SCHEME AND SYLLABUS FOR UNDER GRADUATE COURSE IN CHEMISTRY (Bachelor of Science)

For

I and II Semesters

Framed according to the State Education Policy

(SEP-2024)

(Effective from the Academic Year 2024-2025)

BANGALORE UNIVERSITY

Department of Chemistry

Jnanabharathi Campus

Bengaluru - 560 056

July 2024

FOREWORD

In accordance with the directive from Bangalore University, the Chemistry syllabus for the B.Sc. degree course (SEP-24) was revised. The Bangalore University provided comprehensive guidelines to ensure the curriculum meets contemporary academic standards with applied component.

At the Department of Studies in Chemistry, Bangalore University, a collaborative effort was undertaken with the Chemistry Teachers Forum to form a Core Group comprising faculty from the University Department and affiliated colleges. This Core Group engaged in detailed discussions during Zoom meetings held on 08.06.2024 and 18.06.2024, respectively. The objective was to align the syllabus with the UGC Model Curriculum, which emphasizes interdisciplinary skills, integration of general studies with professional courses, and providing both vertical and horizontal mobility while addressing local educational needs. Faculty members specializing in Inorganic, Organic, and Physical Chemistry conducted both separate and joint brainstorming sessions. These sessions were instrumental in developing a comprehensive draft syllabus for both the I and II semesters. The Chemistry Teachers' Forum designed this syllabus by ensuring the to allow for flexibility in programme, diverse perspectives and educational requirements of the students. Notably, regularly updating the curriculum reflects the commitment to providing high-quality education, fostering a learning environment that promotes critical thinking, innovation, and excellence. Finally, the syllabus revision process not only enhances the academic framework but also ensures that students are equipped with relevant knowledge and skills to meet future challenges and opportunities in the field of Chemistry

The initial Draft Syllabus was shared with a broader group of teachers on 28th June 2024 for further refinement. The final draft, incorporating suggestions from the wider teaching community, was presented to the Department Council on 01.07.2024 of Department of Chemistry, Bangalore University. Following this, it was submitted to the Board of Studies in Chemistry (UG) on 02.07.2024 for approval. I, sincerely, hope that the present syllabus will be a guiding force for the undergraduate students enrolled under Bangalore University Curriculum for years to come.

CHAIRMAN

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Jnanabharathi Campus
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Members of the Committee for the Preparation of the Chemistry Syllabus for the B. Sc., Degree Course (Semester Scheme-SEP)

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Dr. Yogeesha N.	GFGC, Ramanagara
Dr. Nebula Murukesh	St. Francis de Sales College, Electronic city, Bengaluru

Proceedings

Programme outcome:

By the end of the programme the students will:

1. Understand the basic principles of various branches of chemistry.
2. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups.
3. Apply the key concepts and standard methodologies to solve problems related to chemistry.
4. Apply methodologies to the solution of unfamiliar types of problems.
5. Exhibit skills leading to employability in Chemistry and allied industries
6. Comprehend the fundamental aspects of research in Chemistry.
7. Identify chemical formulae and solve numerical problems.
8. Possess the level of proficiency in subject required for post graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects.
9. Introducing Students to modern techniques, various equipments and Chemical softwares.
10. Design solutions stemming from the application of chemistry to local issues.
11. Understand good laboratory practices and safety.
12. Opportunity to the students for getting job in industries besides academic and administrative works.

Program Duration:

The B.Sc. Programme with Chemistry is of three years duration. Each year is called an academic year and is divided into two semesters. Thus, there will be a total of six semesters.

Assessment : Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment Marks /ESE
Theory	20	80
Practical	10	40

The curriculum will be delivered through various methods including chalk and talk, power point presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, field trips/Industry visits, seminars (talks by experts), workshops, projects, models and class discussions. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination (SEE).

