

(Revised)

**B.Sc.-II (Chemistry) Semester III & IV**

**Session 2022-23, 2023-24**

**Programme Code- CHEB3PUP**

SEMESTER III					
Paper	Title	Max. Marks	Sem. Paper Asstt.	Int.	Pass Percentage
CHEB2101T	INORGANIC CHEMISTRY	35	26	09	35%
CHEB2102T	ORGANIC CHEMISTRY	35	26	09	35%
CHEB2103T	PHYSICAL CHEMISTRY	35	26	09	35%
CHEB2104P	PRACTICAL CHEMISTRY-I	45	16 (Pass Marks)		35%

SEMESTER IV					
Paper	Title	Max. Marks	Sem. Paper Asstt.	Int.	Pass Percentage
CHEB2201T	INORGANIC CHEMISTRY	35	26	09	35%
CHEB2202T	ORGANIC CHEMISTRY	35	26	09	35%
CHEB2203T	PHYSICAL CHEMISTRY	35	26	09	35%
CHEB2204P	PRACTICAL CHEMISTRY-II	45	16 (Pass Marks)		35%

**B.Sc.-II (Chemistry), Session 2022-23, 2023-24**

**CHEMISTRY**

**SEM-III**

**PAPER-I**

**INORGANIC CHEMISTRY**

**Max Marks : 35**

**Semester Paper : 26**

**Internal Assessment: 9**

**Pass Marks : 35%**

**30 hours**

**Time allowed - 3 hrs**

**3 period/week**


**INSTRUCTIONS FOR THE PAPER SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

**SECTION-A**

  
**Professor & Head,**  
**Deptt. of Chemistry**  
**Punjabi University, Patiala**

## B.Sc.-II (Chemistry) Semester III & IV

Session 2022-23, 2023-24

### SEMESTER III

Paper	Title	Max. Marks	Sem. Paper	Int. Asstt.	Pass Percentage
I	INORGANIC CHEMISTRY	35	26	09	35%
II	ORGANIC CHEMISTRY	35	26	09	35%
III	PHYSICAL CHEMISTRY	35	26	09	35%
I	PRACTICAL CHEMISTRY-I	45	16 (Pass Marks)		35%

### SEMESTER IV

Paper	Title	Max. Marks	Sem. Paper	Int. Asstt.	Pass Percentage
I	INORGANIC CHEMISTRY	35	26	09	35%
II	ORGANIC CHEMISTRY	35	26	09	35%
III	PHYSICAL CHEMISTRY	35	26	09	35%
I	PRACTICAL CHEMISTRY-II	45	16 (Pass Marks)		35%

## B.Sc.-II (Chemistry), Session 2022-23, 2023-24

### CHEMISTRY SEM-III

#### PAPER-I INORGANIC CHEMISTRY

Max Marks : 35

Semester Paper : 26

Internal Assessment: 9

Pass Marks : 35%

30 hours

Time allowed - 3 hrs

3 period/week

#### INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

#### INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

#### SECTION-A

##### I. Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their simple compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry. (10 Hrs.)

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Punjabi University, Patiala

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## II. Chemistry of Lanthanide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds. (5 Hrs.)

### SECTION-B

## III. Chemistry of Elements of Second and Third Transition Series

General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states. Magnetic behaviour, spectral properties & stereochemistry (10 Hrs.)

## IV. Chemistry of Actinides Elements

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and the later lanthanides. (5 Hrs.)

## CHEMISTRY SEM-III

### PAPER II : ORGANIC CHEMISTRY

Max Marks : 35

Semester Paper : 26

Internal Assessment: 9

Pass Marks : 35%

30 hours

Time allowed - 3 hrs

3 period/week

### INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

### INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

### Section - A

#### I. Alcohols

Classification and nomenclature.

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

Dihydric alcohols-nomenclature, methods of formation, chemical reactions of vicinal glycols-nomenclature, methods of formation chemical reaction of vicinal glycols, oxidative cleavage with  $[Pb(OAc)_4]$  and  $HIO_4$  and Pinacol-Pinacolone rearrangement.

Trihydric alcohol-nomenclature, methods of formation and chemical reactions of

glycerol.

(7 Hrs.)

