Scheme of Instruction & Syllabi

of

Bachelor of Science (Honours)

Chemistry

(Effective from Session 2026-2027)

Third Year

Department of Applied Sciences & Humanities

INVERTIS UNIVERSITY

Bareilly-243123 U.P.

B.Sc. Honours (Chemistry)

This program provides a specialized ability to identify and solve significant problems across a broad range of application areas concerned chiefly with knowledge of as well as of cross-discipline nature, to develop the aptitude to apply the principles of Chemistry and related sciences to articulate an in-depth understanding of core knowledge on various areas of Chemical Sciences. It is designed to help students understand the importance of the role of this knowledge in improving the quality of human life. It also helps students recognize and appreciate the contribution of great scientists in the field of Chemistry and related fields.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

This program acts as a specialized degree and helps to develop critical, analytical and problem-solving skills at a first level. This specialized degree makes the graduates employable in scientific organizations and also to assume expert administrative positions in various types of organizations. Further acquisition of higher-level degrees will help graduates pursue a career in academics or scientific organizations as researchers.

The Program Educational Objectives are to prepare the students to:

1. Work independently or in a team with engineering, medical, ICT professionals and scientists in scientific problem solving.
2. Act as expert administrators in public, private and government organizations, or as business administrators, with further training and education.
3. Pursue master's and doctoral research degrees to work in colleges, universities as professors, or as scientists in research establishments.

INVERTIS UNIVERSITY BAREILLY

PROGRAM OUTCOMES (POs)

After undergoing this programme, a student will be able to execute the following successfully:

1. Scientific knowledge: Apply the knowledge of Chemistry, scientific fundamentals, and scientific specialization to the solution of complex scientific problems.

2. Problem analysis: Identify, formulate, research literature, and analyze scientific problems to arrive at substantiated conclusions using first principles of Chemical sciences and nature.

3. Design/development of solutions: Design solutions for composite scientific problems and design system components and processes to meet specifications, with consideration for public health and safety, and cultural, societal and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern scientific tools including prediction and modeling to complex activities with an understanding of the limitations.

6. Scientific temper and society: Apply reasoning informed by appropriate knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the practice.

7. Environment and sustainability: Understand the impact of professional scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for, sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. Communication: Communicate effectively with their community and with society at large. Be able to comprehend and write effective reports and documentation. Make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of scientific and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in, independent and life-long learning and research in the broadest context of scientific and technological change.

B.Sc. (Honours) (Chemistry)
Scheme of Instruction

I Year

I Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-1	BHP101	Mechanics & Properties of Matter	3	1	0	30	70	100	4
DSC-2	BHP102	Thermodynamics	3	1	0	30	70	100	4
DSC-3	BHC101	General Inorganic Chemistry	3	1	0	30	70	100	4
DSC-4	BHC102	General Organic Chemistry	3	1	0	30	70	100	4
DSC-5	BHM101	Differential Calculus & Matrix	3	1	0	30	70	100	4
DSC-6	BHM102	3-Dimensional Geometry	3	1	0	30	70	100	4
Lab-1	BHP151	Mechanics Lab I	0	0	4	15	35	50	2
Lab-2	BHC151	Organic Chemistry Lab	0	0	4	15	35	50	2
Lab-3	BHM151	MATLAB Programming	0	0	4	15	35	50	2
G.Core	EPC001	AI Based English Proficiency Course - I	0	0	0	0	50	50	2
Total			**18**	**6**	**12**	**225**	**575**	**800**	**32**

II Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-7	BHP201	Optics	3	1	0	30	70	100	4
DSC-8	BHP202	Waves and Oscillations	3	1	0	30	70	100	4
DSC-9	BHC201	General Physical Chemistry	3	1	0	30	70	100	4
DSC-10	BHC202	Inorganic Chemistry of Chemical Bonding	3	1	0	30	70	100	4
DSC-11	BHM201	Real Analysis	3	1	0	30	70	100	4
DSC-12	BHM202	Integral Calculus	3	1	0	30	70	100	4
Lab-4	BHP251	Optics Lab	0	0	4	15	35	50	2
Lab-5	BHC251	Inorganic Chemistry Lab	0	0	4	15	35	50	2
Lab-6	BHM251	Programming with C	0	0	4	15	35	50	2
G.Core	EPC001	AI Based English Proficiency Course - II	0	0	0	0	50	50	2
		Total	**18**	**6**	**12**	**225**	**575**	**800**	**32**