COURSE PATTERN AND SCHEME OF EXAMINATION

Title of the paper	Teaching hours	Contact hours/Week	Exam. hours	IA	Marks	Total Marks	Credits
First Semester							
Chemistry-I BCHMT-01	60	4	3	20	80	100	4
Chemistry Practical-I BCHMP-01	56	3	3	10	40	50	2
Second Semester							
Chemistry-II BCHMT-02	60	4	3	20	80	100	4
Chemistry Practical-II BCHMT-02	56	3	3	10	40	50	2

Scheme of Internal Assessment Marks : Theory

Sl no.	Particulars	I A Marks
1	Attendance	05
2	Internal Tests (Minimum of Two)	10
3	Assignments/Seminars	05
	Total Theory IA marks	**20**

Scheme of Internal Assessment Marks : Practicals

Sl no.	Particulars	I A Marks
1	Practical Test	07
2	Active participation in practical classes	03
	Total Practical IA marks	**10**

QUESTION PAPER PATTERN

First Semester B.Sc. Degree Examination

(SEP Scheme-2024-25)

CHEMISTRY

Time: 3 Hours Max. Marks: 80

Instructions: Answer Q. no. 1 and any 6 of the following

1. Answer any TEN of the following 10X2 = 20 Marks

   a)

   b)

   c)

   d)

   e)

   f)

   g)

   h)

   i)

   j)

   k)

   l)

2. Q. no. 2 from Unit-I 10 Marks

   a)

   b)

   c)

3. Q. no. 3 from Unit-II 10 Marks

   a)

   b)

   c)

4. Q. no. 4 from Unit-III 10 Marks

   a)

   b)

   c)

5. Q. no. 5 from Unit-IV 10 Marks

   a)

   b)

   c)

6. Q. no. 6 from Unit-I and II 10 Marks

   a)

   b)

   c)

7. Q. no. 7 from Unit-II and III 10 Marks

   a)

   b)

   c)

8. Q. no. 8 from Unit-III and IV 10 Marks

   a)

   b)

   c)

9. Q. no. 9 from Unit-I and IV 10 Marks

   a)

   b)

   c)

Pattern for Question Nos. 2 to 9

- 4+3+3 = 10 Marks
- 5+5 = 10 Marks

Scheme of Evaluation for Practical Examination

Sl. no.	Examination particulars	Marks allotted
1	Experimental performance	25
2	Procedure Writing	05
3	Record assessment	05
4	Oral performance (Viva-voce)	05
Total		**40**

First Semester B.Sc. (Chemistry) as per SEP Scheme

Title of the paper	**Chemistry-I (Theory)** BCHT-01	No. of Credits	04
Total Contact hours/Sem	60 hours	Teaching Hours	4 hrs / Week
Internal Assessment marks	20	Summative Assessment Marks	80

Objectives:

The objective of this course is to make the students aware about the SI Units, various analytical methods, types of errors in chemical analysis. It discusses the Periodicity in properties with reference to the *s* and *p* block, which is necessary in understanding their group chemistry, noble gases. The course is also infused with fundamentals of organic chemistry. To establish the applications on the concepts like alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. It is emphasising on the concept of gases, liquids and solutions.

Course Learning Outcomes:

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

- Understanding of the Fundamentals of Analytical Chemistry.
- Understand the use of SI units and its conversion
- Review the modern periodic table and periodic properties
- Knowledge of p, d and f block elements
- Applications of fluorides and oxides
- Basic concepts in organic chemistry
- Detailed study of the Noble gases
- Understand the concept of Gases, liquids and solutions
- To learn the transport processes of liquids and gases.

Course Articulation Matrix: Mapping of course outcome (Cos) with programme outcomes

Sl no.	Course outcome (Cos) / Programme POs)	1	2	3	4	5	6
1	Learn the concepts of chemical analysis, accuracy precision and statistical data treatment	x					
2	Prepare the solutions after calculating the required quantity of chemicals in preparing the reagent/solutions and dilute of stock solution		x				

3	Know the basic information of periodic table and periodic properties		x	x			
4	Properties with reference to the *s* and *p* block elements			x			
5	Understand the concepts of noble gases and their compounds in detail.	x					
6	Elementary ideas on lanthanides and actinides			x	x		
7	To know the importance of Nomenclature and preparations of alkanes, alkynes	x			x	x	
8	Derivation of critical constants T_c, P_c and V_c and their experimental determination		x			x	x

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark X in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: BCHT-01 Chemistry-I:

UNIT-I

Analytical Chemistry **15 hours**

Definitions of the Basic Units: Mass, Length, Time, Temperature, Amount of substance, Derived units, conversion between units.

