SKE'S

Govindram Seksaria Science College, Belagavi

AUTONOMOUS

PROGRAM /COURSE STRUCTURE AND SYLLABUS

BACHELOR OF SCIENCE

CHEMISTRY

Designed in accordance with Learning Outcomes- Based Curriculum Framework (LOCF) of **State Education Policy (SEP) 2024.**

Effective from Academic Year 2024-25 and onwards

BOS Committee-SEP- B.Sc. Chemistry 2024-25

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PROGRAMME OUTCOME

B. Sc. Chemistry

The B.Sc. programme in Chemistry is designed to develop in students in depth knowledge of the core concepts and principles that are central to the understanding of this core science discipline. Undergraduates pursuing this programme of study go through laboratory work that specifically develop their quantitative and qualitative skills, provides opportunities for critical thinking and team work, and exposes them to techniques useful for applied areas of scientific study.

- **Knowledge:** Width and depth: Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main branches of chemistry, namely, organic, inorganic, physical, spectroscopy, analytical and biochemistry. In depth understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.
- **Laboratory Skills:** Quantitative, analytical and instrument-based: A much-valued learning outcome of this programme is the laboratory skills that students develop during the course. Quantitative techniques gained through hands on methods opens the choice of joining the industrial laboratory workforce early on. The programme also provides ample training in handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. Undergraduates on completion of this programme can cross branches to join analytical, pharmaceutical, material testing and biochemical labs besides standard chemical laboratories.
- **Communication:** Communication is a highly desirable attribute to possess. Opportunities to enhance students' ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.
- **Capacity Enhancement:** Modern scientific environment requires students to possess the ability to think independently as well as be able to work productively in groups. This requires some degree of balance. The chemistry honors programme is designed to take care of this important aspect of student development through an effective teaching learning process.
- **Portable Skills:** Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of the chemistry honors programme. These are problem solving, numeracy and mathematical skills- error analysis, units and conversions, information retrieval skills, IT skills and organizational skills. These are valued across work environments.

COURSE STRUCTURE FOR B.Sc. PROGRAMME

Semester	Subjects	Teaching Hours/week	Duration of Exams	Marks			Credits
				IA	Exam	Total	
1	Major1 Theory	04	03	20	80	100	03
	Major1 Practical	04	04	10	40	50	02
	Major2 Theory	04	03	20	80	100	03
	Major2 Practical	04	04	10	40	50	02
	Major3 Theory	04	03	20	80	100	03
	Major3 Practical	04	04	10	40	50	02
	Language1	04	03	20	80	100	04
	Language2	04	03	20	80	100	04
	Compulsory-1	02	02	10	40	50	02
2	Major1 Theory	04	03	20	80	100	03
	Major1 Practical	04	04	10	40	50	02
	Major2 Theory	04	03	20	80	100	03
	Major2 Practical	04	04	10	40	50	02
	Major3 Theory	04	03	20	80	100	03
	Major3 Practical	04	04	10	40	50	02
	Language1	04	03	20	80	100	04
	Language2	04	03	20	80	100	04
	Compulsory-2	02	02	10	40	50	02
Total							**50**

ASSESMENTMETHODS

EVALUATION METHOD FRO INTERNAL ASSESMENT

Assessment Criteria	40 marks
1 st Internal Assessment Test for30 marks 1 hr after 8 weeks and 2 nd Internal Assessment Test for 30 marks 1 hr after 15 weeks. Average of two tests should be considered	10
Assignment	10
Total	20

Practical:

Assessment Criteria	25 Marks
Semester End Internal Assessment Test for 10 marks 4hrs	05
Journal (Practical Record)	05
Total	10

Question Paper Pattern:
G.S.Sc College, Autonomous Belagavi,
Department of Chemistry
Semester B.Sc. (Chemistry)

Sub: Code: Maximum Marks: 80
QP Code Duration: 3 Hrs

Instructions to Candidates: 1). All questions are compulsory
2) Draw neat diagram and give equation wherever necessary

Q.No.1. a. b. c. d, e. f. g. h. i. j. k. l.	**PART A** (**Answer any TEN Questions)** .	2X10=20
2. 3. 4. 5. 6. 7.	**PART B (answer any FOUR)**	4X5=20
8.a. b. 9.a. b. 10.a b. 11.a b.	**PART C (answer any FOUR)**	4X10=40

12.a b.		