## II.- 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. Gatterman synthesis, Hauben. Hostch reaction. Lederer-Mianasse reaction and Reimer-Tiemann reaction.

(8 Hrs.)

### Section - B

## 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 nitrites and from carboxylic acids. Physical properties and Mechanism of nucleophilic addition to carbonyl group with particular emphasis of Benzoin, Aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives, Wittig reaction, and Mannich reaction.

Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV (Meerwein Ponderoff Vorley) reaction, Clemmensen, Wolff-Kishner,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$  reductions. Halogenation of enolizable ketones.

An Introduction to  $\alpha$ ,  $\beta$  unsaturated aldehydes and ketones, Michael addition.

(15 Hrs.)

## CHEMISTRY SEM-III

### PAPER III : PHYSICAL CHEMISTRY

Max Marks : 35

Semester Paper : 26

Internal Assessment: 9

Pass Marks : 35%

30 hours

Time allowed - 3 hrs

3 period/week


### INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

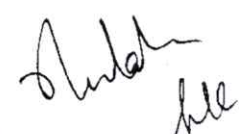
### INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

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## Section - A

### I. Thermodynamics-I

Definition of thermodynamics terms: system, surroundings. Types of systems, intensive and extensive properties. State and path functions and their differentials, Thermodynamic processes, Concept of heat and work, elementary idea of thermochemistry.

First Law of Thermodynamics : statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law. 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.

(10 Hrs.)

### II. Thermodynamics-II- (Part-a)

Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

(5 Hrs.)

## SECTION-B

### III. Thermodynamics-II- (Part-b)

Concept of 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 criterion of spontaneity and equilibrium. Entropy change in ideal gases mixing of gases.

(5 Hrs.)

### IV. Thermodynamics-III

Third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data, Gibbs and Helmholtz functions; Gibbs function ( $G$ ) and Helmholtz function ( $A$ ) as thermodynamic quantities.  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of  $G$  and  $A$  with  $P$ ,  $V$  and  $T$ .

(5 Hrs.)

### V. Chemical Equilibrium

Equilibrium constant and free energy, Thermodynamic derivation of law of mass action. Le Chatelier's principle.

Reaction isotherm and reaction isochore-Clapeyron equation and Clausius-Clapeyron equation.

(5 Hrs.)

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**B.Sc.-II**  
**PRACTICALS CHEMISTRY-I**  
**Sem.-III**

Max. Marks: 45

Time: 4 Hrs.

Pass Percentage: 35%

6 Periods/week

**Volumetric Analysis and TLC**

**Volumetric Analysis**

- (a) Determination of acetic acid in commercial vinegar using NaOH, Alkalinity of water sample.
- (b) Determination of alkaline content of antacid.
- (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
- (d) Estimation of hardness of water by EDT A.
- (e) Estimation of ferrous and ferric by dichromate method.
- (f) Estimation of copper using sodium thiosulphate.

**Organic Chemistry**

**Laboratory Techniques**

Thin Layer Chromatography

Determination of  $R_f$  values of different components.

- (a) Separation of green leaf pigments (spinach leaves may be used)
- (b) Preparation and separation of 2, 4-dinitrophenylhydrazones of acetone, benzophenone and cyclohexanone using toluene and light petroleum mixture (40 : 60).
- (c) Separation of a mixture of dyes.

**PRACTICALS**

**INSTRUCTIONS FOR EXAMINERS AND CANDIDATES**

The practical examination will be held in single session (morning/evening). Candidates are required to perform practicals from volumetric Analysis and TLC. Distribution of marks will be as under (Books may be consulted):

- |     |                    |   |                                      |
|-----|--------------------|---|--------------------------------------|
| (1) | Volumetry analysis | = | 20 marks                             |
|     |                    |   | {Initial write up 7 marks            |
|     |                    |   | (Volumetry; equation:1,              |
|     |                    |   | Indicator:1, end point:1 and general |
|     |                    |   | calculations:4)                      |
|     |                    |   | Performance and results 13 marks     |
|     |                    |   | (initial burette reading:2, final    |
|     |                    |   | reading:2, end point:2 calculations  |
|     |                    |   | and result:7)}                       |
| (2) | TLC                | = | 10 marks (Performance and result)    |
| (3) | Viva-Voce          | = | 10 marks                             |
| (4) | Note Books         | = | 5 marks                              |
|     | <b>Total</b>       | = | <b>45 marks</b>                      |

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**CHEMISTRY  
SEM-IV**

**PAPER I : INORGANIC CHEMISTRY**

**Max Marks : 35**  
**Semester Paper : 26**  
**Internal Assessment: 9**  
**Pass Marks : 35%**

**30 hours**  
**Time allowed - 3 hrs**  
**3 period/week**

**INSTRUCTIONS FOR THE PAPER SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

**Section - A**

**I. Coordination Compounds**

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.  
(10 Hrs.)

