Sardar Patel University, Mandi (H.P.)-175001

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(Established Under H.P. Legislative Assembly Act 03 of 2022 and Recognized Under Section 2(f)-UGC Act 1956)

Department of Chemistry

Scheme & Syllabus
of
Bachelor of Science
(Honours with Research)
In
CHEMISTRY

[Four Years Multidisciplinary Programme]

Based on NEP 2020
Effective from Academic Session 2026-27 Onwards

Faculty of Physical Sciences

Sardar Patel University Mandi (HP)

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B.Sc. (Hons. with Research) in Chemistry Programme: Institutional Program Framework

1. Programme Educational Objectives (PEOs)

The Bachelor of Science (B.Sc.) Programme in Chemistry is designed to equip students with a strong foundation in chemical sciences, foster scientific inquiry, and prepare them for higher education, research, entrepreneurship, and professional careers. Upon completion of the programme, graduates are expected to achieve the following Program educational objectives:

PEO No.	Programme Educational Objective (PEO)
PEO 1	• Demonstrate comprehensive knowledge and understanding of fundamental and advanced concepts, principles, theories, and applications of Chemistry, encompassing its major branches, namely Organic, Inorganic, Physical, Analytical, and Applied Chemistry.
PEO 2	• Develop analytical, quantitative, and problem-solving skills required for the interpretation of chemical phenomena and the solution of theoretical, experimental, and industrial chemistry-related problems.
PEO 3	• Acquire practical laboratory competencies, technical expertise, and research-oriented skills that enable progression to higher studies, professional careers, interdisciplinary domains, and entrepreneurial ventures.
PEO 4	• Cultivate scientific temper, critical thinking, creativity, and intellectual curiosity through experiential learning, inquiry-based education, and exposure to contemporary developments in chemical sciences.
PEO 5	• Attain proficiency in modern laboratory techniques, instrumentation, data analysis, and scientific communication, thereby enhancing employability and preparedness for research, industry, and academic pursuits.
PEO 6	• Develop ethical values, environmental awareness, leadership qualities, teamwork, and effective communication skills, enabling graduates to function as responsible professionals and socially conscious citizens.
PEO 7	• Foster lifelong learning abilities and adaptability to emerging scientific and technological advancements, ensuring sustained professional growth and meaningful contribution to society.

2. Programme Outcomes (POs)

Four-Year Undergraduate Programme (FYUP) in chemistry has the following Programme Objectives (POs):

PO No.	Type of PO	Outcome Descriptor
PO1	**Problem Solving**	• Apply chemical knowledge, scientific principles, and critical thinking to solve familiar and unfamiliar problems encountered in academic, industrial, environmental, and societal contexts.
PO2	**Analytical Reasoning and Critical Thinking**	• Analyze, evaluate, interpret, and synthesize information from diverse sources; identify assumptions, formulate logical arguments, and draw evidence-based conclusions.
PO3	**Creativity and Innovation**	• Demonstrate innovative thinking, creativity, and adaptability in addressing complex scientific problems and developing novel solutions in chemistry and allied disciplines.
PO4	**Communication Skills**	• Communicate scientific ideas, experimental findings, and technical information effectively through oral, written, graphical, and digital modes to both scientific and non-scientific audiences.
PO5	**Research and Inquiry Skills**	• Formulate research questions, design experiments, collect and analyze data, interpret results, and prepare scientific reports while adhering to research ethics and integrity.

PO6	**Teamwork and Collaboration**	• Work effectively as an individual and as a member or leader of diverse teams, demonstrating cooperation, responsibility, and respect for different perspectives.
PO7	**Leadership and Professional Development**	• Exhibit leadership qualities, decision-making ability, project management skills, and professional responsibility in academic, industrial, and community settings.
PO8	**Digital and Technological Competence**	• Utilize information and communication technologies (ICT), scientific software, computational tools, and digital resources for learning, research, data analysis, and problem-solving.
PO9	**Multicultural Competence and Inclusivity**	• Appreciate cultural diversity, gender equity, social inclusion, and global perspectives while engaging respectfully and effectively with individuals from diverse backgrounds.
PO10	**Ethics and Value-Based Learning**	• Demonstrate ethical conduct, integrity, social responsibility, and adherence to professional and scientific standards, including respect for intellectual property and research ethics.
PO11	**Environmental Awareness and Sustainability**	• Understand environmental challenges and sustainability principles, and apply chemical knowledge for environmental protection, pollution mitigation, resource conservation, and sustainable development.
PO12	**Community Engagement and Social Responsibility**	• Participate actively in community outreach, extension activities, and societal initiatives, applying scientific knowledge for the welfare and development of society.

3. Programme Specific Outcomes (PSOs)

Upon completion of the programme, graduates are expected to achieve the following Programme Specific Outcome (PSO):

PSO No.	Type of PSO	Programme Specific Outcome (PSO) Descriptor
PSO 1	**Knowledge & Understanding**	• Comprehensive knowledge and understanding of theoretical and experimental chemistry in diverse areas such as Analytical, Physical, Inorganic, Organic, and Materials Chemistry. • Ability to apply chemical knowledge in multidisciplinary contexts and appreciate its linkages with related disciplines and emerging developments in science and technology.
PSO 2	**Skills Related to One's Specialization**	• Practical and theoretical skills in the major branches of chemistry, including Analytical, Inorganic, Organic, and Physical Chemistry. • Competence to apply specialized knowledge in academic, industrial, and research settings, and to pursue higher studies in chemical sciences and allied disciplines.
PSO 3	**Application of Knowledge & Skills**	• Apply standard chemical principles, methodologies, and experimental techniques for chemical synthesis, analysis, characterization, and investigation. • Address scientific and societal problems arising within chemistry and interdisciplinary fields through evidence-based approaches.
PSO 4	**Quantitative, Analytical & Instrument-Based Skills**	• Proficiency in classical quantitative analysis and modern analytical techniques. • Hands-on experience with analytical instruments and laboratory equipment used in chemical, pharmaceutical, biochemical, environmental, and materials testing laboratories.

