

# **SYLLABUS FOR B.Sc. II YEAR COURSE**

## **CHEMISTRY**

### **SECOND YEAR**



**2023-24**

## B.Sc. II YEAR-2024

### PAPER - I

#### CH-201 Inorganic Chemistry – II

##### UNIT I

###### Chemistry of Transition Elements

General Characteristics and Periodicity in properties with emphasis on their electronic configuration and multiple oxidation states of 3d, 4d and 5d series elements.

Colored ion formation, magnetic, catalytic properties and complex formation tendency in 3d series elements.

##### UNIT II

###### Coordination compounds

Werner's coordination theory and experimental verification, Effective Atomic Number concept, chelates, nomenclature of coordination compounds, stereoisomerism in complexes of coordination number 4 and 6. Complexometric titrations and theory of metallochrome indicators.

##### UNIT III

###### f-Block elements

Chemistry of Lanthanides: Electronic structure, oxidation state, ionic radii, colors, spectral and magnetic properties. Lanthanide contraction and its consequences.

Chemistry of actinides: General characteristics, comparative treatment of actinides and lanthanides with respect to ionic radii, oxidation states, Magnetic behavior and spectral properties.

##### UNIT IV

Concepts of acids and bases: Arrhenius, Brønsted-Lowry, Lewis and Usanovich concept. Acid base titrations, Theory of indicators, Redox titrations

Non aqueous solvents: Physical properties of solvent, types of solvents and their general characteristics. Reactions in non aqueous solvents with reference to liquid  $\text{NH}_3$  and liquid  $\text{SO}_2$

##### UNIT V

###### Quantitative analysis

Types of quantitative analysis: Gravimetric and volumetric analysis.

Precipitation, Co-precipitation and Post precipitation.

Errors in chemical analysis: types of error and their minimization;

Accuracy, Precision, Standard Deviation.

Books Recommended:

1. Inorganic Chemistry by Satya Prakash
2. Inorganic Chemistry by B.R.Puri & L.R. Sharma

## PAPER - II

### CH-202 Organic Chemistry

#### UNIT : I

##### **Electromagnetic Spectrum : Absorption Spectra**

Ultraviolet (UV) absorption spectroscopy – absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. UV applications including identification of groups

#### UNIT : II

##### **Alcohols**

Classification and nomenclature.

Monohydric alcohols – nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols.

Dihydric alcohols – nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol-pinacolone rearrangement.

Trihydric alcohols – nomenclature and methods of formation, chemical reactions of glycerol.

##### **Phenols**

Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

#### UNIT : III

##### **Aldehydes and Ketones**

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Use of acetals as protecting group. Oxidation and reduction of aldehydes and ketones, Baeyer-Villiger oxidation, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$ .

## UNIT : IV

### Reactive methylene compounds and Carboxylic Acid

Reactive methylene compounds: malonic ester and acetoacetic ester – preparation and synthetic applications. Mechanism of Claisen condensation

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Reduction of carboxylic acids. Mechanism of decarboxylation, esterification and hydrolysis of esters (acidic and basic).

## UNIT : V.

### Organic Compounds of Nitrogen

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid.

Alkyl and Aryl amines : Reactivity, structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basic nature of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

### Books Recommended:

1. Advanced Organic Chemistry by Mukherji, Singh & Kapoor
2. Organic Chemistry by Bahal and Bahal
3. Advanced Organic Chemistry by Morrison & Boyd
4. Carbanic Rasayan By K.M Gangotri RBD

## PAPER - III

### CH-203 Physical Chemistry

#### UNIT I

##### Thermodynamics – I

First Law of Thermodynamics: statement, definition of internal energy and enthalpy. Joule-Thomson Effect, Joule – Thomson coefficient and inversion temperature. Calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Second Law of Thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Numericals.

#### UNIT II

##### Thermodynamics – II

**Entropy:** Concept of Entropy, entropy as a state function, entropy as a function of  $V$  &  $T$ , entropy as a function of  $P$  &  $T$ , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz function as thermodynamic quantities, Gibbs – Helmholtz equation. Equilibrium constant and free energy. Reaction isotherm and reaction isochore. Clapeyron equation and Clausius – Clapeyron equation, applications. Third law of thermodynamics: Nernst heat theorem, Statement of third law and evaluation of absolute entropy from heat capacity data. Numericals.

