




**MAHARAJA SURAJMAL BRIJ UNIVERSITY**  
**BHARATPUR (RAJASTHAN)**

**SYLLABUS FOR B.Sc. CHEMISTRY**  
**(THREE/FOUR YEAR UNDER GRADUATE PROGRAMME)**

**I & II SEMESTER**  
**EXAMINATION-2023-24**

  
**डॉ. अरुण कुमार पाण्डेय**  
उपकुलसचिव  
प्रभारी अकादमिक प्रथम

# CHEMISTRY

PROGRAMME PREREQUISITES/ELIGIBILITY
12 <sup>th</sup> standard pass in science from CBSE, RBSE or a recognized board of education.
PROGRAMME OUTCOMES (POs)
<ol style="list-style-type: none"><li>1. Basic Knowledge of Science: Students will get acquainted with the knowledge of chemical science which helps them to understand various phenomena happening in their surroundings.</li><li>2. Dealing with untoward incidence: The knowledge of science will help them to deal with untoward incidents in the neighborhood. For example, sudden explosion by chemicals and excessive misuse of unwanted substances can be managed with basic knowledge of chemistry and environmental pollution can be controlled by the students by spreading awareness in the society about the harmful pollutants.</li><li>3. Proficiency in Scientific Principles: Students will demonstrate a strong understanding of fundamental scientific principles in chemistry and they will be able to apply these principles to analysis and solution.</li><li>4. Quantitative and Computational Skills: Students will acquire proficiency in quantitative, analytical and computational principles. They will be able to perform calculations, manipulate mathematical expressions, and use computational tools to solve scientific problems.</li><li>5. Experimental and Laboratory Skills: Students will gain practical experience conducting experiments, using laboratory apparatus and equipment, and performing experimental data analysis. They will understand the importance of accurate measurement, data interpretation, and documentation.</li><li>6. Employability: Students will get employment in the following sectors:<ul style="list-style-type: none"><li>➤ The students can go in chemical and related industries viz. Pharmaceutical, Agrochemicals, Metallurgical, Fertilizer, Biofertilizer, Organic fertilizer, Textile, Food ceramic, Cement, Petrochemicals, Pesticides Plastics and Polymers etc.</li><li>➤ The students can go for Ballistics, Forensic Lab, Bio Warfare Labs, CBIR Labs, DRDO, Industrial Chemistry etc.</li><li>➤ They can opt a career in Petroleum, Soil Testing Labs environment conservation, preservation, and as Analytical Chemist, Chemical Product Officer, Radiologist and Toxicologist.</li></ul></li><li>7. Development of communication skills: Students will develop effective oral and written communication skills. They will be able to clearly and concisely communicate scientific ideas, principles and experimental results to both technical and non-technical audiences.</li><li>8. Development of Teamwork and Collaboration Skills: Students will develop teamwork and collaboration skills through group projects, laboratory work, and research activities. They will be able to work effectively in diverse teams and contribute to collective goals.</li></ol>

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15/10/23

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## SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0802/03 – Four Year Bachelor of Science (B.Sc. Pass Course)						
Subject/Discipline - Chemistry						
Credit Framework for Four Year Bachelor of Science under NEP – 2020						
Academic Session 2023-2024						
S. No.	Semester	Course Code	Course Title	Credits		Marks
				L	P	
1.	I	CHM-51T-101	Structure-bonding, Mathematical concept and States of matter	4	0	100
2.	I	CHM-51P-102	Chemistry Lab-I	0	2	50
3.	II	CHM-52T-103	Reaction mechanism, Stereochemistry, Aromatic hydrocarbon and Chemical kinetics.	4	0	100
4.	II	CHM-52P-104	Chemistry Lab-II	0	2	50

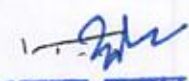
### Scheme of Examination:

1 credit = 25 marks for examination/evaluation

#### Notes:

Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (20% weightage) and (End of Semester Examination) EoSE (80% weightage).

1. Sessional work will consist of class tests, mid-semester examination(s), homework assignments, etc., as determined by the faculty in charge of the courses of study.
2. Each Paper of EoSE shall carry 80% of the total marks of the course/subject. The EoSE will be of 3 hours duration.
  - Part-A of the paper shall have multiple questions of equal marks. This first question shall be based on knowledge, understanding and applications of the topics/texts covered in the syllabus.
  - Part B of the paper shall consist of 4 questions with an internal choice of each. The four questions will be set with one from each of the units with internal choice. Third to fourth questions shall be based on applications of the topics/texts covered in the syllabus (60% weightage) and shall involve solving Problems (40% weightage) if applicable.
3. 75% Attendance is mandatory for appearing in EoSE.
4. To appear in the EoSE examination of a course/subject student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.