- Skills for data collection, interpretation, and quality assessment in professional laboratory environments.

Credit Framework and break down Semester wise

Course Type/ Semester	DSC	DSE	MDC	SEC	AEC	VAC	INP/APT/PRT/COM or Vocation Course	DIS	Total
I	**12**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**20**
II	**12**	**-**	**3**	**3**	**-**	**2**	**4**	**-**	**24**
Exit option with UG Certificate after securing 44 credits along with entry option to second year or third semester									
III	**8 (MJ)+4 (MN)**	**-**	**3**	**3**	**2**	**2**	**-**	**-**	**22**
IV	**8 (MJ)+4 (MN)**	**4**	**-**	**-**	**2**	**2**	**-**	**-**	**20**
Exit option with UG Diploma after securing 86 credits along with entry option to third year or fifth semester									
V	**8 (MJ)+4 (MN)**	**8**	**-**	**-**	**2**	**-**	**-**	**-**	**22**
VI	**8 (MJ)+4 (MN)**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**20**
Award of 3Year Bachelor's Degree after completion of 128 credits									
VII	**12(MJ)**	**4**	**-**	**-**	**-**	**-**	**-**	**4**	**20**
VIII	**8(MJ)**	**4**	**-**	**-**	**-**	**-**	**-**	**8**	**20**
Bachelor's Degree(Honours with Research)after completion of 168 credits									
Total Credits	**92 (76MJ+16MN)**	**28**	**9**	**9**	**8**	**6**	**4**	**12**	**168**

Abbreviations: DSC-Discipline Specific Core, **DSE**- Discipline Specific Elective, **MDC**-Multidisciplinary Course, **SEC**-Skill Enhancement Course, **AEC**-Ability Enhancement Course, **VAC**-Value Added Course, **MJ**-Major, **MN**-Minor, **INP/APT/PRT/COM**-Internship / Apprenticeship/ Project/ Community Outreach, **DIS**-Dissertation

5. Academic Regulations Governing the Undergraduate Programme

- In the first semester, students will be offered three different subjects within the same stream: A, B, and C
- The student will be required to give his/her Major and Minor at the end of the second semester. Such choices, including DSCs made at the end of the second semester, shall remain in effect until the VI semester
- The DSCs of another discipline for the first two semesters of students who opt for Major programmes will be treated as Minors.
- MDCs must be selected from a broad discipline/pool of MDCs other than Major and Minor disciplines/subjects
- AEC/VAC/SEC-3 should be chosen from a pool of courses. Every discipline shall provide these courses, some of which will be offered discipline-specific, while the rest can be open to students of all other disciplines. However, the two SECs (SEC-1 & SEC-2) must be chosen from the discipline-specific (Core and Minor).
- Internship / Apprenticeship/ Project/ Community Outreach will be determined at the end of the first semester to enable students to carry out some INP/APT/PRT/COM activities during winter vacation.
- To pursue an Honours & Honours with research in the 4th year, students will have to successfully complete 3-year UG Degree and choose only one discipline in both semesters, in which s/he have studied 6 DSCs and 5 DSEs in the first three years.
- A student who secures 75% or more marks in aggregate till semester 6 (up to a 3-year degree) shall be eligible for a 4-year degree Honours with Research, provided SPU has approved the college to offer it.
- The Dissertation and Project will start in the VII semester. However, the evaluation and assessment will be conducted in both the VII and VIII semesters.
- In accordance with the provisions of the National Education Policy (NEP) 2020 and the UGC Curriculum and Credit Framework for Undergraduate Programmes (CCFUGP), students enrolled in the Four-Year Undergraduate Programme (FYUGP) shall be eligible for multiple entry and exit in the odd semesters and after even semesters, provided they fulfill the minimum requirements for entry and exit as follows:

Duration of Study	Minimum Credits Earned	Qualification Awarded
After successful completion of 1 Year (Semester I & II)	44 Credits	Undergraduate Certificate
After successful completion of 2 Years (Semester I–IV)	86 Credits	Undergraduate Diploma
After successful completion of 3 Years (Semester I–VI)	128 Credits	Bachelor's Degree
After successful completion of 4 Years (Semester I–VIII)	168 Credits	Bachelor's Degree (Honours) or Bachelor's Degree (Honours with Research)

- A student shall be eligible to appear in the end-semester examination only if he/she has a minimum of 75% attendance. The terms and rules governing condoning can be found in the Examination Section of the Ordinance.

6. Semester wise Scheme for 1st Year B.Sc Chemistry

Semester-I

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC-101T	Inorganic Chemistry-I (Theory)	DSC-A1	3	0	0	3	3	25	50	–	–	75
2	BCHEM-DSC-101P	Inorganic Chemistry-I (Practical)		0	0	1	1	2	–	–	5	20	25
3	BXXXX-DSC-101T	Discipline Specific Course-II (Theory)*	DSC-B1	3	0	0	3	3	25	50	–	–	75
4	BXXXX-DSC-101P	Discipline Specific Course-II (Practical)*		0	0	1	1	2	–	–	5	20	25
5	BXXXX-DSC-101T	Multidisciplinary Course (Theory)*	DSC-B1	3	0	0	3	3	25	50	–	–	75
6	BXXXX-DSC-101P	Multidisciplinary Course (Practical)*		0	0	1	1	2	–	–	5	20	25
7	BCHEM-MDC-101	Introductory Chemistry-I	MDC-1	3	0	0	3	3	25	50	–	–	75
8	BCHEM-SEC-101	Basic Analytical Chemistry-I	SEC-C1	3	0	0	3	3	25	50	–	–	75
9	BXXX-AEC-101	Ability Enhancement Course*	AEC-C1	2	0	0	2	2	15	35	–	–	50
Total							20	23					**500**
Cumulative Credits							20						