#### UNIT III

##### Phase Equilibrium

Statement and meaning of the terms – phase, component and degree of freedom, Gibbs phase rule, phase equilibria of one component system – water and sulphur systems. Phase equilibria of two-component system: simple eutectic systems,– Pb-Ag system, desilverisation of lead.

Two Component Systems– compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (FeCl<sub>3</sub>-H<sub>2</sub>O)system. Freezing mixtures.

Nernst distribution law, deviations from Nernst Law, applications to study of complex ion and solvent extraction.

#### UNIT IV

##### Electrochemistry – I

Conductance, Specific conductance and equivalent conductance. Activity, activity coefficient and ionic strength. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation, determination of  $K_a$  of acids, determination of solubility product of a sparingly soluble salt, Conductometric titrations and their types.

## UNIT V

### Electrochemistry – II.

Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, sign conventions. Electrolytic and Galvanic cells – reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $K$ ). Concentration cell with and without transport (mathematical treatment), liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient.

Potentiometric titrations, Determination of pH using hydrogen, quinhydrone and glass electrodes. Numericals.

### Books Suggested:

1. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
2. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
3. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Shobhan Lal Naginchand & Co.
4. Physical Chemistry By K.R. Genwa RBD
5. Physical Chemistry, Bahal & Tuli, S. Chand & Co. Ltd.
6. Physical Chemistry, R.C. Saraswat and A.K. Goswami, RamPrasad & Sons.

## CH-204 Laboratory Course – II

### Inorganic Chemistry:

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Gravimetric analysis ( by using Silica / Sintered Crucible)

- (i) To estimate Barium as barium sulphate.
- (ii) To estimate copper as cupric oxide/ copper (I) thiocyanate.
- (iii) To estimate Zinc as Zinc oxide.

### Organic Chemistry:

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- (i) Calibration of Thermometer: - The following compounds may be used for the calibration purpose  $80^{\circ}$ - $82^{\circ}$  (Naphthalene),  $113.5^{\circ}$ - $114^{\circ}$  (Acetanilide),  $132.5^{\circ}$ - $133^{\circ}$  (Urea) and  $122^{\circ}$  (Benzoic acid).
- (ii) Qualitative Analysis: - Identification of organic compounds (one liquid one solid) through the functional group analysis (containing only one functional group).

### Physical Chemistry:

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#### Chemical Kinetics:

- (i) To study the hydrolysis of an ester catalyzed by an acid and determine the rate constant and order of reaction.
- (ii) To study saponification of ester and determine the rate constant and order of reaction.
- (iii) To study the reaction b/w acetone and iodine with respect to iodine and determine the rate and order of reaction.

#### Viva

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#### Record

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#### Books Suggested (Laboratory Courses):

1. Experimental Organic Chemistry Vol I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
2. Practical Chemistry, S.Giri, D.N.Bajpai and O.P.Pandey Publ. S. Chand
3. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
4. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.
5. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
6. Advanced Experimental Chemistry, Vol. I-Physical, J.N. Gurtu and R. Kapoor, S. Chand & Co.
7. Selected Experiments in Physical Chemistry, N.G. Mukherjee, J.N. Ghose & Sons.

#### Examination & Marking Scheme

Time: 5 hours

Max. Marks: 75

Min. Pass Marks: 27

	Regular Student	Ex Student
Gravimetric Exercise	20	20
Qualitative Organic Analysis	20	20
Physical Experiment	15	15
Viva- Voice	5	5
Sessional and Record	15	...
Total	75	60*

\*To be converted out of 75

Gravimetric Exercise- An error up to 0.5% carries full marks. For each subsequent 0.1% error deduct 1 mark, 8 marks reserved for procedure.

Qualitative Organic Analysis: Two organic compounds (one solid and one liquid) 2 mark each for correct identification of functional group, 2 marks each for element detection, 4 marks each for identification and 2 mark each for systematic work and proper record.

Physical Experiment: Observations- 6 mark, Calculation and Formula-5, Result-4 marks.