Chemical concentrations: Molar concentration, Analytical molarity, Equilibrium molarity of a particular species, Percent concentration, Parts per million/billion (ppm/ppb), Volume ratios for dilution procedures.

Preparation of solutions: standard solutions, primary standards, secondary standards.

Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method - accuracy, precision, sensitivity, selectivity and method validation.

Errors and treatment of analytical data: Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. Standard calibration curve - correlation coefficient (R^2). Numerical problems.

UNIT-II

Periodic table and Periodic properties **3 hours**

Review of the modern periodic table and Periodic Properties

Comparative study of elements of alkali and alkaline earth metals, chalcogens and halogens with respect to electronic configuration, atomic and ionic radii, ionisation energy and electronegativity.

p-Block Elements **5 hours**

Group–13: Structure of diborane and higher Boranes (B_4H_{10} and B_5H_9), Boron nitrogen compounds ($B_3N_3H_6$ and BN), Lewis acid nature of BX_3.

Group – 14: Carbides; Classification as ionic, covalent, interstitial. Structures and reactivity. Industrial applications. Silicones; Classification – straight chain, cyclic and cross-linked. Group – 15: Nitrides – Classification – ionic, covalent and interstitial. Reactivity – hydrolysis. Reactions of hydrazine, hydroxyl amine, phosphazenes.

General study of d and f block elements. **4 hours**

Transition elements: electronic configuration, atomic and ionic radii, ionization energy, oxidation states, redox potentials, spectral and magnetic properties, catalytic activity, interstitial compound formation. Lanthanides and Actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion exchange method for separation of Lanthanides. comparison of oxidation states, complex formation and magnetic properties of d and f block elements.

Noble gases **3 hours**

Introduction, isolation of Helium from Natural gas, applications of Noble gases. Preparation properties and structures of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

Unit-III

Basic concepts in organic chemistry: **3 hours**

Bond cleavage – homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes – explanation for stability and reactivity based on inductive, resonance and hyperconjugation effects. Types of reactions - addition, substitution and elimination. Concept of isomerism - structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral centre – definition and examples.

Aliphatic Hydrocarbons **12 hours**

Alkanes: Sources, nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes, Corey-House synthesis, Wurtz reaction and Wurtz-Fittig reaction- their merits and demerits.

Difference between conformation and configuration. Conformations of ethane, propane and butane, explanation of stability based on energy profile diagrams.

Conformation and stability of 1,2- dichloroethane, ethylene glycol and acetaldehyde.

Cycloalkanes: Nomenclature. Method of formation, explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds. Conformations of cyclohexane (chair, twist boat, boat, half-chair and envelop forms and their stability). Geometrical isomerism with examples, *cis* and *trans* isomerism in 1,2- dimethylcyclopropane and 1,2-dimethylcyclohexane.

Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration-demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and importance.

Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.

Alkynes: Preparation- Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: alkylation of terminal alkynes and conversion to higher alkynes, ozonolysis and oxidation with hot alk. $KMnO_4$.

Unit-IV

Gaseous state **9 hours**

Introduction: Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule (explanation of the terms only). Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for RMS velocity, average velocity and relationships between them. Numerical problems.

Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details).

Derivation of critical constants T_c, P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c. Amagat's mean density method for V_c. Problems on the calculation of T_c, P_c and V_c, *a* and *b*.

Law of corresponding states-statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

Liquids and Solutions **6 hours** **Viscosity**-Definition, mathematical expression, coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it.

Surface tension-Definition, mathematical expression, effect of temperature and solute on it.