L – Lecture
T – Tutorial
P – Practical

MSM – Mid Semester Marks
ESM – End Semester Marks

B.Sc. (Honours) (Chemistry)
Scheme of Instruction

II Year

III Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-13	BHP301	Electromagnetic Theory	3	1	0	30	70	100	4
DSC-14	BHP302	Semiconductor Physics	3	1	0	30	70	100	4
DSC-15	BHC301	Organic Chemistry of Functional Groups	3	1	0	30	70	100	4
DSC-16	BHC302	Thermodynamics and Chemical Equilibria	3	1	0	30	70	100	4
DSC-17	BHM301	Probability Theory & Statistics	3	1	0	30	70	100	4
DSC-18	BHM302	Differential Equations	3	1	0	30	70	100	4
Lab-7	BHP351	Thermal Physics Lab	0	0	4	15	35	50	2
Lab-8	BHC351	Synthesis in Chemistry Lab	0	0	4	15	35	50	2
Lab-9	BHM351	Aptitude and Reasoning	0	0	4	15	35	50	2
Total			**18**	**6**	**12**	**225**	**525**	**750**	**30**

IV Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-19	BHP401	Digital Electronics	3	1	0	30	70	100	4
DSC-20	BHP402	Modern Physics	3	1	0	30	70	100	4
DSC-21	BHC401	Advanced Inorganic Chemistry	3	1	0	30	70	100	4
DSC-22	BHC402	Heterocyclic and Polycyclic Chemistry	3	1	0	30	70	100	4
DSC-23	BHM401	Integral Transform	3	1	0	30	70	100	4
DSC-24	BHM402	Numerical Analysis	3	1	0	30	70	100	4
Lab-10	BHP451	Semiconductor Lab	0	0	4	15	35	50	2
Lab-11	BHC451	Instrumentation in Chemistry Lab	0	0	4	15	35	50	2
Lab-12	BHM451	Numerical Analysis Lab	0	0	4	15	35	50	2
Total			**18**	**6**	**12**	**225**	**525**	**750**	**30**

L – Lecture
T – Tutorial
P – Practical
MSM – Mid Semester Marks
ESM – End Semester Marks

B.Sc. (Honours) (Chemistry)
Scheme of Instruction

III Year

V Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-25	BHC501	Coordination Chemistry	3	1	0	30	70	100	4
DSC-26	BHC502	Biochemistry	3	1	0	30	70	100	4
DSC-27	BHC503	Electrochemistry and Kinetics	3	1	0	30	70	100	4
DSC-28	BHC504	Green Chemistry	3	1	0	30	70	100	4
VAC-1	BHC505	Introduction to Data Science	2	0	0	15	35	50	2
Lab-13	BHC551	Inorganic Chemistry Lab	0	0	4	15	35	50	2
Lab-14	BHC552	Data Science Lab	0	0	4	15	35	50	2
FW	BHC553	Internship/Field Work	0	0	0	30	70	100	4
Total			**14**	**4**	**8**	**195**	**455**	**650**	**26**

VI Semester			Teaching Scheme			Marks Distribution			Credits
Paper	**Code**	**Subject**	**L**	**T**	**P**	**MSM**	**ESM**	**Total**	
DSC-29	BHC601	Organometallics and Bio-Inorganic Chemistry	3	1	0	30	70	100	4
DSC-30	BHC602	Advanced Organic Chemistry	3	1	0	30	70	100	4
DSC-31	BHC603	Advanced Physical Chemistry	3	1	0	30	70	100	4
DSC-32	BHC604	Computational Chemistry	3	1	0	30	70	100	4
VAC-2	BHC605	Environmental Science	2	0	0	15	35	50	2
Lab-15	BHC651	Physical & Organic Chemistry Lab	0	0	4	15	35	50	2
Project	BHC652	Project Work	0	0	0	50	100	150	6
Total			**14**	**4**	**4**	**200**	**450**	**650**	**26**

L – Lecture
T – Tutorial
P – Practical
MSM – Mid Semester Marks
ESM – End Semester Marks

Detailed Syllabus

for

Bachelor of Science (Honours)
in
Chemistry

Third year
(w.e.f. 2026-27)

BHC501: Coordination Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test - 12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 Marks

Course Objectives:

1. Introduce the fundamental concepts of coordination compounds and Werner's coordination theory.
2. To learn the classification of ligands and the IUPAC nomenclature of coordination compounds.
3. Develop the ability to determine coordination numbers and predict the geometry of metal complexes.
4. Explain the VBT and CFT descriptions of bonding in complex compounds.
5. Introduce the MOT treatment of metal–ligand bonding in octahedral complexes.