Abbreviations: L-Lecture, P-Practical, C-Credits, CH-Contact Hours, IA-Internal Assessment, ESE- End Semester Examination

Note:

- XXXX*- Short form of the department whose MDC is offered in the curriculum
- The Discipline-Specific Courses (DSCs) of Chemistry may be opted as Minor Courses by students of other disciplines and vice versa for Chemistry students also in accordance with the NEP-2020 guidelines.

Semester-II

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC-201T	Organic Chemistry-I (Theory)	DSC-A1	3	0	0	3	3	25	50	–	–	75
2	BCHEM-DSC-201P	Organic Chemistry-I (Practical)		0	0	1	1	2	–	–	5	20	25
3	BXXXX-DSC-201T	Discipline Specific Course-II (Theory)*	DSC-B1	3	0	0	3	3	30	50	–	–	75
4	BXXXX-DSC-201P	Discipline Specific Course-II (Practical)*		0	0	1	1	2	–	–	5	20	25
5	BXXXX-MC-201T	Multidisciplinary Course (Theory)*	DSC-B1	3	0	0	3	3	25	50	–	–	75
6	BXXXX-MC-201P	Multidisciplinary Course (Practical)*		0	0	1	1	2	–	–	5	20	25
7	BCHEM-MDC-201	Introductory Chemistry-II	MDC-1	3	0	0	3	3	25	50	–	–	75
8	BCHEM-SEC-201	Basic Analytical Chemistry-II	SEC-C1	3	0	0	3	3	25	50	–	–	75
9	BCHEM-I/A/P/C-201	Internship/Apprenticeship/Project/Community Outreach	Experiential Learning	4	0	0	4	4	–	–	–	–	100
10	VAC-201	Value Added Course	VAC	2	0	0	2	2	15	35	–	–	50
Total							**24**	**35**					**600**
Cumulative Credits							**44**						

Note:

- Exit option with UG Certificate after securing 44 credits(*with 4 credits of I/A/P/C/ or work-based vocational course of during winter/summer term), along with entry option to second year or third semester

Semester-III

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-301 T		DSC	3	0	0	3	3	25	50	-	-	75
2	BCHEM - DSC(MJ)-301 P		DSC	0	0	1	1	2	-	-	5	20	25
3	BBOTA-DSC(MJ)-301T		DSC	3	0	0	3	3	25	50	-	-	75
4	BBOTA-DSC(MJ)-301P		DSC	0	0	1	1	2	-	-	5	20	25
5	BZOOL-DSC(MN) 301T		DSC	3	0	0	3	3	25	50	-	-	75
6	BZOOL-DSC(MN)-301P		DSC	0	0	1	1	2	-	-	5	20	25
7	BXXXX-MDC-301		MDC	3	-	-	3	3	25	50	-	-	75
8	BCHEM-SEC-301		SEC	3	-	-	3	3	25	50	-	-	75
9	BXXXX-AEC-301		AEC	2	-	-	2	2	15	35	-	-	50
10	BXXXX.-VAC-101		VAC	2	-	-	2	2	15	35	-	-	50
Total							**22**	**35**					
Cumulative Credits							**66**						

Semester-IV

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-401 T		DSC	3	-	-	3	3	25	50	-	-	75
2			DSC	-	-	1	1	2	-	-	5	20	25
3			DSC	3	-	-	3	3	25	50	-	-	75
4			DSC	-	-	1	1	2	-	-	5	20	25
5			DSC	3	-	-	3	3	25	50	-	-	75
6			DSC	-	-	1	1	2	-	-	5	20	25
7			MDC	3	-	-	3	3	25	50	-	-	75
8			SEC	3	-	-	3	3	25	50	-	-	75
9			AEC	2	-	-	2	2	15	35	-	-	50
10			VAC	2	-	-	2	2	15	35	-	-	50
Total													
Cumulative Credits							**86**						

Note:

- Exit option with UG Diploma after securing 86credits along with entry option to third year or fifth semester

Semester-V

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-501 T		DSC	3	-	-	3	3	25	50	-	-	75
2								2	-	-	5	20	25
3								3	25	50	-	-	75
4								2	-	-	5	20	25
5								3	25	50	-	-	75
6								2	-	-	5	20	25
7								3	25	50	-	-	75
8								3	25	50	-	-	75
9								2	15	35	-	-	50
10								2	15	35	-	-	50
Total													
Cumulative Credits													

Note: if any

Semester-VI

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-601 T		DSC	3	-	-	3	3	40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									-	-	60	40	100
									-		60	40	100
											100	-	100
Total													
Cumulative Credits							**128**						

Note:

- Award of 3Year Bachelor's Degree after completion of 128 credits
- Any other

Semester-VII

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-701 T		DSC	3	-	-	3	3	40	60	-	-	100
Total													

Cumulative Credits		

Note: if any

Semester-VIII

S. No.	Course Code	Course Title	Category	L	T	P	C	CH	Theory Assessment		Practical Assessment		Total
									IA	ESE	IA	ESE	
1	BCHEM-DSC(MJ)-801 T		DSC	3	-	-	3	3	40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									40	60	-	-	100
									-	-	60	40	100
									-		60	40	100
											100	-	100
Total													
Cumulative Credits							**168**						

Note:

- Bachelor's Degree (Honours with Research) after completion of 168 credits
- Any other

7. Syllabus

Syllabus of B.Sc. (Hons. with Research) in Chemistry Programme

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-DSC-101 T	Inorganic Chemistry-I	3	0	0	3	45	Core
Prerequisite		Basic knowledge of atomic structure, electronic configuration, periodic properties, chemical bonding, and elementary quantum concepts, along with fundamental mathematics and physics at the 10+2 level.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. To understand various atomic theories, quantum mechanical model, and other aspects of atomic structure.
2. To have a comprehensive review of ionic bonding and energy considerations in ionic bonding.
3. To get acquainted with chemical bonding in covalent compounds with emphasis on various theories of covalent bonding.
4. To have practical knowledge of preparations of solutions and estimation of some of the chemical species from solutions and mixtures of solutions.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Explain and apply the quantum mechanical model of the atom, including quantum numbers, wave functions, radial and angular distribution functions, and the shapes of atomic orbitals.
CO2	Determine electronic configurations of atoms and evaluate effective nuclear charge using Slater's rules to interpret atomic properties and trends.
CO3	Predict and analyze molecular geometries and bonding characteristics using radius ratio rules, VSEPR theory, molecular orbital theory, and concepts of ionic and covalent bonding.
CO4	Correlate the nature of chemical bonding with the structure, stability, and physicochemical properties of inorganic molecules and ions.
CO5	Demonstrate laboratory skills in the preparation and standardization of solutions of different concentrations and perform quantitative estimation of selected chemical species using volumetric methods.

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Atomic Structure:** Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. Schrodinger wave equation and meaning of various terms in it. Significance of ψ and ψ2 . Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations, Slater rules and applications	**15 Hours**
2	**Ionic Bonding:** 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. Statement of Born-Landé equation for calculation of lattice energy, Born-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.	**15 Hours**
3	**Covalent Bonding:** Covalent bonding- VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristicsfor s-s,s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals ,MO treatment of homonuclear diatomic molecules up to Ne (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches	**15 Hours**

iv. Suggested readings:

1. Lee, J.D. Concise Inorganic ChemistryELBS,1991.
2. Cotton, F.A.,Wilkinson, G.&Gaus,P.L. Basic InorganicChemistry,3rd ed.,Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley &Sons.
4. Huheey,J.E.,Keiter,E.A.,Keiter,R.L.& Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Assignments & Presentations	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
2	BCHEM-DSC-101 P	Inorganic Chemistry-1	0	0	1	1	15	Core
Prerequisite		Basic knowledge of laboratory safety, measurement techniques, preparation of solutions, mole concept, and fundamental principles of volumetric analysis and acid–base titrations at the 10+2 level.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. Develop proficiency in the preparation of standard solutions and perform their standardization using appropriate volumetric techniques.
2. Apply acid–base titration methods for the quantitative estimation of sodium carbonate and other basic substances.
3. Acquire practical skills in analyzing mixtures containing sodium carbonate and sodium bicarbonate using the double indicator titration method.
4. Understand and perform redox titrations for the quantitative estimation of oxalic acid using potassium permanganate as an oxidizing agent.
5. Develop competency in quantitative chemical analysis by estimating the composition of mixtures containing oxalic acid and sodium oxalate using suitable volumetric methods.
6. Enhance laboratory skills, analytical thinking, accuracy in measurements, data recording, and interpretation of experimental results while following safe laboratory practices.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Prepare solutions of different concentrations and perform standardization of acid solutions using appropriate volumetric techniques.
CO2	Estimate the concentration of sodium carbonate by acid-base titration using a standardized hydrochloric acid solution.
CO3	Analyze and determine the composition of a mixture containing sodium carbonate and sodium bicarbonate using the double indicator titration method.
CO4	Determine the concentration of oxalic acid through redox titration with standardized potassium permanganate solution.
CO5	Estimate the amounts of oxalic acid and sodium oxalate present in a given mixture using suitable volumetric analytical methods.

iii. Syllabus:

S. No.	Aim of the Experiment
1	Preparation of solutions of different concentration and standardization of acid solutions.
2	Estimation of sodium carbonate using standardized HCl solution.
3	Estimation of sodium carbonate and sodium bicarbonate present in a mixture.
4	Estimation of oxalic acid by titrating it with KMnO4.
5	Estimation of oxalic acid and sodium oxalate in a given mixture

iv. Suggested Readings:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education,2012.
2. Mendham, J.Vogel's Quantitative Chemical Analysis, Pearson,200

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	5	20

Total Marks	25

vi. Components of Internal Evaluation:05

S. No.	Type of Assessment	Marks
1	Routine class Performance	5

vii. Instructions for End Semester Exam:

S. No.	Type of Assessment	Marks
1	Performance	10 Marks
2	Viva-Voce	5 Marks
3	Practical File/Record	5 Marks
4	**Total**	**20 Marks**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-MDC-101	Introductory Chemistry-I	3	0	0	3	45	Core
Prerequisite		Basic knowledge of atomic structure, electronic configuration, periodic properties, chemical bonding, and elementary quantum concepts, along with fundamental mathematics and physics at the 10+2 level.						
Course Coordinator		Dr. ……						

i. Course Objectives:

1. To develop an understanding of various atomic models, the concepts of atomic and molecular masses, the mole concept, and the determination of empirical and molecular formulae.
2. To provide a comprehensive understanding of the three states of matter with special emphasis on gas laws, critical temperature, vapour pressure, viscosity, and surface tension.
3. To introduce the fundamental concepts of carbon and its compounds, including the nomenclature of organic compounds and the basic reactions of hydrocarbons and their derivatives