Completely miscible liquids: Fractional distillation, Tc curves for all the three types, azeotropic mixtures with examples. Critical solution temperature (three types), examples. Effect of addition of salt on CST of phenol-water system.

Immiscible liquids: Steam distillation and its applications.

Distribution law: Statement, partition coefficient and condition for validity of distribution law. Application-solvent extraction.

Reference books :

1. Analytical Chemistry: Basic Concepts, Priti Malhotra, Ane Books Pvt Ltd, 2021.
2. Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
3. Inorganic Chemistry, ELBS 2nd Edition, D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
4. Organic Chemistry, Morrison, R.T. & Boyd, R.N. Pearson, 2010.
5. Physical Chemistry, Castellan, G.W. 4th Ed. Narosa, 2004.
6. Advanced Organic Chemistry, Bahl, A. & Bahl, B.S, S. Chand, 2010.

Additional References:

1. Organic Chemistry, Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. John Wiley & Sons, 2014.
2. Inorganic Chemistry, 4th Edition, J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
3. Analytical Chemistry, Gary D. Christian, 6th Edition, Wiley, 2007
4. Physical Chemistry, Barrow, G.M. Tata McGraw-Hill, 2007.

I Semester: Practical I (Inorganic Chemistry)

Title of the paper	**Chemistry-I (Practical)** BCHP-01	No. of Credits	02
Duration of the Examination	03 hours	Teaching Hours	3 hrs / Week
Internal Assessment marks	10	Summative Assessment Marks	40

Course Learning Outcomes:

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

- Understand the calibration and handling of the glass wares
- Learn to carryout titrations
- Preparation of a solution of the desired concentration and the desired volume along with calculations to be taught
- Determination of the percentage of the given analyte
- Estimation of binary mixture.

Course Articulation Matrix: Mapping of course outcome (COs) with programme outcomes

Sl no.	Course outcome (Cos) / Programme POs)	1	2	3	4	5	6
1	Understand the safety practices in the Chemistry Laboratory	x	x				
2	Develop awareness regarding toxicity of chemicals		x		x		
3	Prepare standard/working solutions, standard solutions		x	x			
4	Determination of the respective analyte			x			
5	Determination of the percentage of the chemicals in a given solution	x				x	
6	Estimation of an analyte in the standard solutions			x	x		
7	Estimation of binary mixtures	x			x	x	
8	Derivation of critical constants T_c, P_c and V_c and their experimental determination		x			x	x

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark X in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: BCHP-01 Chemistry-I:

List of Experiments to be conducted

1. Calibration of glass wares; pipette, burette and volumetric flask.
2. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution using internal indicator.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution using external indicator.
4. Estimation of sodium thiosulphate using standard potassium dichromate solution.
5. Determination of the percentage of available chlorine in the given sample of commercial bleaching powder.
6. Determination of percentage of manganese dioxide from pyrolusite ore.
7. Estimation of the amount of alkali present in soaps/detergents.
8. Estimation of potassium permanganate using standard sodium oxalate solution.
9. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
10. Estimation of the amount of carbonate and bicarbonate in the given mixture.

Second Semester B.Sc. (Chemistry) as per SEP Scheme

Paper Title	**Chemistry-II (Theory)**	No. of Credits	04
Total Contact hours / Sem	60 hours	Teaching Hours	4 hrs / Week
Internal Assessment marks	20	Summative Assessment Marks	80
Paper	II	Duration of the Examination	03 hours

Objectives:

The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding. Structure, properties and applications of silicates. To establish applications of aromatic hydrocarbons, alkyl and aryl halides. Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, radial and angular distribution curves, shapes of s, p, and d orbitals. The constitution of the course strongly focuses on the Colligative properties of the solutions. It helps in understanding the photophysical and photochemical processes. The course explains the properties of Colloids and relates with the Surface chemistry and catalysed surface reactions. This course helps the students to relate the structure of an organic compound to its physical and chemical properties.