Detailed Syllabus:

Unit 1 — Fundamentals, Nomenclature & Isomerism
Double salts and complex salts — distinguishing features; Werner's coordination theory and its postulates. Effective Atomic Number (EAN) rule. Classification of ligands: unidentate, bidentate and polydentate ligands; ambidentate ligands; chelating ligands and the chelate effect. Coordination number and common geometries of complexes. IUPAC nomenclature of coordination compounds (up to two metal centres). Isomerism in coordination compounds: constitutional isomerism (ionisation, hydrate, linkage and coordination isomerism) and stereoisomerism (geometrical and optical isomerism) in complexes of coordination number 4 and 6, including square planar and octahedral geometries

Unit 2- Bonding Theories — Valance Bond Theory and Crystal Field Theory
Valence Bond Theory (VBT) description of coordination compounds and its limitations.
Elementary Crystal Field Theory (CFT): splitting of d-orbitals in octahedral, tetrahedral, square planar and other (ML4, ML6, ML8) fields. Factors affecting the crystal field splitting energy (Δo); the spectrochemical series of ligands. Crystal Field Stabilisation Energy (CFSE) in weak- and strong-field environments; pairing energy; high-spin and low-spin complexes; spin isomerism. Octahedral Site Stabilisation Energy (OSSE); tetragonal distortion and the Jahn–Teller theorem, with applications. Achievements and limitations of Crystal Field Theory; the nephelauxetic effect. Stabilisation of unusually high and low oxidation states of 3d-series elements by ligand fields.

Unit 3- Elementary Molecular Orbital Theory (MOT)
Elementary idea of Molecular Orbital Theory (MOT) for coordination compounds: qualitative σ- and π-bonding in octahedral complexes (pictorial approach) and their influence on metal oxidation states.

Textbooks:

1. Puri, Sharma & Kalia — *Principles of Inorganic Chemistry* (Vishal Publishing Co.) 2. Satya Prakash, G.D. Tuli, S.K. Basu & R.D. Madan — *Advanced Inorganic Chemistry, Vol. I* (S. Chand & Sons)

Reference Books:

1. J.D. Lee — *Concise Inorganic Chemistry* (Wiley/ELBS)
2. G.L. Miessler, P.J. Fischer & D.A. Tarr — *Inorganic Chemistry* (Pearson)
3. James E. Huheey, E.A. Keiter & R.L. Keiter — *Inorganic Chemistry: Principles of Structure and Reactivity* (Pearson)

Course Outcomes:

After completing the course, students will be able to:

CO1.	Distinguish between double salts and complex salts and state the postulates of Werner's coordination theory.
CO2.	Classify ligands (unidentate, bidentate, polydentate, ambidentate, chelating) and assign correct IUPAC names to coordination compounds (up to two metal centres).
CO3.	Determine the coordination number and predict the geometry of simple coordination compounds.
CO4.	Identify and differentiate constitutional isomerism and stereoisomerism (geometrical and optical) in complexes of coordination number 4 and 6.
CO5.	Apply Crystal Field Theory to explain d-orbital splitting, CFSE, high-spin/low-spin behaviour, and Jahn–Teller distortion.
CO6.	Describe, using elementary Molecular Orbital Theory, the qualitative σ- and π-bonding present in octahedral complexes.

BHC502: Biochemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To introduce the structure, classification, and metabolism of carbohydrates.
2. To develop an understanding of amino acids and protein structure.
3. To familiarize students with enzymes, vitamins, and nucleic acids.
4. To provide knowledge of lipid structure, membranes, and lipid metabolism.

Detailed Syllabus:

Unit 1 — Carbohydrates and metabolism

Carbohydrates: definition, classification (mono-, oligo- and polysaccharides); structure, reducing and non-reducing sugars; structure and biological importance of sucrose, lactose, maltose, starch, glycogen and cellulose. Carbohydrate metabolism: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations.

Unit 2- Amino Acids and Proteins

Amino acids: classification (based on structure, polarity and nutritional requirement), essential and non-essential amino acids; peptide bond formation and its characteristics. Proteins: classification (fibrous and globular); levels of protein structure — primary, secondary (α-helix, β-pleated sheet), tertiary and quaternary structures; protein denaturation and renaturation.

Unit 3 — Enzymes, Vitamins and Nucleic Acids

Enzymes: nomenclature and classification; active site and specificity (lock-and-key and induced-fit models); mechanism of enzyme catalysis; factors affecting enzyme activity (temperature, pH, substrate and enzyme concentration). Vitamins: classification into fat-soluble (A, D, E, K) and water-soluble (B-complex and C) vitamins; structure, coenzyme role and deficiency diseases. Nucleic acids: structure of nucleosides and nucleotides; Watson–Crick double-helical model of DNA; structure and function of RNA, comparison of DNA and RNA.

Unit 4 -Lipids

Lipids: classification — simple, compound and derived lipids; structure and function of saturated and unsaturated fatty acids, essential fatty acids; triacylglycerols, phospholipids, glycolipids and cholesterol; biological role of lipids. Bio membranes: role of membrane lipids; membrane transport mechanisms — passive diffusion, facilitated diffusion and active transport. Lipoproteins: classification (VLDL, LDL and HDL) and their role in lipid transport; concept of 'good' and 'bad' cholesterol.

Text Books:

1. Nelson, D. L. & Cox, M. M. (2021). Lehninger Principles of Biochemistry (7th ed.). W. H. Freeman & Company.
2. Voet, D., Voet, J. G. & Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). John Wiley & Sons.