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Apply the concepts of different atomic models, atomic and molecular masses, and the mole concept to solve basic chemical problems.
CO2	Explain the properties and behaviour of the three states of matter, including gas laws, vapour pressure, viscosity, and surface tension.
CO3	Demonstrate an understanding of the fundamental concepts of carbon compounds, including IUPAC nomenclature and the basic reactions of organic compounds.
CO4	Classify different types of matter and correlate their physical properties with intermolecular interactions.
CO5	Solve numerical and conceptual problems related to atomic structure, mole calculations, and the physical properties of matter using appropriate chemical principles

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Atoms and Molecules:** Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Thompson's model and its limitations, Rutherford's model and its limitations, Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, Avagadro's hypothesis, atoms and molecules, atomic mass, molecular mass, Mole concept (including numerical problems), Emperical and molecular formula (including numerical problems).	**15 Hours**
2	**States of Matter:**Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charle's law, Gay Lussac's law, Avogadro's law, ideal behaviour, empirical derivation of gas equation, Avogadro number, ideal gas equation. Kinetic energy andmolecular speeds (elementary idea), deviation from ideal behaviour, liquefaction of gases, critical temperature. Liquid State – Vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations).	**15 Hours**
3	**Carbon and its Compounds:**Carbon compounds: Covalent bonding in carbon compounds. Versatile nature of carbon. Homologous series. Nomenclature of carbon compounds containing functional groups (halogens, alcohol, ketones, aldehydes, alkanes and alkynes), difference between saturated hydrocarbons and unsaturated hydrocarbons. Chemical properties of carbon compounds (combustion, oxidation, addition and substitution reaction). Ethanol and Ethanoic acid (only properties and uses)	**15 Hours**

iv. Suggested readings:

1. Lee,J.D. Concise Inorganic ChemistryELBS,1991.
2. Cotton,F.A.,Wilkinson,G.&Gaus,P.L. Basic Inorganic Chemistry,3rd ed.,Wiley.
3. Huheey,J.E.,Keiter,E.A.,Keiter,R.L.&Medhi,O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
4. Atkins' Physical Chemistry, Atkins,P.,Paula,J.d.,Keeler,J., by OUP Oxford.
5. Bruce,P.Y., Organic Chemistry, by Pearson.

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Assignments & Presentations	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-SEC-101	Basic Analytical Chemistry-I	2	0	1	3	45	Core
Prerequisite		Basic understanding of analytical chemistry, solution chemistry, acid–base concepts, pH, titration methods, and fundamental laboratory techniques acquired through introductory undergraduate chemistry courses						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. To develop a sound understanding of the fundamentals of analytical chemistry, including the presentation and interpretation of analytical data, sources of errors in analysis, and the principles involved in the chemical analysis of water and determination of its various quality parameters.
2. To provide comprehensive knowledge of food processing and preservation, with special emphasis on food adulteration and the analysis of common food preservatives and colouring agents.
3. To enable students to determine the composition and pH of soil and apply complexometric titration techniques for the estimation of ions present in soil samples.
4. To impart an understanding of the principles and mechanisms of solvent extraction, along with familiarity with important solvent extraction techniques used in chemical analysis.
5. To develop practical skills in quantitative analysis through the estimation of Fe(II) and Cu(II) by titrimetric methods and the determination of refractive indices of selected liquids.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Explain the fundamental concepts of analytical chemistry, including sampling techniques, errors in analysis, and presentation of experimental data.
CO2	Describe methods of food processing and preservation, identify common food adulterants, and analyze their presence in food samples.
CO3	Determine the composition and pH of soil samples and estimate selected ions using complexometric titration techniques.
CO4	Apply solvent extraction principles for the qualitative and quantitative separation of metal ions and organic species using appropriate extraction techniques.
CO5	Perform volumetric estimations of Fe(II) and Cu(II) and measure the refractive indices of pure solvents using standard analytical procedures.

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Introduction to Analytical Chemistry:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures. **Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	**10 Hours**
2	**Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter. **Analysis of Soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesiumions as Calcium carbonate by complexometric titration.	**10 Hours**
3	**Solvent Extraction:** Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media. Techniques of extraction: batch, continuous and counter current extractions. Stereo isomeric separation and analysis: Measurement of optical rotation, calculation of enantiomeric excess (ee)/ diastereomeric excess (de).	**10 Hours**

PRACTICAL COMPONENT OF SKILL ENHANCEMENT COURSE		
S.No	**Aim of the Experiment**	**Contact Hours**
1	Estimation of number of molecules of water of crystallization in Mohr's salt by titrating with $K_2Cr_2O_7$.	**15 hours**
2	Estimation of percentage of Fe(II)ions in green vitriol by titrating it with $K_2Cr_2O_7$.	
3	Estimation of Cu(II)ions iodometrically using sodium thiosulphate solution($Na_2S_2O_3$).	
4	Refractive Index(R*I*) Measurements:	

iv. Suggested readings:

1. Willard,H.H.,Merritt, L.L.,Dean,J.& Settoe,F.A. Instrumental Methods of Analysis.7thEd.Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog,D.A.,Holler F.J.& Nieman,T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Skoog,D. A.;West,D.M.&Holler,F.J. Fundamentals of Analytical Chemistry 6thEd.,Saunders College Publishing, Fort Worth (1992).
4. Harris,D. C. Quantitative Chemical Analysis, W.H. Freeman.
5. Dean,J.A. Analytical Chemistry Notebook, McGraw Hill.
6. Svehla, G.Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
7. Mendham, J.Vogel's Quantitative Chemical Analysis, Pearson, 2009.
8. G. Raj, Advanced Physical Chemistry, Practical Handbook, Edition (2016)
9. Yadav, J.B., Advanced Practical Physical Chemistry, Handbook, Edition (2016)