  
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5. Credit points in a Course/Subject will be assigned only if, the student obtains at least a C grade in midterm and EoSE examination of a Course/Subject.

## Syllabus: UG0802/03 - B.Sc. (Pass Course)

### CHEMISTRY

#### Semester – I (2023-2024)

Course Code	Course Title	Duration	Maximum Marks	Minimum Marks
CHM-51T-101	Structure-bonding, Mathematical concept and States of matter	MT - 1 Hr. EoSE - 3 Hrs.	MT - 20 EoSE - 80	MT - 08 EoSE - 32
CHM-51P-102	Chemistry Lab-I	MT - 2 Hrs. EoSE - 4 Hrs.	MT - 10 EoSE - 40	MT - 04 EoSE - 16
Prerequisites/Eligibility	12 <sup>th</sup> standard pass in science from CBSE, RBSE or a recognized board of education.			
<p><b>Course Objectives:</b> The aim of this course is to provide students with a theoretical understanding of the basic constituents of matter; atoms, ions and molecules in terms of their electronic structure and chemical bonding of these are to be explained by applying basic quantum chemistry. The objective of this course is to explain the basic concepts of mathematics and to explain the structural differences and transformations between states of matter. In addition, the laboratory course is designed to provide students with practical experience in basic qualitative analytical techniques, the use of laboratory techniques, and the determination of physical properties of matter.</p>				
<p><b>Course Outcomes:</b> By the end of this course, students will have a clear understanding of various concepts related to atomic and molecular structure, chemical bonding, mathematical concepts, and states of matter. Students will also have practical experience in calibration of glassware, qualitative analysis of radicals, identification of functional groups in organic compounds, determination of various physical properties of substances, crystallization and preparation of standard solutions of different concentrations.</p>				

### Syllabus

CHM-51T-101: Structure-bonding, Mathematical concept and States of matter.  
(4 Hrs./week)

Duration

1 Hour  
3 Hours

Maximum Marks

Midterm – 20 Marks  
EoSE – 80 Marks

Minimum Marks

Midterm – 08 Marks  
EoSE – 32 Marks

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M. Singh  
R. S. D.  
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### Unit-I

**Ionic Solids:** General characteristics of ionic bonding, ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice enthalpy and Born-Landé equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, Solvation enthalpy and solubility of ionic solids, polarizing power and polarizability, Fajan's rule. lattice defects, semiconductors.

**Metallic bond:** Free electron, valence bond and band theories.

**Weak Interactions:** Hydrogen bonding, Van der Waals forces.

15 Lecture

### Unit-II

**Covalent Bond:** Valence bond theory and its limitations, Directional character, Hybridization. Valence shell electron pair repulsion (VSEPR) theory to  $\text{NH}_3$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{ICl}_2^-$ ,  $\text{H}_2\text{O}$ .

**Molecular Orbital Theory:** LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for combinations of atomic orbitals, MO treatment of homonuclear and heteronuclear (CO and NO) diatomic molecules. Comparison of VB and MO approaches.

Multicenter bonding in electron deficient molecules, bond strength and bond energy, ionic character in covalent compounds, calculation of percentage ionic character from dipole moment and electronegativity difference.

15 Lecture

### Unit-III

**Mathematical Concepts:** Logarithmic relations, curve sketching, linear graphs and calculations of slopes, differentiation of functions like  $kx$ ,  $e^x$ ,  $x^n$ ,  $\sin x$  and  $\log x$ ; maxima and minima, partial differentiation and integration of some useful/relevant functions;

**Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid.

**Solid State:** Definition of space lattice, unit cell.

Laws of crystallography- (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

Basic concept of X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl and CsCl (Laue's method and powder method.)

15 Lecture

### Unit-IV

**Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state.

**Critical Phenomenon:** PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.

**Molecular Velocities:** Root mean square, average and most probable velocities. Qualitative

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discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect.)  
 Colloidal State: Definition of colloids, classification of colloids.  
 Solids in liquids (sols): properties - kinetic, optical and electrical, stability of colloids. Protective action, Hardy-Schulze law, gold number.  
 Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.  
 Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

15 Lecture

**Suggested Books and References:**

1. Lee, J.D. Concise Inorganic Chemistry Wiley, India.
2. Housecroft, Catherine E. & Sharpe, Alan G. Inorganic Chemistry, Pearson Education Ltd.
3. Tuli, G. D. Advanced Inorganic Chemistry, S. Chand, New Delhi.
4. Satya Prakash Advanced Inorganic Chemistry, S. Chand, New Delhi.
5. Adams, D. M. Inorganic Solids – Introduction to Concepts in Solid-state Structural Chemistry, John Wiley, London.
- ⇒ 6. Puri, Sharma & Kalia, Principles of Inorganic Chemistry, S. Chand, New Delhi.
7. Puri, B. R., Sharma, L. R. & Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.
8. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House.
9. Atkins, W. Physical Chemistry, Oxford University Press.
10. Silby, R. J. & Alberty, R. A. Physical Chemistry, John Wiley & Sons.
11. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill.
12. Kapoor, K. L. A Textbook of Physical Chemistry, (Volume I) Macmillan India Ltd.