LEARNING OUTCOMES / COURSE OUTCOMES

B.Sc. Semester –I

After successful completion of three-year degree program in Chemistry a student should be able to;

1. Describe the dual nature of radiation and matter; dual behavior of matter and radiation, de Broglie's equations, Heisenberg Uncertainty principle and their related problems.
2. Electronic configurations of the atoms.
3. Define periodicity, explain the cause of periodicity in properties, and classify the elements into four categories according to their electronic configuration.
4. Define atomic radii, ionization energy, electron affinity and electronegativity, discuss the factors affecting atomic radii, describe the relationship of atomic radii with ionization energy and electron affinity, and describe the periodicity in atomic radii, ionization energy, electron affinity and electronegativity.
5. Explain bond properties, electron displacement effects (inductive effect, electrometric effect, resonance effect and hyper conjugation effect). Steric effect and their applications in explaining acidic strength of carboxylic acids, basicity of amines.
6. Understand basic concepts of organic reaction mechanisms, types of organic reactions, structure, stability and reactivity of reactive intermediates.
7. Describe important characteristics of configurational and conformational isomers. Practice and write conformational isomers of ethane, butane and cyclohexane.
8. Understand the various concepts of geometrical isomerism and optical isomerism. Describe CIP rules to assign E, Z notations and R& S notations. Explain D and L configuration and threo and erythro nomenclature.
9. Explain racemic mixture and racemization, resolution of racemic mixture through mechanical separation, formation of diastereomers, and biochemical methods, biological significance of chirality.
10. Understand different types of chromatographic techniques and their applications

CHEMISTRY LAB

After studying this course and performing the experiments set in it students will be able to:

1. Basic concepts involved in titrimetric analysis, primary standard substances, preparation of standard solutions.
2. Explain the principles of acid-base, redox and iodometric titrations.
3. Work out the stoichiometric relations based on the reactions involved in the titrimetric analysis.
4. Describe the significance of organic quantitative analysis.
5. Determine the amount of phenol, aniline, amide, ester and formaldehyde in a given solution by performing blank titration and main titrations.

B Sc Chemistry-Semester 1

Title of the Course: Chemistry -1T

Subject code: SEPBSCHEMT01

Number of Theory Credits	Number of lecture hours/ semester	Number of practical credits	Number of practical hours / semesters
3	60	2	60
		Marks: Theory- 80	IA-20 Total = 100

Unit -I: Atomic Structure and ionic bonding	**15 Hours**

Review of Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle and numerical problems. Quantum mechanical model of atoms, Time independent Schrodinger equation and meaning of various terms in it (no derivation). Significance of ψ and ψ^2. Significance of quantum numbers. Shapes of orbitals *s, p,* and *d*. Nodal surface and nodal plane.

Relative energies of atomic orbitals, Rules for filling electrons in various orbitals: Aufbau principle, Pauli's exclusion Principle, Hund's rule of maximum multiplicity, (*n + l*) rule, Stability of half-filled and completely filled orbitals, electronic configurations of the atoms (Up to Z= 36) ion's. Concept of exchange energy.

UNIT-II: Fundamentals of Organic Chemistry, Alkenes and Alkynes	**15 Hours**

Electronic displacements: Inductive effect, Electrometric effect, Resonance and Hyper conjugation effect with suitable example. Cleavage of bonds: Homolysis and Heterolysis. Structure, shape and reactivity of nucleophiles and electrophiles: Structure, shape and reactivity of organic molecules.

Reactive Intermediates: Carbocation, Carbanions, free radicals and their stability.

Aromaticity: Benzenoids and Huckel's rule.

Alkenes: Chemical reactions of alkenes: Peroxide effect and its mechanism, hydroboration, oxidation, Ozonolysis with respect to 2-butene.

Alkynes: Acidity of Alkynes, reactions of acetylene: Metal ammonia reduction, oxidation & polymerization

Alkyl Halides: Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. Preparation of alkyl halides from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation.

Aryl Halides: Preparation of aryl halides (Chloro, bromo and iodo-benzene) from phenol, Sandmeyer & Gattermann reaction.

UNIT-III Ionic Equilibria	15 Hours

Strong, moderate and weak electrolytes, degree of ionization, factors affectingdegree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Theory of indicators, action of phenolphthalein, action of methyl orange,

Salt hydrolysis: Hydrolysis constant, degree of hydrolysis and pH for different salts (Weak acid weak base, strong acid weak base, strong acid strong base and weak acid strong base). Numerical problems. Buffer solutions. Buffer capacity and buffer index, buffer mixture of a weak acid and its salt, buffer mixture of a weak base and its salt, calculation of pH values of buffer mixture, Hendersson-Hasselbalch equation.

Solubility and solubility product of sparingly soluble salts-applications of solubility product principle.