Reference Books:

1. Voet, D. & Voet, J. G. (2011). Biochemistry (4th ed.). John Wiley & Sons.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J. & Stryer, L. (2019). Biochemistry (9th ed.). W. H. Freeman & Company.
3. Satyanarayana, U. & Chakrapani, U. (2017). Biochemistry (5th ed.). Elsevier (Books and Allied Ltd.).
4. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J. & Weil, P. A. (2018). Harper's Illustrated Biochemistry (31st ed.). McGraw-Hill.

Course Outcomes:

After completing the course, students will be able to:

CO1.	Explain the classification, structure and biological importance of carbohydrates, and describe glycolysis and the fermentation pathways, recognising ATP as the cellular currency of energy.
CO2.	Classify amino acids and explain peptide bond formation; describe the hierarchical organisation of protein structure (primary, secondary, tertiary and quaternary) and the forces governing protein stability, denaturation and renaturation.
CO3.	Explain enzyme nomenclature, mechanism of catalysis and the factors affecting enzyme activity; correlate the structure of vitamins with their coenzyme functions; and describe the structure of nucleic acids and differentiate DNA from RNA.
CO4.	Describe the classification, structure and metabolic fate of lipids and the organisation of bio membranes.
CO5.	Evaluate the Biochemistry of the compounds and understand their properties

BHC503: Electrochemistry And Kinetics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To give an overview of conductance.
2. To give complete knowledge of types of chemical kinetics envolved in reactions.
3. To describe phenomena in photochemistry.
4. To explain the different laws related to photochemistry.
5. To explain the Arrhenius theory.
6. To explain the applications of conductance measurement.

Detailed Syllabus:

Unit-1 Electrochemistry

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent conductivity, and molar conductivity; variation of conductivity with dilution for strong and weak electrolytes. Molar conductivity at infinite dilution and Kohlrausch's law of independent migration of ions.

Ionic mobility and ionic velocity; determination of ionic mobilities. Transference number and its relation to ionic mobility; determination of transference numbers by Hittorf's and Moving Boundary methods. Debye–Hückel–Onsager equation, Wien effect, Debye–Falkenhagen effect, and Walden's rule. Applications of conductance measurements.

Unit-2 Chemical Kinetics

Chemical Kinetics: Rate of reaction, order and molecularity, rate laws, differential and integrated rate equations (up to second order), determination of rate laws, complex reactions (opposing, parallel, and chain reactions), Arrhenius equation, activation energy, and collision theory.

Unit-3 Surface Chemistry

Adsorption, physical adsorption, chemisorption, adsorption isotherms, and nature of adsorbates. catalysis: Types of catalysts, specificity and selectivity, catalysis at solid surfaces, and catalytic efficiency of nanoparticles.

Unit-4 Photochemistry

Characteristics of electromagnetic radiation. Lambert–Beer's law, absorption coefficient, and limitations of Lambert-Beer's law. Laws of photochemistry and quantum yield. Photochemical equilibrium, photochemical reaction rates, photosensitized reactions, and quenching.

Text Books:

1. Laidler, K. J. Chemical Kinetics Pearson Education: New Delhi (2004).

2. J. L. Powell & B. Crasemann, Quantum Mechanics, (Addison-Wesley Pubs.Co.,1965)

Reference Books:

1. Ball, D. W. Physical Chemistry, Thomson Press, India (2007).
2. Castellan, G. W. Physical Chemistry, 4th Ed. Narosa (2004).
3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press(2006).

Course Outcomes:

After completing the course, students will be able to:

CO1.	Understand various types of conductance and analyze the effect of various variables on conductivity
CO2.	Identify chemical kinetics and understand consecutive and parallel reactions.
CO3.	Evaluate the performance of catalysis and its different applications and understand the photosensitized reactions.
CO4.	Analyze & solve the performance chain reactions.
CO5.	Evaluate quantum mechanical results related to photochemistry

BHP504: Green Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. Understand the principles and metrics of Green Chemistry for sustainable chemical practices.
2. Explain atom economy, waste prevention, and environmental performance indicators
3. Identify safer chemicals, solvents, and sustainable alternatives used in modern chemistry.
4. Understand green synthetic methodologies microwave, and ultrasound-assisted synthesis.
5. Recognize industrial applications of green technologies, bioplastics, and safer manufacturing practices.
6. Develop awareness of sustainable laboratory practices and environmentally chemical processes.

Detailed Syllabus:

Unit 1: Foundations, Principles, and Metrics of Green Chemistry

A. Introduction & Historical Context: Definition, origin, and evolution of Green Chemistry. The global paradigm shift toward sustainability; distinction between environmental chemistry (remediation) and green chemistry (prevention at source). Introduction to the 12 Principles of Green Chemistry with real-world examples.