**Syllabus**

CHM-51P-102: Chemistry Lab I

(4 Hrs./week)

**Duration**

**Maximum Marks**

**Minimum Marks**

2 Hours

Midterm – 10 Marks

Midterm – 04 Marks

4 Hours

EoSE – 40 Marks

EoSE – 16 Marks

**Inorganic Chemistry**

10 marks

Separation and identification of six radicals (3 cations and 3 anions) in the given inorganic mixture including special combinations.

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**Organic Chemistry****Laboratory Techniques****3 marks**

- (a) Determination of melting point (naphthalene, benzoic acid, urea, etc.); boiling point (methanol, ethanol, cyclohexane, etc.); mixed melting point (urea-cinnamic acid, etc.).  
 (b) Crystallization of phthalic acid and benzoic acid from hot water, acetanilide from boiling water, naphthalene from ethanol etc.; Sublimation of naphthalene, camphor, etc.

**Qualitative Analysis****7 marks**

Identification of functional groups (unsaturation, phenolic, alcoholic, carboxylic, carbonyl, ester, carbohydrate, amine, amide, nitro and hydrocarbon) in simple organic compounds (solids or liquids) through element detection (N, S and halogens).

**Physical Chemistry****Viscosity and Surface Tension:****10 marks**

- a) To determine the viscosity/surface tension of a pure liquid (alcohol etc.) at room temperature. (Using the Ostwald viscometer/stalagmometer).  
 b) To determine the percentage composition of a given binary mixture (acetone and ethyl methyl ketone) by surface tension method.  
 c) To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method.  
 d) To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity of these solutions.

**Viva voce****5 marks****Practical Record****5 marks****Syllabus: UG0802/03-B.Sc. (Pass Course)****CHEMISTRY**  
**Semester – II (2023-2024)**

Course Code	Course Title	Duration	Maximum Marks	Minimum Marks
CHM-52T-103	Reaction mechanism, Stereochemistry, Aromatic hydrocarbons and Chemical kinetics.	MT - 1 Hr. EoSE - 3 Hrs.	MT - 20 EoSE - 80	MT - 08 EoSE - 32
CHM-52P-104	Chemistry Lab-II	MT - 2 Hrs. EoSE - 4 Hrs.	MT - 10 EoSE - 40	MT - 04 EoSE - 16

Course Objectives: The objective of this course is to provide students with a theoretical understanding of the types of organic reactions and their mechanisms, generation and stability

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of various intermediates, determination of reaction mechanism, stereochemistry of organic compounds with an understanding of the enantiomers, diastereomers, D/L and R/S nomenclature. The aim of this course is to explain the structure and reactivity of aromatic hydrocarbons, and to explain the order and molecularity of the reactions, the rate law and order of reactions determination. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

**Course Outcomes:** By the end of this course, students will have a clear understanding of drawing logical and detailed reaction mechanisms for various fundamental reactions of aliphatic and aromatic hydrocarbons, methods of determining the reaction mechanisms, classifying the molecules as chiral or achiral, determining the D/L and R/S nomenclature of stereoisomers and identifying the formation of racemic mixture or optically active compounds during the reactions. Students will also have an understanding about order and molecularity of reactions, rate law and methods determining of order and kinetic parameters of reactions. Students will also have practical experience in quantitative analytical techniques including volumetric analysis, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

## Syllabus

**CHM-52T-103: Reaction mechanism, Stereochemistry, Aromatic hydrocarbons and Chemical kinetics.**

Duration	Maximum Marks	Minimum Marks
1 Hour	Midterm – 20 Marks	Midterm – 08 Marks
3 Hours	EoSE – 80 Marks	EoSE – 32 Marks

### Unit-I

**Introductory Concept and Mechanism of Organic Reactions:** IUPAC nomenclature of organic compounds, Dipole moment, Inductive and field effects, electromeric effect, conjugation, resonance and resonance energy, hyperconjugation. Homolytic and heterolytic bond cleavage. Type of reagents, electrophiles and nucleophiles. Reactive intermediates - carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (generation, reactions and stability). Types of organic reactions. Markovnikov's rule, Anti-Markovnikov's rule, Saytzeff's rule and Hofmann elimination. Energy considerations. Methods of determination of reaction mechanism (product analysis, intermediates, isotope labelling, kinetic and stereochemical studies), isotope effects.