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Lab CCA (Performance + Assignment in the form of Practical File)	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

DSC FOR CHEMISTRY

SEMESTER-II

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-DSC-201T	Organic Chemistry-I	3	0	0	3	45	Core
Prerequisite		Basic understanding of chemical bonding, electronic effects, hydrocarbons, functional groups, isomerism, and fundamental concepts of organic chemistry acquired at the Senior Secondary (10+2) level..						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. Understand basic concepts of organic chemistry, such as structure, shape and reactivity of organic molecules, reactive intermediates and aromaticity.
2. Understand the fundamental concepts of stereochemistry including conformational, optical, andgeometrical isomerism.
3. Get acquainted with the methods of preparation and properties of aliphatic hydrocarbons (alkanes, alkenes and alkynes).
4. To have practical knowledge of determination of melting and boiling point of organic compounds, separation of organic compounds from their mixtures by chromatographic techniques, and synthesis of some organic compounds

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Explain the properties and behaviour of organic compounds based on fundamental concepts of organic chemistry and identify various reactive intermediates involved in organic reactions.
CO2	Apply the principles of stereochemistry to represent, visualize, and interpret the three-dimensional structures of organic molecules.
CO3	Analyze the preparation methods, properties, reactions, and applications of aliphatic hydrocarbons, including alkanes, alkenes, and alkynes.
CO4	Differentiate and interpret the reactivity patterns of organic compounds based on the nature and stability of reaction intermediates.
CO5	Demonstrate laboratory skills to determine melting and boiling points, separate organic compounds using paper and thin-layer chromatography, and synthesize selected organic compounds.

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Fundamentals of Organic Chemistry & Stereochemistry-I:** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyper conjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. Conformations with respect to ethane, butane and cyclohexane.	**15 Hours**
2	**Stereochemistry-II :** Interconversion of Wedge Formula, Newman, Sawhorse and Fischer projections. Concept of chirality (up to two carbon atoms) Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis-trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). Conformations with respect to ethane, butane and cyclohexane.	**15 Hours**
3	**Aliphatic Hydrocarbons (Alkanes, Alkenes &Alkynes):** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes:**(Upto5Carbons).Preparation:Catalytichydrogenation,Wurtzreaction,Kolbe'ssynthesis,fromGrignard reagent. Reactions: Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and *anti*-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.	**15 Hours**

	Alkynes: (Upto 5 Carbons) Preparation: Acetylene from $CaC_2$and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.	

iv. Suggested readings:

1. Graham Solomon,T.W., Fryhle, C.B.& Dnyder, S.A. Organic Chemistry, John Wiley& Sons(2014).
2. Mc Murry,J.E. Fundamentals of Organic Chemistry,7thEd.Cengage Learning India Edition,2013.
3. Sykes, P.A. Guide book to Mechanism in Organic Chemistry, Orient Longman, New Delhi(1988).
4. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education,2000.
5. Finar, I.L. Organic Chemistry (Vol. I &II),E.L.B.S.
6. Morrison, R.T.& Boyd,R.N. Organic Chemistry,Pearson,2010.
7. Bahl,A. & Bahl, B.S. Advanced Organic Chemistry, S.Chand, 2010.

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Assignments & Presentations	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
2	BCHEM-DSC-201 P	Organic Chemistry-1	0	0	1	1	15	Core
Prerequisite		Basic knowledge of laboratory safety, purification techniques, melting and boiling point determination, chromatography, and simple organic synthesis at the Senior Secondary (10+2) level.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. Develop practical skills in determining the melting point and boiling point of organic compounds and relate these physical constants to the purity and identification of compounds.
2. Understand the principles and applications of paper chromatography for the separation and identification of amino acids and sugars.
3. Acquire proficiency in thin layer chromatography (TLC) for the separation and analysis of organic compounds and interpretation of chromatographic results.
4. Develop the ability to calculate and interpret Rf values for assessing the efficiency and reliability of chromatographic separations.
5. Enhance laboratory competence through accurate observation, data recording, result interpretation, and adherence to standard laboratory safety and good laboratory practices.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Determine the melting point and boiling point of solid and liquid organic compounds using standard laboratory techniques.
CO2	Perform **the** separation of mixtures of amino acids or sugars using radial or ascending paper chromatography and interpret the chromatographic results.
CO3	Separate and identify the components of mixtures such as o- and p-nitrophenol or o- and p-aminophenol **using** thin layer chromatography (TLC)**.**
CO4	Calculate the **Rf values** of separated compounds and evaluate the effectiveness of chromatographic separation techniques.
CO5	Demonstrate proficiency in handling laboratory equipment, recording observations accurately, and following safe laboratory practices during organic chemistry experiments.

iii. Syllabus:

S. No.	Aim of the Experiment
1	To determine the melting and boiling point of given organic compounds (Solid and liquid).
2	Preparation of Lassaigne's extract and detection of extra elements in given sample
3	Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).
4	Organic Synthesis: (i) Preparation of Iodoform. (ii) Preparation of Glucosazone

iv. Suggested Readings:

1. 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.
2. Mann,F.G. & Saunders,B.C. Practical Organic Chemistry Orient-Longman,196

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	5	20
Total Marks	25	

vi. Components of Internal Evaluation:05

S. No.	Type of Assessment	Marks
1	Routine class Performance	5

vii. Instructions for End Semester Exam:

S. No.	Type of Assessment	Marks
1	Performance	10 Marks
2	Viva-Voce	5 Marks
3	Practical File/Record	5 Marks
4	**Total**	**20 Marks**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	**BCHEM-MDC-201**	**Introductory Chemistry-II**	**3**	**0**	**0**	**3**	**45**	**Core**
Prerequisite		Students should have a sound understanding of the fundamental concepts of chemistry covered up to the +2 (Senior Secondary) level and should have successfully completed the Introductory Chemistry-I **course**.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. To develop an understanding of the concepts of water conservation, techniques for water purification, and principles of wastewater management.
2. To acquire basic knowledge of pesticides and fertilizers, including their applications, benefits, and potential adverse effects on human health and the environment.
3. To gain familiarity with the fundamentals of various types of renewable and non-renewable energy resources and their significance in sustainable development.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Explain the principles and importance of water conservation, water purification techniques, and wastewater management practices.
CO2	Apply the knowledge of biological and chemical methods of pest control using natural and synthetic pesticides for addressing agricultural and environmental challenges.
CO3	Analyze the benefits and adverse effects of commonly used pesticides and fertilizers on human health and the environment.
CO4	Differentiate between renewable and non-renewable energy resources based on their characteristics, applications, and environmental impacts.
CO5	Evaluate the significance of sustainable utilization of water, agrochemicals, and energy resources in promoting environmental conservation and sustainable development

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Water:** Sources of drinking water and uses, water conservation, Permissible TDS, Techniques of purification of water, R.O. water purification process (Osmosis and Reverse Osmosis), wastewater management	**15 Hours**
2	**Pesticides and fertilizers** Generalintroductionanddefinition,biologicalcontrolandchemicalcontrol:naturalandsyntheticpesticides, benefits and adverse effects of DDT, BHC, malathion, biofertilizers, chemical fertilizers and their uses, acid rain.	**15 Hours**
3	**Energy:** Energy sources, renewable energy (solar,wind,hydro)andnon-renewablesources,cellsandbatteries,fuelcell, solar cell, capacitors and super capacitors	**15 Hours**

iv. Suggested readings:

1. Water Treatment, How To Make Water Safe To Drink, David Holman
2. Energy,A Beginner's Guide, Vaclav Smil,2017
3. Goyal,PK, Water Pollution Causes, Effects and Control Newage International Publishers
   Pesticide Chemistry and Toxicology, D.K.SinghVolume1,Bentham Books Sharjah

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Assignments & Presentations	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-SEC-201	Basic Analytical Chemistry-II	2	0	1	3	45	Core
Prerequisite		Students should have a sound understanding of the fundamental concepts of chemistry covered up to the **+2** level and should have successfully completed the Basic Analytical Chemistry-I course.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. Develop a solid understanding of the principles and qualitative as well as quantitative aspects of various chromatographic methods, with special emphasis on paper chromatography.
2. Acquire comprehensive knowledge of different chromatographic techniques, including thin layer chromatography, column chromatography, ion-exchange chromatography, gas chromatography, and high-performance liquid chromatography (HPLC).
3. Gain in-depth knowledge of gravimetric and volumetric analysis, with special emphasis on volumetric titrimetry, gravimetric titrimetry, and coulometric titrimetry.
4. Develop practical skills through hands-on exposure to the separation of mixtures by paper chromatography, complex formation using dimethylglyoxime (DMG), and distillation techniques.

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ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Explain the basic principles of chromatography, different chromatographic methods, and the separation of metal ion mixtures using paper chromatography.
CO2	Apply various chromatographic techniques, including thin layer chromatography, column chromatography, ion-exchange chromatography, gas chromatography, and HPLC, for the identification, purification, and separation of chemical species.
CO3	Interpret and utilize the fundamental principles of gravimetric and volumetric analysis for the quantitative determination of known and unknown analytes in different samples.
CO4	Perform the separation of mixtures using paper chromatography, dimethylglyoxime (DMG) complexation, and distillation techniques through laboratory practices.
CO5	Analyze and select appropriate analytical and separation techniques for specific chemical investigations and experimental requirements.

iii. **Syllabus:**

Section	Contents	Contact Hours
1	**Chromatography I :** General introduction to chromatography, principles of chromatography, Classification, Mechanism of separation (Adsorption, Partition & Ion exchange), Development of Chromatogram: Frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: Paper chromatography (Various modes of development, nature of the paper, detection of spots, retardation factors, factors that affect the reproducibility of Rf values, selection of solvent, quantitative analysis, Separation of mixture of metal ions (Fe^{3+} and Al^{3+}) by Paper chromatography	**10 Hours**
2	**Chromatography II:** TLC (stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, Rf values, quantitative analysis, applications), Column Chromatography,IonExchangeChromatography.Determinationofionexchangecapacityofanion/cation exchange resin, Gas chromatography (GC) and High-performance liquid chromatography (HPLC).	**10 Hours**
3	**Quantitative methods of analysis:** ***Gravimetric analysis***: Precipitation methods, Volatilization methods, Properties of precipitates and precipitating reagents, Drying and Ignition of precipitates, ***Volumetric analysis.*:** Definitions: Titrimetry, Volumetric titrimetry, Gravimetric titrimetry, Coulometric titrimetry, Theory of acid–base indicators, Action of Phenolphthalein, Action of Methyl Orange, selection of indicators and their limitations	**10 Hours**
PRACTICAL COMPONENT OF SKILL ENHANCEMENT COURSE		
S.No	**Aim of the Experiment**	**Contact Hours**
1	Separation of a mixture of two cations (Fe^{3+},Al^{3+},Co^{2+} and Ni^{2+}) by paper chromatography	
2	Estimation of Cu^{2+} and Ni^{2+} by gravimetric method.	

