# SYLLABUS
# ACADEMIC SESSION- 2023-24

## Generic Elective Papers (GE) (Minor-Chemistry) for otherDepartments/ Disciplines

## B.Sc. (HONOURS) I year
## Biotechnology/Mathematics

**UNDERGRADUATE PROGRAMME**
**Choice Based Credit System (CBCS)**

## FACULTY OF SCIENCES
## MATA GUJRI COLLEGE FATEHGARH SAHIB
## (An Autonomous College)
## Affiliated to Punjabi University Patiala

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*Prof. (Dr.) Sonal Singhal*
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*Mrs. Priya Sharma*

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## Generic Elective Papers (GE) (Minor Chemistry) for other Departments/ Disciplines

| CourseCode | Course Name | L T P (Credits) | No. of Lectures | Max.Marks (External+Internal) |
|---|---|---|---|---|
| BSHCHE-GE-1 | Chemistry-I | 4 0 0 (4) | 60 | 100 (75+25) |
| BSHCHE-GE 1(L) | Chemistry-I Lab | 0 0 2 (2) | 60 | 50 |
| BSHCHE-GE-2 | Chemistry-II | 4 0 0 (4) | 60 | 100 (75+25) |
| BSHCHE-GE 2(L) | Chemistry-II Lab | 0 0 2 (2) | 60 | 50 |
| BSHCHE-GE-3 | Chemistry-III | 4 0 0 (4) | 60 | 100 (75+25) |
| BSHCHE-GE 3(L) | Chemistry-III Lab | 0 0 2 (2) | 60 | 50 |
| BSHCHE-GE-4 | Chemistry-IV | 4 0 0 (4) | 60 | 100 (75+25) |
| BSHCHE-GE 4(L) | Chemistry-IV Lab | 0 0 2 (2) | 60 | 50 |
| BSHCHE-GE-5 | Chemistry-V | 4 0 0 (4) | 60 | 100 (75+25) |
| BSHCHE-GE 5(L) | Chemistry-V Lab | 0 0 2 (2) | 60 | 50 |
| BSHCHE-GE-6 | Chemistry-VI | 4 0 0 (4) | 60 | 100(75+25) |
| BSHCHE-GE 6(L) | Chemistry-VI Lab | 0 0 2 (2) | 60 | 50 |

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# Generic Elective Papers (GE) (Minor-Chemistry)
# BSHCHE-GE-1 CHEMISTRY I

Maximum Marks: 100 Time: 3 Hrs.
External Examination: 75 Pass marks: 40%
Internal Assessment: 25
(Credits: -04) Theory: 60Lectures

## Course Objectives

- The course is intended to emphasize on atomic structure and bonding.
- The course will enable the students to learn the basic concepts of chemical bonding and quantum mechanical approach to bonding.
- To describe the importance of 3-Dimensional structure of molecule and effect of this on physical and chemical properties.

## Course outcomes

After the completion of this course, the students will be able to:

- Understand the basic concepts of quantum mechanics and its applications in the study of structure of atom and bonding in molecules.
- Learn the concepts of electronic displacement and stereochemistry of organic molecules.
- Get complete knowledge of basic properties and chemical reactions of aliphatic hydrocarbons.

## Instructions for the Paper-Setter

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consistof 9 questions from the whole syllabus and will be of 3 marks each.

## Instructions for the Candidates

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

## UNIT-I

### Inorganic Chemistry

### Atomic Structure:

Idea of de Broglie matter waves, Heisenberg's uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of $\Psi$ and $\Psi^2$, probability distribution curves, shapes of s, p, d, f orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rules, electronic configuration of elements, effective nuclear charge & Slater's rules.

### Periodic table and atomic properties

Classification of periodic table into s, p, d, f blocks, atomic and ionic radii, ionization

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energy, electron affinity and electronegativity.