B. Waste Prevention and Atom Economy: Concept of source reduction; hazardous waste minimization strategies. Metrics of chemical efficiency: detailed mathematical calculation of % Atom Economy, Yield vs. Atom Economy, and Environmental Factor (E-factor) using classic reactions (e.g., substitution vs. addition reactions).

C. Designing Safer Chemicals & Solvents: Toxicity evaluation, basic principles of toxicology in molecule design. Alternatives to volatile organic solvents (VOCs). Introduction to "Green Solvents": properties, synthesis, and industrial utility of water, supercritical fluids ($scCO_2$), ionic liquids, and bio-derived solvents.

Unit 2: Green Synthetic Methodologies & Alternative Energy Parameters

A. Catalysis in Green Synthesis: The vital role of catalysts in green manufacturing. Homogeneous vs. heterogeneous green catalysis. Advantages of biocatalysis (enzymatic reactions), phase-transfer catalysis, and biomimetic catalysts over traditional stoichiometric reagents.

B. Non-Conventional Energy Sources: Activation of chemical reactions using sustainable energy inputs. Microwave-assisted Synthesis: Principles of dielectric heating, comparison with conventional thermal heating, solvent-free microwave reactions. Ultrasound-assisted (Sonochemical) Synthesis: Acoustic cavitation, mechanical and chemical effects, synthesis of organometallic and organic compounds.

Unit 3: Industrial Applications, Future Trends

Industrial Applications & Green Technology: Green polymers and bioplastics

(Polylactic acid - PLA). Minimizing chemical accidents via inherently safer chemistry. Real-world applications of green chemistry in the textile, pharmaceutical, and agrochemical industries.

Text Books:

1. **Anastas, P. T., & Warner, J. C. (1998).** Green Chemistry: Theory and Practice. Oxford University Press. (The foundational academic text outlining the definitive 12 principles of green chemical design used across global university frameworks).
2. **Ahluwalia, V. K. (2012).** A Textbook of Green Chemistry. Narosa Publishing House, New Delhi. (A widely prescribed academic guide specifically tailored for Indian undergraduate standard curricula under UGC/CBCS learning frameworks).

Reference Books:

1. **Lancaster, M. (2010).** Green Chemistry: An Introductory Text (2nd ed.). Royal Society of Chemistry (RSC). (A crucial resource mapping core alternative energy profiles, microwave metrics, and industrial sustainability parameters).
2. **Sheldon, R. A. (2007).** The E Factor 15 years on: green chemistry and sustainability with catalysts. Green Chemistry, 9(12), 1273-1283. (A high-impact academic research reference addressing standard metric calculations for waste minimization).

Course Outcomes:

After completing the course, students will be able to:

CO1.	Describe the concepts, principles, and significance of Green Chemistry.
CO2.	Calculate atom economy and evaluate the environmental efficiency of chemical reactions
CO3.	Select appropriate green solvents, catalysts, and safer reagents for sustainable synthesis.
CO4.	Apply alternative energy techniques such as microwave and sonochemical methods in chemical synthesis.
CO5.	Evaluate industrial green chemistry practices for minimizing waste and chemical hazards.
CO6.	Demonstrate environmentally responsible thinking in laboratory work and sustainable chemical process design.

BHC505- Introduction of Data Science	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test - 12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6 Marks Attendance - 12 Marks
Credits: 4	End Semester Exam - 70 Marks

Course Objectives:

The main goal of this course is to help students:

1. Learn and understand data science
2. Understand about probability and statistics for data science
3. Learn about statistical hypothesis testing
4. Understand about data preparation for analysis
5. Learn about data visualization and interpretation

Detailed Syllabus

UNIT 1	**Introduction to data science**: Data science, types of data, Basic methods of data analysis, common misconceptions of data analysis, application of data science
UNIT 2	**Probability and Statistics for data science**: Introduction, objectives, probability, conditional probability, Bayes theorem
UNIT 3	**Statistical Hypothesis Testing**: Estimation of parameters of the population, Significance testing of statistical Hypothesis, Examples using correlation and regression, Types of error in hypothesis testing
UNIT 4	**Data Preparation for Analysis**: Introduction, objectives, need for data preparation, Data preprocessing, data cleaning, data integration, data reduction, data transformation, selection and data extraction
UNIT 5	**Data Visualization and Interpretation**: Introduction, objectives, different types of plots, histograms, box plot, scatter plots, bubble chart, distribution plot, pair plot, line graph, pie chart, area chart etc.

Text Books:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Michael Berthold, David J. Hand," Intelligent Data Analysis", Springer

Reference Books:

1. Ethics and Data Science, Mike Loukides, Hilary Mason and D J Patil, O'Reilly, Ethics and Data Science 1st edition, 2018.
2. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2nd edition, 2014.

3. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer
4. David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big Data Analytics”, EMC Education Series, John Wiley
5. Frank J Ohlhorst, “Big Data Analytics: Turning Big Data into Big Money”, Wiley and SAS Business Series
6. Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier
7. Michael Berthold, David J. Hand,” Intelligent Data Analysis”, Springer

Course Outcomes:

After completing the course, students will be able to:

1. Understand the fundamental concepts of data science.
2. Apply the data analysis techniques to demonstrate the data science process.
3. Understand concept of machine learning used in the data science process.
4. Visualize and present the inference using various tools.
5. Learn to think through the ethics surrounding privacy, data sharing.

BHP551: Inorganic Chemistry Lab	
Teaching Scheme	**Examination Scheme**
Practical: 4 hrs/Week Credits: 2	Attendance - 5 Marks Teachers Assessment - 10 Marks End Semester Exam - 35 Marks

Course Objectives:

1. Develop practical skills for the estimation of Cu, Fe, Ni and Al.
2. To synthesize inorganic preparation.
3. To learn the crystallization technique
4. To detect extra elements.

List of Experiments:

Student has to perform the following experiments:

Section A: The following quantitative estimations are to be carriedout.

1. Estimation of nickel (II) using Dimethyl lyoxime as the precipitant.
2. Estimation of copper as CuSCN
3. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$ through heterogeneous and homogeneous media.
4. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$(aluminiumoxinate).

Section B: Inorganic Preparations:

1. Tetraammine copper (II) sulphate, $[Cu(NH_3)_4]SO_4$ H_2O
2. Potassium trisoxalatochromate (III), $K_3[Cr(C_2O_4)_3]$
3. Cis and trans $K[Cr(C_2O_4)_2$ $(H_2O_2]$ Potassium dioxalatodiaquachromate(III) Pentaamminecarbonato Cobalt (III) ion

Reference Books:

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986

2. Advanced Practical Chemistry Jagdamba Singh, L.D.S Yadav and R.K.P. Singh,

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental principles and estimation of Cu, Fe, Ni and Al.
CO2.	To learn the synthesize inorganic preparation.
CO3.	Understand the crystallization techniques
CO4.	**Analyse** the extra elements detection.
CO5.	**Evaluate** experimental results using appropriate calculations, graphs, and error estimation techniques.

BHC552: Data Science Lab	
Teaching Scheme Lab: 2Hrs/Week Tutorials: 0 Hrs./Week Credits: 2	**Examination Scheme** Internal-15Marks External- 35 Marks

Course Objectives:

1. To understand variables, loops and functions
2. To understand Working with lists, dictionaries, tuples, and data frames
3. To understand Handling missing values, duplicates, and data type conversions, Filtering, sorting
4. To calculate mean, median, variance, and standard deviation and create different types of plots like histograms, and box plots perform
5. To Simulate Binomial, Poisson, and Normal distributions

List of experiments/Programs

Program 1	Write a program to perform basic arithmetic operations using variables.
Program 2	Find the largest of three numbers using conditional statements.
Program 3	Generate Fibonacci series up to *n* terms.
Program 4	Find factorial of a number using a function.
Program 5	Create a function to check whether a number is prime.
Program 6	Perform basic operations on a list (insert, delete, search, sort).
Program 7	Demonstrate tuple creation, indexing, slicing, and unpacking.
Program 8	Identify and remove missing values from a DataFrame.
Program 9	Filter student records based on marks greater than 75.
Program 10	Calculate mean, median, mode, variance, and standard deviation of a dataset.
Program 11	Compute summary statistics using Pandas (describe()).
Program 12	Create a box plot to detect outliers in a dataset
Program 13	Simulate a Binomial distribution and visualize it.
Program 14	Generate a Normal distribution and verify the empirical rule (68–95–99.7).
Program 15	Perform Independent Sample T-test and Chi-square Test using SciPy.

Course Outcomes:

At the end of course, the student will be able to

1. Explain variables, loops and functions.
2. Working with lists, dictionaries, tuples, and data frames.
3. Understand Handling missing values, duplicates, and data type conversions, Filtering, sorting.
4. Calculate mean, median, variance, and standard deviation and create different types of plots like histograms, and box plots perform.
5. Simulate Binomial, Poisson, and Normal distributions.

BHC553: Internship / Field Work	
Teaching Scheme	**Examination Scheme**
Credits: 4	Internal Assessment - 30 Marks End Semester Exam - 70 Marks

Course Objectives:

1. **Provide students with practical exposure** to professional, industrial, research, or field environments related to Chemistry and allied disciplines.
2. **Enable students to apply theoretical knowledge and practical skills** to real-world problems and professional situations.
3. **Develop professional competencies**, including teamwork, communication, time management, documentation, and technical report writing.
4. **Familiarize students with career opportunities** in industry, research, higher education, and other interdisciplinary fields.