3	To separate a mixture of Ni^{2+}&$Fe^{3+}$by complexing with DMG and extracting the Ni^{2+}DMG complex in chloroform.	**15 hours**
4	Separation of mixture of two organic liquids by distillation (i) Ethanol and water (ii) Propan-1-olandpropanone	

iv. Suggested readings:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A., Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. 3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
3. Harris,D.C. Quantitative Chemical Analysis, W.H.Freeman.
4. Dean,J.A. Analytical Chemistry Notebook, McGraw Hill.
5. Day,R.A.& Underwood,A.L. Quantitative Analysis, Prentice Hall of India.
6. 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.
7. Mann,F.G. & Saunders,B.C. Practical Organic Chemistry Orient-Longman,1960

v. Evaluation Pattern:

Components	Internal Assessment	Semester End Examination
Marks	25	50
Total Marks	75	

vi. Components of Internal Evaluation:

S. No.	Type of Assessment	Marks
1	Lab CCA (Performance + Assignment in the form of Practical File)	10 marks
2	Class Test/House Test	10 Marks
3	Attendance (The marks would be given in the following manner: (75%-79.9%:1 Mark : 1; 80%-84.9%: 2; 85%-89.9%: 3; 90%-94.9%: 4 and 95%-100%: 5).	5 marks

vii. Instructions for the Paper Setter:

1. Pattern of Mid Semester Examination

S. No.	Particulars	Details
1	Maximum Marks	10 Marks
2	Number of Sections	2 (Section A & Section B)
3	Section A	Consists of four short-answer questions. All questions are compulsory. Each question carries 1 mark.

2. Pattern of End Semester Examination

Part	Section/Block	Questions Set	Questions to be Attempted	Marks per Question	Marks to be Attempted
A	Section/Block I	2	Any 1	12	12
B	Section/Block II	2	Any 1	12	12
C	Section/Block III	2	Any 1	12	12
D	All Sections/Blocks (I, II & III)	10 Short-Answer Questions	Any 7	2	14
Total	—	16 Questions	—	—	50 Marks

viii. Pass marks

S. No.	Requirement	Minimum Percentage
1	Pass in each individual component (CCE, ESE)	**35%**
2	Pass in aggregate of the subject	**40%**

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S. No.	Course Code	Course Title	L	T	P	C	CH	Course Type
1	BCHEM-I/A/P/C-201	**Internship/Apprenticeship/Project/Community Outreach**	0	0	4	4	60	Core Research
Prerequisite		Students should have successfully completed the prescribed foundational and core chemistry courses of the programme and possess basic knowledge of laboratory practices, chemical safety, scientific methods, and data analysis. They should also demonstrate effective communication, teamwork, ethical conduct, and a willingness to engage in industrial, research, community outreach, or field-based learning activities.						
Course Coordinator		**Dr. ……**						

i. Course Objectives:

1. To provide students with hands-on exposure to the application of chemistry in academic, industrial, environmental, and societal settings.
2. To develop practical skills, problem-solving ability, professional ethics, teamwork, and communication skills.
3. To promote community engagement and social responsibility through chemistry-related outreach activities.
4. To enhance employability and research aptitude through experiential learning.

ii. Course Outcomes: On completion of this course, the students are expected to

CO1	Apply theoretical concepts of chemistry to solve practical problems encountered in industrial, laboratory, environmental, or community settings.
CO2	Demonstrate competency in laboratory practices, safe handling of chemicals and instruments, documentation, and adherence to professional ethics.
CO3	Design, execute, and interpret a project or field-based study using appropriate scientific methods and analytical skills.
CO4	Communicate scientific findings effectively through technical reports, presentations, and interaction with diverse stakeholders.
CO5	Work effectively both independently and as a member of a team, exhibiting responsibility, leadership, and professional conduct.

iii. **Syllabus:**

	Course Outline	Contact Hours
Students shall undertake any one of the following activities, subject to institutional feasibility and approval of the Department:		
1	**Internship/Apprenticeship** • Training in chemical industries, quality control laboratories, testing laboratories, pharmaceutical units, food processing units, educational institutions, research laboratories, or other approved organizations. • Exposure to laboratory practices, instrumentation, safety protocols, documentation, and	**60 Hours**

	professional work culture.	
2	**Project Work** • Laboratory-based experimental project. • Literature survey and review-based project. • Field-based chemistry project related to environmental monitoring, water analysis, soil analysis, waste management, or allied areas. **Preparation of a project report under the supervision of a faculty member**	
3	**Community Outreach/Extension Activities** • Awareness programmes on water quality, sanitation, waste segregation, and environmental conservation. • Demonstration of simple chemistry experiments in schools. Participation in science outreach camps, exhibitions, and community engagement activities	

iv. Course Requirements

1. Maintenance of a logbook/record of activities.
2. Submission of an internship completion certificate (where applicable).
3. Submission of a project/outreach report.
4. Seminar presentation and viva-voce examination.

v. Evaluation Pattern and Assessment Components

The duration, credit allocation, assessment pattern, and evaluation methodology shall be determined by the University from time to time and implemented subject to institutional feasibility. Supervisor's Evaluation, Project/Internship/Outreach Report, Seminar Presentation, and Viva-Voce has been listed in assessment rubrics table below:

Assessment Component	Criteria	Marks
1. Supervisor's Evaluation	Regularity, punctuality, discipline, professional ethics, initiative, teamwork, technical skills, and overall performance at the workplace/field/laboratory.	**30**
2. Project/Internship/Outreach Report	Organization, objectives, methodology, observations/data analysis, discussion, conclusions, originality, report presentation, and proper referencing.	**30**
3. Seminar Presentation	Subject knowledge, content organization, clarity of presentation, communication skills, use of visual aids, time management, and ability to respond to	**20**

	questions.	
4. Viva-Voce	Understanding of the work carried out, conceptual clarity, analytical ability, application of knowledge, and responses to questions.	**20**
Total Marks		**100**