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### Unit-II

**Stereochemistry of Organic Compounds:** Concept of isomerism, Types of isomerism, Difference between configuration and conformation, Flying wedge and Fischer projection formulae.

**Optical Isomerism:** Elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity. Properties of enantiomers, chiral and achiral molecules with two stereogenic centres. Diastereomers, threo and erythro isomers, meso compounds. Resolution of enantiomers. Inversion, retention and racemization (with examples).

Relative and absolute configuration, sequence rules, D / L and R / S systems of nomenclature.

**Geometrical Isomerism:** Determination of configuration of geometric isomers - cis / trans and E / Z systems of nomenclature. Geometrical isomerism in oximes and alicyclic compounds.

**Conformational Isomerism:** Newman projection and Sawhorse formulae, Conformational analysis of ethane, *n*-butane and cyclohexane.

15 Lecture

### Unit-III

**Arenes and Aromaticity:** Nomenclature of benzene derivatives. The aryl group, aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO diagram.

**Aromaticity:** Huckel rule, aromatic ions-three to eight membered.

**Aromatic electrophilic substitution:** General pattern of the mechanism, role of sigma and pi complexes. Mechanism of nitration, halogenation, sulphonation, mercuration, chloromethylation and Friedel crafts reactions. Energy profile diagrams. Activating and deactivating substituents.

Directive influence orientation and ortho/para ratio. Side chain reactions of benzene derivatives.

Birch reduction.

15 Lecture

### Unit-IV

**Chemical Kinetics:** Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction: concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions - zero order, first order, second order and pseudo-order; half-life and mean-life. Determination of the order of reaction - differential method, method of integration, method of half-life period and isolation method.

Radioactive decay as a first order phenomenon.

Experimental methods of chemical kinetics: conductometric, potentiometric, optical methods, (polarimetry) and spectrophotometric method. Theories of chemical kinetics. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.

Simple collision theory based on hard sphere model transition state theory (equilibrium hypothesis)

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**Suggested Books and References:**

1. Gupta, S. S. Organic Chemistry, Oxford University Press.
2. Ahluwalia, V. K. Organic Reaction Mechanisms, Narosa Publishing House, New Delhi.
3. Agarwal, O. P. Organic Chemistry – Reactions and Reagents: Covering Complete Theoretical Organic Chemistry, Goel Publishing House, Meerut.
4. Morrison R. T. & Boyd R. N. Organic Chemistry, Prentice Hall.
5. Finar, I. L. Organic Chemistry (Vol. I & II) ELBS.
6. Bahl A. & Bahl B. S. Advanced Organic Chemistry, S. Chand.
7. Jain, M.K. & Sharma, S.C. Modera Organic Chemistry, Vishal Publishing Co.
8. March, J. & Smith, M. B. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Wiley.
9. Ahluwalia, V. K. Stereochemistry of Organic Compounds, Springer.
10. Puri, B. R., Sharma, L. R. & Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.
11. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House.
12. Kapoor, K. L. A Textbook of Physical Chemistry, (Volume 5) Macmillan India Ltd.

**Syllabus**

CHM-52P-104: Chemistry Lab II

Duration

2 Hours

4 Hours

Maximum Marks

Midterm – 10 Marks

EoSE – 40 Marks

4 Hrs./week

Minimum Marks


Midterm – 04 Marks

EoSE – 16 Marks

Inorganic Chemistry  
Volumetric Analysis

- (a) Determination of acetic acid in commercial vinegar using NaOH
- (b) Determination of alkali content in antacid tablet using HCl
- (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
- (d) Estimation of hardness of water by EDTA
- (e) Estimation of ferrous and ferric by dichromate/permanganate method.
- (f) Estimation of copper using thiosulphate by iodometric method.

10 marks

  
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Organic Chemistry

10 marks

Qualitative Analysis

Identification of organic compound through the functional group analysis, determination of melting point, boiling point and specific test.

Physical Chemistry

10 marks

Chemical Kinetics:

- To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl acetate catalyzed by hydrogen ions at room temperature.
- To study the effect of acid strength on the hydrolysis of an ester.
- To compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying the kinetics of hydrolysis of ethyl acetate.
- To study kinetically the reaction rate of decomposition of iodide by H<sub>2</sub>O<sub>2</sub>.

Viva voce

5 marks

Practical Record

5 marks

M. Singh  
16/10/2023

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16/10/2023

  
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