Course Learning Outcomes:

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

- Thorough understanding of chemical bonding with special emphasis on ionic, covalent bonding
- Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR
- theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Formulate the mechanism of colligative properties.
- Deeper insight of Quantum Mechanics
- Use the concepts learnt to predict feasibility of photochemical reactions.
- Understanding of surface phenomena like surface tension, Adsorption, Colloids

Course Articulation Matrix: Mapping of course outcome (COs) with programme outcomes

Sl no.	Course outcome (Cos) / Programme POs)	1	2	3	4	5	6
1	Approaches related with the valence bond theory and hybridization	x		x			
2	Understanding the mechanism of nucleophilic and electrophilic reactions	x			x		
3	To discuss on the postulates of quantum mechanics		x		x		
4	Learn the importance of orbital shapes			x	x	x	
5	Structure and applications of zeolites and silicates	x				x	
6	Understand the laws of photochemistry and photochemical processes		x		x		
7	Kinetic, Optical and Electrical stability of colloids	x	x			x	
8	Gain an insight to the mechanism behind the reaction and the significance of catalysts		x			x	x

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark X in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: BCHP-02 Chemistry-II:

UNIT-I

Chemical Bonding **13 hours**

Ionic bond: Lattice energy, Born-Haber cycle, Born-Lande equation (No derivation), problems on it. Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds. Polarization concept, Fajan's rule, polarity and polarizability of ions.

Covalent bond: Valence bond approach; hybridization and directional characteristics of sp, sp^2, sp^3, sp^2d, sp^3d^2. Shapes of $BeCl_2$, BF_3, $SiCl_4$, PCl_5 and SF_6. VSEPR theory: shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3 and ICl_2. Molecular orbital theory: H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-}, O_2^{2+}, CO and NO (bond order, stability and magnetic properties to be discussed). Bond length, bond angle and bond energy. Polar and non-polar molecules, dipole moment.

Weak interactions: i). Hydrogen bonding: Intra molecular and Intermolecular types, anomalous properties of HF, H_2O, NH_3, alcohols, carboxylic acids, nitro phenols and bio molecules. ii) van der Waals forces: Noble gases and molecular crystals (dry ice, Iodine and solid SO_2)

Metallic bond: Band theory, electrical properties of metals, semiconductors and insulators.

Silicates **2 hours**

Structure of SiO_4^{4-}, classification of silicates based on the structure. Zeolites: structure and applications.

UNIT-II

Aromatic hydrocarbons **10 hours**

Nomenclature. Structure of benzene using molecular orbital theory. Criteria for aromaticity-Huckel's rule (Examples: cyclopentadienyl anion, cycloheptatrieneyl cation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity.

General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.

Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene.

Alkenyl benzenes: Styrene, cis- and trans-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.

Organic halogen compounds **5 hours**

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - S_N1 and S_N2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

UNIT-III

Quantum Mechanics and Atomic Structure **12 hours**

Review of Bohr's atomic model:

Derivation of expressions for radius, energy and ionization energies of hydrogen like atoms. Numerical Problems.

Limitations of classical mechanics. Wave particle duality, Uncertainty principle.

New quantum mechanics-sinusoidal wave (Explanation). Schrodinger wave equation- derivation. Postulates of quantum mechanics.

Significance of the terms; Hamiltonian operator, Eigen function; Ψ (significance of ψ and ψ^2) and Eigen values.

Application of Schrodinger equation to particle in one dimensional box (derivation required), and to the hydrogen atom (detailed solution not required). Expressing the solution as a product of $\psi_{n,l,m}(r, \theta, \varphi) = \psi_{n,\ l.\ (r)}\psi_{\ l.\ m\,(\theta,\ \varphi)}$. Explanation on quantum numbers (only qualitative). Radial and angular probability distribution. Orbitals: shapes of s, p, d and orbitals. Contour, probability and boundary surface diagrams of orbital representation.

Colligative properties **3 hours**

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions.

Dilute solutions- Review of colligative properties and concentration terms.

Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (π); (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems.

