

MODULE 1: ATOMIC AND MOLECULAR STRUCTURE (10 LECTURES)

- **Failure of Classical Mechanics**
 - Newtonian Mechanics
 - Maxwell Wave Mechanics
- **Properties of Particles at Atomic and Sub-Atomic Level**
 - Electromagnetic Radiation
 - Dual Nature of Electron and Electromagnetic Radiation
 - Planck's Theory
 - Photoelectric Effect
 - Heisenberg Uncertainty Principle
- **Molecular Properties**
 - Paramagnetic Properties
 - Principles for Combination of Atomic Orbitals to Form Molecular Orbitals
 - Formation of Homo and Hetero Diatomic Molecules
 - Energy Level Diagrams of Molecular Orbitals
- **Coordination Numbers and Geometries**
 - Isomerism in Transition Metal Compounds
 - Crystal Field Theory
 - Energy Level Diagrams for Transition Metal Ions
 - Magnetic Properties

MODULE 2: SPECTROSCOPIC TECHNIQUES AND APPLICATIONS (8 LECTURES)

- **Principles of Vibrational and Rotational Spectroscopy**
 - Selection Rules for Diatomic Molecules
- **Electronic Spectroscopy**
 - UV-VIS Spectroscopy
 - * Related Rules
 - * Applications
- **Fluorescence and Its Applications in Medicine**
- **Nuclear Magnetic Resonance (NMR)**
 - Basic Principle
 - Applications
- **Magnetic Resonance Imaging (MRI)**
 - Basics

MODULE 3: INTERMOLECULAR FORCES AND PROPERTIES OF GASES (4 LECTURES)

- **Types of Interactions**
 - Ionic
 - Dipolar
 - Van der Waals
- **Equations of State**
 - Ideal and Real Gases
 - Deviation from Ideal Behavior
 - Van der Waals Gas Equation

MODULE 4: USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA AND WATER CHEMISTRY (8 LECTURES)

- **Thermodynamic Functions**
 - Energy
 - Enthalpy
 - Entropy
 - Free Energy
 - Equations Interrelating Thermodynamic Properties
- **Free Energy Applications**
 - EMF and Cell Potentials
 - Nernst Equation and Applications
 - Corrosion
 - Metallurgy through Ellingham Diagrams
- **Solubility Equilibria**
- **Water Chemistry**
 - Hard and Soft Water
 - Quality Parameters for Drinking and Industrial Use
 - Hardness Calculation in All Units
 - Hardness Estimation using EDTA and Alkalinity Method
 - Hardness Removal by Soda Lime and Ion Exchange Method

MODULE 5: PERIODIC PROPERTIES (4 LECTURES)

- Zeolite Method
- Effective Nuclear Charge
- Penetration of Orbitals
- Variations of s, p, d, and f Orbital Energies in the Periodic Table
- Electronic Configurations
- Atomic and Ionic Sizes
- Ionization Energies
- Electron Affinity and Electronegativity

- Polarizability
- Acid-Base Principle of HSAB Theory
- Oxidation States
- Hybridization and Molecular Geometries

MODULE 6: STEREOCHEMISTRY (4 LECTURES)

- Representations of 3-D Structures
- Structural Isomers and Stereoisomers
- Configurations and Symmetry
- Chirality
- Enantiomers
- Diastereomers
- Optical Activity
- Absolute Configurations
- Conformational Analysis

MODULE 7: ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULE (4 LECTURES)

- **Introduction to Intermediates**
- **Reactions Involving**
 - Substitution
 - Addition
 - Elimination
 - Oxidation-Reduction
 - Diels-Alder Cyclization
 - Epoxide Ring Openings
- **Synthesis of a Commonly Used Drug Molecule (e.g., Aspirin)**