**Ionic Bonding:** General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

**Covalent Bond:** Valence bond theory (Heitler-London and Pauling approach) and its limitation, directional characteristics of covalent bond, various type of hybridization and shapes of the simple inorganic molecules and ions ($BeF_2$, $BF_3$, $CH_4$, $PF_5$, $SF_6$, $IF_7$, $SO_4^{-2}$, $ClO_4^{-1}$, $NO_3^{-1}$) valence shell electron pair repulsion (VSEPR) theory to $NH_3$, $H_3O^+$, $SF_4$, $ClF_3$, $H_2O$, $SnCl_2$, $ClO_3^{-1}$ and $ICl_2^{-1}$. Molecular orbital theory of homonuclear ($N_2$, $O_2$) heteronuclear (CO and NO) diatomic molecules. **(30 lectures)**

## UNIT-II

### Organic Chemistry

### Structure and Bonding

Localized and delocalized chemical bond, Van der Waal's interactions, resonance: conditions, resonance effect and its applications, hyperconjugation, inductive effect, electromeric effect & their comparison.

### Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions.

Reactive intermediates: **C**arbocations, carbanions, free radicals, carbenes, (formation, structure & stability).

### Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism — elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centre, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, R & S systems of nomenclature.

Geometric isomerism: Determination of configuration of geometric isomers. E & Z system of nomenclature.

**(30 lectures)**

### Reference Books:


1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
4. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
5. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.



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# BSHCHE-GE-1(L): CHEMISTRY I LAB

Max. Marks: 50 No. of Lectures: 60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits- 02)

## Course Objectives

The objective of the course is to provide:

- An insight into the volumetric analysis (including redox titrations and acid-base titration.
- The deep knowledge of elemental analysis of organic compounds andchromatographic techniques.

## Course Outcomes

By the end of this course, students will be able to

- Determine the concentration of the primary and secondary solutions in terms ofmolarity & normality.
- Apply the principle of iodometry for the estimation of different ions.
- To develop the technique of chromatographic methods for the separation ofmixture.
- Get thorough knowledge of elemental analysis used for analysis of organiccompounds.

## UNIT-I

### Inorganic Chemistry:

#### 1. Titrimetric Analysis:

I. **Preparation of solutions:** To prepare the solutions of titrants of different Molarity/Normality.

II. **Acid-Base Titrations:**

a) Estimation of strength of oxalic acid solution using sodium hydroxide.

b) Estimation of strength of sodium carbonate and sodium hydroxide present together in a mixture.

III. **Oxidation-Reduction Titrimetry**:

a) Estimation of oxalic acid using standardized KMnO4 solution.

b) Determination of strength of Mohr's salt using Potassium dichromate (diphenyl amine as internal indicator)

## UNIT II

### Organic Chemistry:

#### 1. Element Detection:

Detection of extra elements (N, S, Cl, Br, I) in organic compound (containing upto two extra elements)

#### 2. Chromatography

a. Separation of a mixture of two amino acids by ascending and radial paper chromatography

b. Separation of a mixture of two sugars by ascending paper chromatography.

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**Reference Books:**

1. Svehl a, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

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# BSHCHE-GE 2: CHEMISTRY II

Maximum Marks: 100 Time: 3 Hrs
External Examination: 75 Pass marks: 40%
Internal Assessment: 25 Theory: 60 lectures
(Credits: 04)

## Course Objectives

- The objective of this course is to describe the basic concepts of thermodynamics, chemical equilibrium, and ionic equilibrium.
- To acquaint the students with aromatic hydrocarbons & halogenated hydrocarbons along with their comparative studies.

## Course Outcomes

The students will be able to

- Explain the fundamental thermodynamic properties and also be able to define and apply the laws of thermodynamics.
- Demonstrate an understanding of major reactions of alcohol, phenol, ether and carbonyl compounds.
- Get the knowledge about reactions of alkyl and aryl halides including the characteristics of nucleophilic substitution reactions.

## Instructions for the Paper-Setter

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

## Instructions for the Candidates

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory. Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

## UNIT-I

### Physical Chemistry

### Thermodynamics-I

Chemical Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems.