UNIT-IV

Photochemistry **5 hours**

Introduction to photochemical reactions, Laws of photochemistry-Grotthus-Draper law, Stark-Einstein law. Differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene. Reasons for the high and low quantum yield. Problems based on quantum efficiency. Photosensitization and photostationary equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors. Jablonski diagram. Explanation of internal conversion, inter- system crossing Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.

Colloids **5 hours**

Definition of colloids. Classification of colloids. Solids in liquids (sols): preparations and properties – Kinetic, Optical and Electrical stability of colloids. Protective action. Hardy–Schultz law and Gold number. Liquids in liquids (emulsions): Types of emulsions, preparation and

emulsifier. Liquids in solids (gels): Classification, preparations and properties. General applications of colloids.

Adsorption and catalysis **5 hours**

Introduction. Types of adsorptions. Factors influencing adsorption. Freundlich adsorption isotherm. Langmuir theory of unilayer adsorption isotherm. Applications.

Catalysis –Types and theories (intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular and bi-molecular surface reactions. pH dependence of rate constant of catalyzed reactions. Autocatalysis.

Reference Books :

1. Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001.
2. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998.
3. Basic Inorganic Chemistry, 3rd Edition, F. A. Cotton, G. Wilkinson, P. L. Gaus-John Wiley & Sons, 1995.
4. Fundamentals of Organic Chemistry, McMurry, J.E., 7th Edition, Cengage Learning India Edition, 2013.
5. Text Book of Physical Chemistry, K. L. Kapoor, McGraw Hill Education Private Limited, 2022.
6. Introduction to Quantum Theory and Atomic Structure, P.A. Cox, Oxford Chemistry Primers, 1996.

Additional References:

1. Text Book of Physical Chemistry, Soni P.L., Dharmarha OP, Dash UN, Sultan Chand & Sons, 2023.
2. Organic Chemistry, Finar, I.L. Vol. 1, 6th Edition, Pearson, 2002.
3. Physical Chemistry, Puri, Sharma, Pathania, 48th Edition, Vishal Publishing Company 2021.
4. Fundamentals of Photochemistry, K K Rohatgi, K K Mukherjee, New Age International, 2021.

II Semester: Practical II (Physical Chemistry)

Paper Title	**Chemistry-II (Practical)**	No. of Credits	02
Duration of the Examination	03 hours	Teaching Hours	3 hrs / Week
Internal Assessment marks	10	Summative Assessment Marks	40

Course Learning Outcomes :

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

- Perform colorometric titrations
- Know the principle and handling of pH meter, colorimeter, viscometer
- Determination of the density and surface tension

- Study of the variation of viscosity of a solute
- Study of critical solution temperature.

Course Articulation Matrix: Mapping of course outcome (COs) with programme outcomes

Sl no.	Course outcome (Cos) / Programme POs)	1	2	3	4	5	6
1	Know the importance of surface tension	x	x				
2	Understanding of the concepts of viscosity.		x		x		
3	Gain insight on the distribution coefficient, when solute undergo association or dissociation			x	x		
4	Applicability of transition temperature				x	x	
5	Knowledge in maintaining laboratory equipments		x			x	x
6	Understand the basic principles of colorimeter		x		x		

Course Articulation Matrix relates course outcomes of course with the corresponding programme outcomes whose attainment is attempted in this course. Mark X in the intersection cell if a course outcome addresses a particular programme outcome.

Title of the Course: BCHP-02 Chemistry-II:

List of Experiments to be conducted

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Study of the variation of viscosity of sucrose solution with the concentration of a solute.
5. Determination of molar mass of polymer by viscosity method.
6. Determination of transition temperature of a salt hydrate by thermometric method.
7. Determination of degree of dissociation of KCl by Walker-Lumsden method.
8. Determination of critical solution temperature of phenol water system.
9. Determination of distribution coefficient of benzoic acid between water and toluene.
10. Study of kinetics of the reaction between KI and $K_2S_2O_8$ by colorimetric method.