UNIT-IV: Analytical Chemistry	15 Hours

Definition of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Choice of an analytical method-accuracy, precision, sensitivity, selectivity, method validation. Figures of merits of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range).

Errors and treatment of analytical data: Absolute and relative errors, accuracy and precision, statistical treatment of finite samples: mean, median, range, standard deviation. Determinate and indeterminate errors, minimization of errors. Numerical problems.

Concentration of solutions: Percent by mass, Percent by volume, molarity, molarity, normality and Mole fraction and ppm.

Titrimetric analysis: Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Preparation of ppm level solutions from source materials (salts), conversion factors.

Acid-base titrimetry: Theory, Indicators for acid-base titrations, Titration curves for all type of acid-base titrations. Quantitative applications – selecting and standardizing a titrant.

Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water.

References

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. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models inInorganicChemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles ofStructure and Reactivity*, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* JohnWiley &Sons (2014).
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage LearningIndiaEdition, 2013.
7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, NewDelhi(1988).
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
9. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.

PRACTICALS

Paper Title: Chemistry-1 **Credits: 02**
Paper Code: SEPBSCHEMP01 **Teaching Hours: 04/Week, 52/Semester**
Internal Assessment: 10 Marks **Annual practical: 40 marks**

I] **Volumetric Analysis**

1. Preparation of standard solutions of some salts
2. Estimation of sodium carbonate and sodium hydrogen carbonate present in amixture.
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
5. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
6. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$ (demo only).
7. Determination of the percentage loss in weight of

I) Zinc carbonate II) mixture of barium sulphate and ammonium chloride

Examination

In the practical examination, in a batch at least 15 (Fifteen) students may be made. Viva questions may be

Distribution of Marks:

Accuracy	:	25 Marks
Calculation and presentation	:	05
Journal	:	05 Marks
Viva Voce	:	05 Marks
Total	:	40 Marks

Deduction of marks for accuracy: ±0.2cc-25 marks, ± 0.4cc- 22 marks, ±0.6cc-20 marks, ±0.8cc-15 marks, ±0.9cc-12 marks, above ±0.9-zero marks.
(At least two concordant readings tobe considered)

References

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C.Denney J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
3. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
4. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
6. Finar, I. L. Organic Chemistry (Volume I), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
7. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
8. Organic Reaction mechanism by V. K. Ahluwalia and K. Parashar (Narosa Publishers).
9. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
10. A Guide book to mechanism in Organic Chemistry by Peter Sykes. Pearson.

BSC II SEMESTER

Course Outcomes:

After the completion of this course, the student would be able to

1. Understand ionic bonding, and factors influencing it.
2. Know how different analytes in different matrices (water and real samples) can be determined by UV spectrophotometric analysis.
3. Buffers, solubility product, solubility and its applications.
4. Types of nucleophilic substitution reactions
5. Know the preparation of aldehydes, ketones and their reactions
6. Explain mechanism of esterification reaction.
7. Predict the probable mechanism for a given reaction, explain the importance of reaction intermediates, its role and techniques of generating such intermediates

CHEMISTRY LAB

After studying this course and performing the experiments set in it student will be able to:

1. Identify binary mixture and its analysis
2. Identify the given organic compound from preliminary analysis
3. Determine the physical constant of the compound
4. Confirm the compound from identification of functional groups and preparation of derivative

BSc Chemistry-Semester 2

Title of the Paper: Chemistry-2T

Subject code: SEPBSCHEMT02

Number of Theory Credits	Number of lecture hours/ semester	Number of practical credits	Number of practical hours / semesters
4	60	3	60
Marks: Th-80, IA-20 Total: 100			

UNIT-I: Chemical Bonding and Molecular Structure -I: Atomic Structure	**15 Hours**

Ionic Bonding: Definition and properties of ionic compounds. Lattice energy, solvation energy, solubility of ion compound. Born-Haber cycle and its applications. **Polarization:** Polarizing power and polarizability. Fajan's rules, percentage ionic character in covalent compounds. Problems

Covalent bonding: Definition and properties of covalent bond

***VB Approach*:** Hybridization, inorganic examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. VSEPR theory and structure of NH_3, H_2O and SF_4.

***MO Approach*:** Salient features, formation of MO'S by LCAO method, conditions for formation of MO'S, bonding and antibonding MOs, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (molecular configuration, bond order, bond length, magnetic behavior and stability) and heteronuclear diatomic molecules CO and NO. Comparison of VB and MO Approaches.

UNIT-IV: Purification of organic compounds and Stereochemistry	**15 Hours**

Methods of purification: Crystallization, sublimation, distillation, fractional distillation, distillation under reduced pressure and steam distillation.