**II. Oxidation and Reduction**

Use of redox potential data-analysis of redox cycle, redox stability of water-Frost, Latimer and Pourbaix diagrams. Principles involved in the extraction of the elements.  
(5 Hrs.)

**Section - B**

**III. Acids and Bases**

Arrhenius, Bronsted-Lowry, the Lux-Flood solvent system and Lewis concepts of acids and bases.  
(7Hrs.)

**IV. Non-aqueous Solvents**

Physical properties of a solvent, types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid  $\text{NH}_3$  and liquid  $\text{SO}_2$   
(8 Hrs.)

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**CHEMISTRY  
SEM-IV**

**PAPER II : ORGANIC CHEMISTRY**

**Max Marks : 35**  
**Semester Paper : 26**  
**Internal Assessment: 9**  
**Pass Marks : 35%**

**30 hours**  
**Time allowed - 3 hrs**  
**3 period/week**

**INSTRUCTIONS FOR THE PAPER SETTER**

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

**INSTRUCTIONS FOR THE CANDIDATES**

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

**Section - A**

**I. Carboxylic Acids**

Nomenclature, structure and bonding. physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of amides, Reactions of carboxylic acids, Mechanism of decarboxylation.

Methods of formation and chemical reactions of Halo acids and Hydroxyacids. Maleic acid, tartaric acid and citric acid. (Structural Formula only).

Methods of formation and chemical reaction of unsaturated monocarboxylic acids. Dicarboxylic acids, methods of formation and effect of heat and dehydrating agents.

(10 Hrs.)

**II. Carboxylic Acid Derivatives**

Structure and nomenclature of acid chlorides, esters. amides and acid anhydrides. Relative stability and reactivity of acyl derivatives.

Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic derivatives, chemical reactions, Mechanism of esterification and hydrolysis (acidic and Basic).

(5 Hrs.)

**SECTION-B**

**III. Ethers and Epoxides**

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions-cleavage and autooxidation, Ziesel' s Method.

Synthesis of epoxides, acid and base catalysed ring opening of epoxide, orientation of ring opening reactions of Grignard and organolithium reagents with epoxide.

(3 Hrs.)



#### IV. Fats, Oils and Detergents

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates. (3 Hrs.)

#### V. Organic Compounds of Nitrogen

##### a) Nitro Compounds

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reactions in acidic, neutral and alkaline media, Picric acid. (4 Hrs.)

##### b) Amines

Reactivity, structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting the basicity of amines. Amine salts as phase-transfer catalyst and preparation of alkyl and aryl amines (reduction of nitro compounds and nitriles), reductive amination of aldehydic and ketonic compounds Gabriel-phthalimide reaction, Hoffmann bromamide reaction. (5 Hrs.)

### CHEMISTRY SEM-IV

#### PAPER III : PHYSICAL CHEMISTRY

Max Marks : 35

Semester Paper : 26

Internal Assessment: 9

Pass Marks : 35%

30 hours

Time allowed - 3 hrs

3 period/week

#### INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective section of the syllabus and will carry 4 marks each. Section C will consist of 5 short answer questions that will cover the entire syllabus and will be of 2 marks each. Use of scientific non-programmable calculator is allowed.

#### INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of A & B Sections and Section C 9th question being compulsory.

#### Section - A

##### I. Phase Equilibrium

Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule; phase equilibria of one component system-water and S systems.

Phase equilibria of two component systems-solid-liquid equilibria, simple eutectic Pb-Ag systems, desilverisation of lead.

Solid Solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H<sub>2</sub>O), (FeCl<sub>3</sub>-H<sub>2</sub>O) systems. Freezing mixtures,

acetone-dry ice.