Scope / Guidelines:

1. Students shall undertake an internship of **a minimum duration of 2–4 weeks or equivalent field work** in a research laboratory, industry, academic institution, or reputed organisation related to Chemistry, Instrumentation, Materials Science, or an allied area. Alternatively, students may undertake supervised field work, community-based activities, or a survey-based study under the guidance of a faculty mentor.
2. The internship or field work shall be **approved in advance by the Department** in consultation with the faculty mentor and, where applicable, the host organisation.
3. Students shall maintain a **work diary/logbook** documenting their activities, learning experiences, tasks performed, and skills acquired during the internship or field work.
4. Students shall follow the **professional, safety, ethical, and academic guidelines** of the host organisation or field activity.
5. At the completion of the internship/field work, students shall submit a **certificate from the host organisation**, wherever applicable, along with a comprehensive report in the format prescribed by the Department.
6. Students shall present their experience and learning outcomes through a **seminar/presentation** and appear for a viva-voce as part of the final evaluation.

Evaluation Scheme:

1. Internal Assessment (30 Marks): work-diary/log book, mentor's assessment and a mid-term presentation.

2. End Semester Examination (70 Marks): submission of the internship/field-work report and a viva-voce examination before a departmental committee.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** relevant concepts and principles of Chemistry applicable to the assigned internship or field-work activities.

CO2.	**Explain** the tasks, procedures, tools, and professional practices encountered during the internship or field work.
CO3.	**Apply** theoretical knowledge and practical skills to address real-world problems and perform assigned professional or field-based tasks.
CO4.	**Analyse** observations, work experiences, technical information, or field data using appropriate scientific and analytical methods.
CO5.	**Evaluate** the outcomes of the internship or field work and critically reflect on the skills acquired, challenges encountered, and possible improvements.
CO6.	**Develop** professional competencies and effectively communicate the internship/field-work experience through a structured report, presentation, and viva-voce.

BHC601: Organometallics and Bio-Inorganic Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To describe the organometallic compounds.
2. To explain different types of metal carbonyls and metal clusters
3. To explain the ferrocene preparation's and properties.
4. Understand about metal ions in biological system.
5. To explain the iron Bio-system.

Detailed Syllabus:

Unit-1 Organometallic Compounds:
Definition and classification of organometallic compounds, calculation of Effective Atomic Number (EAN) rule, 18 electron rules. Reactions of organometallic compounds

Unit-2 Metal carbonyls:
Preparation, properties, structure and bonding of mononuclear carbonyls. π-acceptor behaviour ofcarbon monoxide, synergic effect (MO diagram of CO), ferrocene and its reactions.

Unit-3 Cluster Compounds:
Introduction, Carbonyl clusters and inorganic metal clusters, calculation of metal-metal bonds, Isolobal analogy, synthesis of carbonyl clusters.

Unit-4 Bioinorganic Chemistry:
Metal ions are present in biological systems, classification of elements according to their action in biological system. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity. Iron and its application in biosystems, Haemoglobin; Storage and transfer of iron.

Text Books:

1. **The Organometallic Chemistry of the Transition Metals** (7th Edition) by Robert H. Crabtree
2. **Bioinorganic Chemistry** by Ivano Bertini; Harry Gray; Stephen J. Lippard; Joan Valentine; ISBN: 0935702571 Publication Date: 1994-04-01

Reference Books:

1. **Inorganic Chemistry 5th Ed** by Gary L. Miessler; Paul J. Fischer; Donald A. Tarr ISBN: 9780321811059, Publication Date: 2013-01-20
2. **Organometallic and Bioinorganic Chemistry,** Ajai Kumar, AARYUSH EDUCATION

Course Outcomes:

After completing the course, students will be able to:

CO1.	To learn organometallic compounds.
CO2.	To understand the different types of metal carbonyls and metal clusters
CO3.	Understand the ferrocene preparation’s and properties.
CO4.	Understand the extra elements detection.
CO5.	To learn about metal ions in biological system.
CO6.	To learn the iron Bio-system.

BHC602: Advanced Organic Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To explain emission and absorption spectroscopy
2. To explain Molecular Spectroscopy.
3. To explain the UV Spectroscopy.
4. To explain about IR and NMR spectroscopy.

Detailed Syllabus:

Unit-1 General Principles of Spectroscopy and UV–Visible Spectroscopy
Introduction to spectroscopy, Absorption spectroscopy, Emission spectroscopy, Electromagnetic spectrum and interaction of radiation with matter. Basic principles of UV–Visible spectroscopy, Types of electronic transitions ($\sigma\rightarrow\sigma^*$, $n\rightarrow\sigma^*$, $\pi\rightarrow\pi^*$, $n\rightarrow\pi^*$), Chromophores and auxochromes, Absorption maximum (λmax), Factors affecting λmax, Bathochromic (red) shift and Hypsochromic (blue) shift, Intensity of absorption (molar absorptivity) Applications of UV–Visible spectroscopy

Unit-2 Infrared (IR) Spectroscopy
Basic principles of IR spectroscopy, Molecular vibrations {Fundamental vibrations, non-fundamental vibrations (overtones, combination bands)}, Stretching and bending vibrations, Fingerprint region and its significance, Functional group region, Applications of IR spectroscopy in functional group identification.