Conformational isomerism: Conformational analysis of ethane and butane.

Geometrical isomerism: definition, E and Z system of nomenclature, notation for 2-butene and butenedioic acid, rules for assigning notations. Determination of configuration of butenedioic acid by anhydride formation, dipole moment measurement, melting point and stability.

Optical isomerism: Chirality, van't Hoff-Lebel hypothesis, enantiomers. Optical activity, enantiomers, distereoisomers, epimers, anomers, racemic and meso compounds (Examples lactic and tartaric acids.), racemization, resolution of racemic mixture by chemical method, asymmetric synthesis, Walden inversion.

Relative and absolute configuration, Sequence rule, D & L configurations and R & S notations.

UNIT-III: Chemical Energetics and chemical equilibrium	15 Hours

Chemical Energetics: Important principles and definitions of thermodynamics and thermochemistry. First law of thermodynamics.

Concept of standard state and standard enthalpies of formations. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature- Kirchhoff's equation. Joule-Thomson effect, derivation of Joule Thomson coefficient for an ideal gas and inversion temperature

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium (Van't Hoff reaction isotherm).

Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases. Variation of equilibrium constants with temperatures.

Self-Study:

UNIT-IV: Spectroscopy	15 Hours

Principles of spectroscopy, Electromagnetic radiation (Quantum and Wave theory), interaction of electromagnetic radiation with matter, some phenomena related to radiation (Diffraction, refraction, reflection, scattering and dispersion). Atomic and molecular spectra, Born-oppenheimer approximation, types of molecular spectra.

Introduction to conventional methods of elucidation of structure of organic compounds (chemical degradation) and comparison with spectroscopic methods, electromagnetic spectrum.

UV spectroscopy: Principle, types of transitions, chromophores, concept of auxochromes and their effect on λ_{max}, bathochromic shift, hypsochromic shift, hypochromic and hyperchromic shift. Woodward and Fieser rules and illustration of calculation of λ_{max} taking myrcene and B- phelladrene as examples.

References

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* JohnWiley &Sons (2014).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning IndiaEdition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, NewDelhi(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).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage LearningIndiaPvt. Ltd., New Delhi (2009).
10. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
11. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction. **Carboxylic Acids:** Acid strengths of mono, di and tri chloroacetic acids and nitro, chloro and hydroxy substituted benzoic acids, mechanism of esterification and hydrolysis of ester (Aac2 and Bac2).Reactions of carboxylic acids - i) Conversion into acid derivatives(acid chlorides, amides,

esters and anhydrides), ii) Curtius rearrangement, iii) Reaction with organometallic compounds and iv) Hell-Volhard-Zelinsky reaction.

Ethers: Nomenclature of ethers and their methods of preparation, chemical reactions - Reaction with HI, hot and cold taking symmetric and unsymmetrical ethers. Crown ethers: Definition, examples, use of crown ethers as phase transfer catalysts.

Epoxides: Synthesis of 1,2-epoxy ethane and 1,2-epoxycyclopentane, acid catalyzed ring opening of 1,2-epoxycyclopentane in aqueous solution.

Self-Study:

PRACTICALS

Number of Theory Credits	Number of lecture hours/ semester	Number of practical credits	Number of practical hours / semester
4	60	3	60
			Marks: Th-80, IA-20 Total: 100

I] **Spotting of Organic compounds**

1. Oxalic acid	2. Salicylic acid	3. Phthalic acid	4. Phenol	5. Benzamide
6. 2-naphthol	6. Benzaldehyde	7. Acetone	8. Acetanilide	7. Naphthalene
8. Ethyl Benzoate	9. Aniline	10. Urea		

Analysis of given compound by

1. Element detection 2. Solubility 3. Functional group 4. Physical constant
5. Preparation of derivative and its melting/boiling point.

Examination

In the practical examination, in a batch at least 15 (Fifteen) students may be made. Viva questions may be asked on any of the experiments prescribed in the practicalsyllabus.

Distribution of Marks:

1. Identification of the binary mixture	05 marks
2. Preliminary tests and presentation	05 marks,
3. Group test based on solubility	03 marks
4. Distinguishing test and C.T	07 marks (3+4)
5. Preparation of derivative	03 marks
6. Melting point of derivative	02 marks
7. Journal	05marks
8. Viva voce	05marks
Total	**40 marks.**

References Textbooks

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13.
4. Chemical Analysis of Foods – H.E. Cox and Pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
6. Physical Chemistry – P l Atkins and J. de Paula – 7thEd. 2002, Oxford University Press.