Partially miscible liquids: Lower and upper consolute temperature, Effect of impurity on consolute temperature. Immiscible liquids, steam distillation.

Nernst distribution law, thermodynamic derivation & applications. (10 Hrs.)

## II. Electrochemistry-I (a)

Electrical transport-conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance with dilution.

Migration of ions and Kohlrausch law. Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsagar's equation for strong electrolytes (elemental treatment only). (5 Hrs.)

## SECTION-B

## III. Electrochemistry-I (b)

Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductance measurements: determination of degree of dissociation, determination of  $K_a$  of acids, determination of solubility product of a sparingly soluble salts, conductometric titrations. (5 Hrs.)

## IV. Electrochemistry-II

Types of reversible electrodes--gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode-reference electrodes-standard electrode. potential, sign conventions, electrochemical series and its significance.

Electrolyte 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 reaction ( $G$ ,  $H$  and  $K$ ), polarization, over potential and hydrogen over voltage.

Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient potentiometric titrations.

Definition of pH and pK., determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods.

Buffers--mechanism of buffer action, Henderson-Hazel equation, Hydrolysis of salts, Corrosion-types, theories and methods of combating it. (10 Hrs.)

## B.Sc.-II PRACTICALS CHEMISTRY-II Sem.-IV

Max. Marks: 45

Time: 4 Hrs.

Pass marks: 35%

6 Periods/week

### Qualitative Analysis

Detection of elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in

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simple organic compounds.

### Physical Chemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.
2. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
3. To determine the enthalpy of solution of solid calcium chloride.

### INSTRUCTIONS FOR EXAMINERS AND CANDIDATES

The practical examination will be held in single session (morning/evening). Candidates are required to perform practicals from Qualitative Organic Analysis and Physical Chemistry Experiments. Distribution of marks will be as under (Books may be consulted):

(1)	Organic Qualitative Analysis	=	15 marks (Detection of elements identification and confirmation of functional group by 2 confirmatory tests.)
(2)	Physical Chemistry Experiment	=	15 marks {Initial Write up 5 marks (Theory/principle:1, Procedure:2, General Calculations:2 ) Performance and result: 10 marks (Full credit up to 10% error)}
(3)	Viva-Voce	=	10 marks
(4)	Note Books	=	5 marks
	<b>Total</b>	=	<b>45 marks</b>


### BOOKS SUGGESTED (THEORY COURSES)

1. *Basic Inorganic Chemistry*. F.A. Cotton, G. Wilkinson and P.L. Gaus. Wiley.
2. *Concise Inorganic Chemistry*. I.D. Lee. ELBS.
3. *Concepts of Models of Inorganic Chemistry*. B. Doaglas. D. McDaniel and I. Alexander, John Wiley.
4. *Inorganic Chemistry*. D.E. Shriver, P. W. Aikins and C.H. Langford. <Oxford.
5. *Inorganic Chemistry*. W. W. Porterfield Addison. Wesley.
6. *Inorganic Chemistry*. A.G. Sharpe, ELBS.
7. *Inorganic Chemistry*. G.L. Miessler and O.A. Tarr, Prentice Hall.
8. *Organic Chemistry*. Morrison and Boyd, Prentice Hall.
9. *Organic Chemistry*. L.G. Wade Jr. Prentice Hall.
10. *Fundamentals of Organic Chemistry*. Solomons, John Wiley.
11. *Organic Chemistry*. Vol. I, II & III. S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
12. *Organic Chemistry*. F.A. Aarey, McGraw Hill India.
13. *Introduction to Organic Chemistry*. Stretwieser, Heathcock and Kosover, Machmilan.
14. *Physical Chemistry*. G.M. Barrow, International Student Edition. McGraw Hill.
15. *Basic Programming with Application*. V.K. Jain, I'ata McGraw Hill.
16. *Computers and Common. Sense*. B. Ryal and Shely, Prentice Hall.

17. *University General Chemistry*. C.N.B. Rao. Macmillan.  
18. *Physical Chemistry*. R.A. Alberty, Wiley Eastern Ltd.  
19. *The Elements of Physical Chemistry*, P.w. Aikins, Oxford.  
20. *Physical Chemistry Through Problems*. S.K. Dogra and S. Dogra. Wiley Eastern Ltd.

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