



Maharaja Surajmal Brij University
Bharatpur (Rajasthan)
Syllabus of Chemistry
Undergraduate Programme
(V & VI Semester)
Academic Session (2025-26)

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Semester – V

CHE-20T-501 (Inorganic And Spectroscopy)

UNIT- I

Metal-ligand bonding in Transition Metal Complexes:

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal- field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

Magnetic properties of Transition Metal Complexes:

Types of magnetic behaviour, Methods of determining magnetic susceptibility, spin-only formula, L-S coupling. Correlation of μ and values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Electron spectra of Transition Metal Complexes:

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.

15 Lectures

UNIT- II

Hard and Soft Acids and Bases(HSAB):

Classification of acids and bases as hard and soft Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, electronegativity and hardness and softness.

Organometallic Chemistry:

Definition, nomenclature and classification of organometallic compounds preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metalethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

12 Lectures

UNIT- III

Heterocyclic Compounds

Introduction: Molecular orbital diagram and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five- and six-membered heterocycles, preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher-indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis, Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

13 Lectures

UNIT- IV

Spectroscopy

Introduction: Electromagnetic radiation, spectrum, basic features of different spectrometers, statement of the Born-Openheimer approximation, degrees of freedom.

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Rotational Spectrum: Diatomic molecules, Energy levels of a rigid rotator (semi-classical principles), selection rules, spectral intensity, using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotation, isotope effect.

Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum: Basic principles and applications, concept of polarizability, pure rotational and pure vibrational Raman Spectra of diatomic molecules, selection rules.

Electronic Spectrum: Concept of Potential Energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Frank Condon principle. Qualitative description of σ , π and n M.O. their energy levels and the respective transitions.

18 Lectures

Semester – VI

CHE-20T-601 (Bioinorganic, NMR Spectroscopy And Photochemistry)

UNIT- I

Bioinorganic Chemistry:

Essential and trace elements to Biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkalian and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.

Inorganic Polymers:

Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

12 Lectures

UNIT- II

Nuclear Magnetic Resonance (NMR) Spectroscopy:

Proton magnetic resonance ($^1\text{H-NMR}$) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals. Interpretation of NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. Problems Pertaining to the structure elucidation of simple organic compounds using NMR data.

Organic Synthesis via Enolates: Acidity of α -hydrogens in reactive methylene compounds, alkylation of diethyl malonate and ethyl acetoacetate. Claisen condensation, Keto-enol tautomerism in ethyl acetoacetate. Synthetic applications of ethyl acetoacetate and malonic ester.

18 Lectures

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UNIT- III

Carbohydrates

Classification and nomenclature, Monosaccharides, mechanism of osazone formation. Epimers, anomers and mutarotation. Interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Erythro and threodiastereomers. Conversion of glucose into mannose.

Structure and nomenclature of peptides and Proteins. Classification of proteins. Peptide structure Determination, end-group analysis, selective hydrolysis of peptides. Classical peptide synthesis. Solid-phase peptide synthesis. **15 Lectures**

UNIT- IV

De Broglie hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of

The Wave function, postulates of quantum mechanics, Eigen value & Eigen function, operators Normalisation and orthogonality, particle in a one dimensional box.

Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of Photochemistry Grothus-Draper law, Stark -Einstein law, Jablonski diagram depicting Various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). quantum yield, photosensitized reactions-energy transfer processes (simple examples). **15 Lectures**

SEMESTER -V

CHE-20P-502

PRACTICAL

INORGANIC CHEMISTRY

Synthesis and Analysis of:

- Potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$
- Bis (dimethyl glyoximate) nickel (II) complex, $[Ni(DMG)_2]$
- Tetramminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4$
- Potassium cis-diaquabis (oxalato) chromate (III) dihydrate, $K[cis-Cr(H_2O)_2(C_2O_4)] \cdot 2H_2O$

Steam Distillation

- Naphthalene from its suspension in water
- Clove oil from Clove
- Separation of o- and p- nitrophenols

Qualitative Analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, for separation and preparation of suitable derivatives.

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- (b) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
- (c) To study the saponification of ethyl acetate conductometrically.
- (d) To determine the ionization constant of a weak acid conductometrically.
- (e) To determine potentiometrically the given ferrous ammonium sulphate solution using $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ as titrant and calculate the redox potential of $\text{Fe}^{2+}/\text{Fe}^{3+}$ system on the hydrogen scale.

CHE-20P-602 PRACTICAL: SEMESTER -VI

Instrumentation

Calorimetry

- (a) Job's
- (b) Molar ratio method Adulteration-Food stuffs
Adulteration-Food stuffs
Effluent analysis water analysis

Solvent Extraction

Separation and estimation of Mg (II) and Fe (II)

Ion Exchange Method

Separation and estimation of Mg (II) and Fe (II)

Column Chromatography

- Separation of fluorescein and methylene blue
- Separation of leaf pigments from spinach leaves
- Resolution of racemic mixture of (+) mandelic acid

Synthesis Organic Compounds

- (a) Acetylation of salicylic acid, aniline, glucose and hydroquinone,
Benzoylation of aniline and phenol
- (b) Aliphatic electrophilic substitution
Preparation of iodoform from ethanol and acetone
- (c) Aromatic electrophilic substitution
Nitration
Preparation of m-dinitrobenzene
Preparation of p-nitroacetanilide
Halogenation
Preparation of p - bromoacetanilide
Preparation of 2, 4, 6 - tribromophenol
- (d) Diazotization / coupling
Preparation of methyl orange and methyl red
- (e) Oxidation
- (f) Preparation of benzoic acid from toluene
- (f) Reduction
Preparation of aniline from nitrobenzene
Preparation of m-nitroaniline from m-dinitrobenzene.


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Refractometry, Polarimetry

- (a) To verify the law of refraction of mixture (e.g. of glycerol and water) using Abbe's refractometer.
- (b) To determine the specific rotation of a given optically active compound.

Molecular Weight Determination

- (a) Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
- (b) Determination of the apparent degree of dissociation of an electrolyte (e.g. NaCl) in aqueous solution at different concentrations by ebullioscopy.

Colorimetry

- (a) To verify Beer-Lambert law $\text{KMnO}_4/\text{K}_3\text{Cr}_2\text{O}_7$ and determined the concentration of the given solution of the substance.

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