with experimental procedures like analysis of salts and different titrations for analysis of unknown materials both qualitatively and quantitatively.
- Students have an opportunity to understand the fundamental Organic Chemistry and its applications.
- Students learn the chromatographic separation technique of oraganic compounds.
- Thermochemistry and Calorimetry concepts are learnt along with the calorimetric measurements in laboratories.

Outcomes of the course: Core Course (Honours in Chemistry)

Inorganic Chemistry

Atomic Structure

To make students understand atomic structure based on quantum mechanical considerations.

Periodicity of Elements

Students take up the periodicity of properties of elements and understands the chemistry behind variation of such properties, which helps them in understanding chemical processes involving inorganic materials.

Chemical Bonding

Force that binds the atoms is taken up and students get the opportunity to understand bonding and allied topics. Students also learn about other non-specific forces and its interactions.

Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions and

Principles involved in volumetric analysis are taken up for study.

PHYSICAL CHEMISTRY:

Gaseous state:

Chemistry of gases, concept of ideal and real gases and understanding of behaviour of gases in the light of microscopic properties help students to get an insight of gaseous world.

Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Qualitative discussion of structure of water. Studies of liquid state help in applying the idea for many applications.

Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals are also studied.

Ionic equilibria:

Solution Chemistry involving electrolytes and its ions are studied in details. Ionization, Dissociation, pH, Solubility etc. Gives a solid foundation for further studies in Chemistry.

ORGANIC CHEMISTRY

Basics of Organic Chemistry

Chemistry of Organic Compounds, Electronic Displacements arising from Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength and Homolytic and Heterolytic fission with suitable examples are learnt

Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules and Optical Isomerism help in understanding stereochemistry of compounds.

Chemistry of Aliphatic Hydrocarbons

Chemistry of hydrocarbons involving C-C single, C=C pi bonds are studied as basic Organic Chemistry.

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism, Directing effects of the groups help to better understanding of Mechanism of reactions.

PHYSICAL CHEMISTRY- II

Chemical Thermodynamics

Laws of Thermodynamics and Thermochemistry gives a solid foundation to study thermochemical data of chemical reactions and processes.

Systems of Variable Composition, Chemical Equilibrium, Solutions and Colligative roperties of Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions are also taken up.

INORGANIC CHEMISTRY-II

General Principles of Metallurgy, Acids and Bases, Chemistry of *s* and *p* Block Elements like Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens are studied.

Noble Gases:

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond

treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory

Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

ORGANIC CHEMISTRY-II

Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Structure, reactivity and preparation of Alcohols, Phenols, Ethers and Epoxides, Carbonyl Compounds, Carboxylic Acids and their Derivatives are studied in details.

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Sulphur containing compounds:

Preparation and reactions of thiols, thioethers and sulphonilic acid are also taught.

Program Specific Outcome of Program Course (GENERAL) in CHEMISTRY

Six semester (three years) Program Course in Chemistry is designed to understand, learn the subject of Chemistry both theoretically and with in-hand practices in laboratories so that students pursuing the course are well-trained with the knowhow and training to find jobs in industry and health care providing organizations. Each course has a Practical component to enrich the students with practices of knowledge.

Course Outcome of Program Course in CHEMISTRY

Inorganic and Organic Chemistry:

(ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS)

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and Quantum mechanics is introced.

Chemical Bonding and Molecular Structure involving Ionic Bonding, Covalent bonding from VB and MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ . Comparison of VB and MO approaches also help in understanding progress in concepts and ideas.

Fundamentals of Organic Chemistry, Stereochemistry , Aliphatic Hydrocarbons and Reactions of formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4 are also studied to give an exposure to organic chemistry.

Physical and Functional Organic Chemistry:

(CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I)

Section A: Physical Chemistry-1

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics, **Chemical Equilibrium**, **Ionic Equilibria**: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle are studied to acquire the concept of Thermodynamics and Solution Chemistry.

Section B: Organic Chemistry

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons, **Alkyl and Aryl Halides, Alcohols, Phenols and Ethers (Upto 5 Carbons), Aldehydes and ketones** are studied to study and analyse reactions and synthesis of different compounds.

Physical Chemistry and Organic Chemistry-II

SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

Section A: Physical Chemistry-2

Solutions and Dilute solutions, Phase Equilibria , Conductance Electrochemistry of cells are studied to give the basic idea of Physical Chemistrty.

Section B: Organic Chemistry

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Chemistrty of Carboxylic acids and their derivatives, Carboxylic acid derivatives (aliphatic), Amines and Diazonium salts (Preparationfrom aromatic amines. Reactions: conversion to benzene, phenol, dyes) are studied .

Amino Acids, Peptides and Proteins and **Carbohydrates**: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation are also studied.

Inorganic and Physical Chemistry-II

TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

Section A: Inorganic Chemistry-2

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination. (10 Lectures)

Section B: Physical Chemistry-3

Physical chemistry of Gases is studied to have an insight into the world of gases. Basic chemistry of liquids is also learnt.

Solids

Study of Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices, Miller indices, X–Ray diffraction by crystals, Bragg's law, Structures of NaCl, KCl and CsCl (qualitative treatment only), Defects in crystals, Glasses and liquid crystals help to understand Material Science.

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Study help to understand kinetics of synthetic organic chemistry.