First law: statement of first law, internal energy (U) as state function, work (w) & heat (q) as path functions, enthalpy (H) & enthalpy change (ΔH), heat capacity, relation between heat capacities.

**Thermochemistry**: standard state, standard enthalpy of formation, standard enthalpy of combustion, standard enthalpy of neutralization, Hess's law and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature on enthalpy of reactions (Kirchhoff's

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equations).

**Thermodynamics-II**

Second Law: need for the second law of thermodynamics, Carnot cycle, statement of the second law of thermodynamics, concept of entropy, calculation of entropy changes for reversible and irreversible processes, physical significance of entropy.

**Thermodynamics-III**

Work function, Gibbs free energy, statement of third law of thermodynamics, exception to third law (concept of residual entropy).

**Ionic equilibria:**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water, ionization of weak acids & bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, buffer solutions**.** **(30 lectures)**

## UNIT-II

**Aromatic Hydrocarbons**

Structure and aromatic character of benzene.

Preparation: methods of preparation of benzene from phenol, benzoic acid, acetylene, and benzene sulphonic acid.

Reactions: electrophilic substitution reactions in benzene citing examples of nitration, halogenation, sulphonation and Friedel-Craft's alkylation and acylation.

**Chemistry of Halogenated hydrocarbons:**

**Alkyl halides:** Methods of preparation (from alkenes and alcohols), nucleophilic substitution reactions – SN1 and SN2 mechanisms with stereochemical aspects, effect of solvent, effect of substituent and its orientation; nucleophilic substitution vs elimination.

**Aryl halides**: Preparation (Sandmeyer reaction), including preparation from diazonium salts. nucleophilic aromatic substitution; Benzyne mechanism.

**Alcohols:**

Preparation: Preparation of $1^{\circ}$, $2^{\circ}$ and $3^{\circ}$ alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid, and esters.

Reactions: With sodium, HX (Lucas's test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. $HNO_3$).

**Aldehydes and ketones (aliphatic and aromatic):**

Preparation: from acid chlorides and nitriles.

Reactions: Aldol condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction & Wolff Kishner reduction. **(30 lectures)**

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**Reference Books:**


1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
8. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).



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# BSHCHE-GE-2(L): CHEMISTRY II LAB

Max. Marks: 50 No. of Lectures: 60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits-02)

## Course Objectives

- The objective of the course is to provide an insight into the thermochemistry including determination of heat capacity, enthalpy of neutralization, enthalpy of ionization and enthalpy of hydration.
- To give the knowledge of pH measurement which is useful in chemical analysis.
- To develop the skills for the determination of melting & boiling point of organic compounds. Along with this, the technique of crystallization is developed in a learner which is used for the purification of substance.
- To provide an insight into organic synthesis of various compounds including its mechanistic and synthetic approach.

## Course Outcomes

After the completion of this course, the students will be able to

- Study the heat and energy associated with a chemical reaction.
- Use the essential skill of preparing the buffer solution on academic and industrial front.
- Turn a recipe to a successfully completed synthesis and understand the chemical principle behind. Along with this, they will be capable to purify the compound by the means of crystallization and distillation.

## UNIT I (Physical Chemistry)

### 1. Thermochemistry:

a) Determination of heat capacity of calorimeter.

b) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

c) Determination of enthalpy of ionization of acetic acid.

d) Determination of integral enthalpy of solution of salts ($KNO_3$, $NH_4Cl$).

### 2. Ionic equilibria:

Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

## UNIT II (Organic chemistry)

### 1. Criteria of Purity:

a) Purification of organic compounds by crystallization using the following solvents:

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Water
Alcohol
Alcohol-Water

b) Determination of the melting points of organic compounds

c) Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method).

2. **Organic Preparations:**

Preparation of Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone (Recrystallisation, determination of melting point and calculation of quantitative yields to be done.)

**Reference Books:**

a. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
b. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
c. Khosla, B. D; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand and Co: New Delhi (2011).

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