Unit-3 Nuclear Magnetic Resonance (NMR) Spectroscopy
(A) Proton NMR (^{1}H NMR): Basic principles of NMR spectroscopy, Nuclear spin and magnetic properties, Chemical shift (δ scale), Shielding and deshelling effects, Spin-spin coupling, Coupling constant (*J* value), Interpretation of simple ^{1}H NMR spectra.

(B) Two-Dimensional NMR Spectroscopy: Introduction to 2D NMR, COSY (Correlation Spectroscopy), NOESY (Nuclear Overhauser Effect Spectroscopy), Applications of 2D NMR in structure elucidation.

Unit-4 Applications of Spectroscopic Techniques: Combined applications of UV-Visible, IR, and NMR spectroscopy, Identification and structural elucidation of simple organic molecules, Interpretation of spectral data for organic compounds.

Reference Books:

1. Kemp, W. Organic Spectroscopy, Palgrave.
2. Kalsi, P. S. Textbook of Organic Chemistry (1st Ed.), New Age International (P) Ltd.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson

Education).

Course Outcomes:
After completing the course, students will be able to:

CO1.	To explain about emission and absorption spectroscopy
CO2.	To understand the Molecular Spectroscopy.
CO3.	Understand the Ultraviolet Spectroscopy.
CO4.	To explain about IR and NMR spectroscopy.
CO5.	**Analyze** the principles and applications of spectroscopy

BHC603- Advanced Physical Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To give an overview of Quantum Chemistry.
2. To describe the approximation methods.
3. To describe molecular spectroscopy.
4. To describe the working principle of Li-ion batteries.
5. To explain the solid oxide fuel cells.
6. To explain the electric vehicles and solar cells.
7. To explain the nano-materials application in energy storage systems.

Detailed Syllabus:

Unit-1: Quantum Chemistry

Wave Mechanics: de Broglie hypothesis, Heisenberg's uncertainty principle. Schrödinger Wave Equation: Time-dependent and time-independent forms. Particle in a Box: 1-D and 3-D box solutions, normalization, and zero-point energy. Atomic Structure: Hydrogen and hydrogen-like atoms, angular momentum, and spin. Approximation Methods: Perturbation theory and Variation method.

Unit-2: Nanomaterials in Batteries

Lithium-Ion Batteries (LIBs): Mechanisms of charge storage, limitations of conventional electrodes, and the role of nano-architectures in accommodating volume changes during intercalation. Commercial Applications: Integration of nanotechnology in electric vehicles (EVs), portable electronics, and grid-scale energy storage. Degradation and Challenges: Thermal runaway, structural degradation, and electrolyte decomposition at the nanoscale.

Unit-3: Super-capacitors, Fuel Cells and Photovoltaic systems

Charge Storage Mechanisms: Electric Double-Layer Capacitance (EDLC), Pseudo capacitance (redox), and Battery-Capacitor hybrid behavior. Fuel Cell Types: Proton Exchange Membrane Fuel Cells (PEMFC) and Solid Oxide Fuel Cells (SOFC). Grid-Connected Photovoltaics**:** Large arrays used to supply power to utility grids and commercial power stations. Building-Integrated Photovoltaics (BIPV): Integrating solar technology directly into the architecture of buildings (e.g., solar windows or roof tiles).

Text and Reference Books:

1. Physical Chemistry: A Molecular Approach" by Donald A. McQuarrie
2. Quantum Chemistry" by Ira N. Levine
3. Fundamentals of Molecular Spectroscopy" by C. N. Banwell and E. M. McCash
4. Introduction to Spectroscopy" by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James A. Vyvyan

5. Advances in Lithium-Ion Batteries" by Walter A. Schalkwijk and Bruno Scrosati (Editors)
6. Materials for Lithium-Ion Batteries" by C. Julien and Z. Stoynov (Editors)
7. Supercapacitors: Fast Electrochemical Storage and Conversion of Electric Energy by Yuping Wu and Rudolf Holze (Springer, 2026)
8. Fuel Cells: From Fundamentals to Applications by Supramaniam Srinivasan
9. Handbook of Photovoltaic Science and Engineering" by Antonio Luque and Steven Hegedus (Editors)

Course Outcomes:

After completing the course, students will be able to:

CO1.	State that Schrodinger equation.
CO2.	Describe the qualitative treatment of simple harmonic oscillator model of vibrational motion.
CO3.	Derive the rigid rotator model of rotation of diatomic molecule.
CO4.	Explain the nano-materials applications in Li-ion batteries
CO5.	Describe the super-capacitors and fuel cell designs and applications.
CO6.	Briefly describe the thermal runaway, structural degradation, and electrolyte decomposition at the nanoscale.

BHC604: Computational Chemistry	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	Class Test -12 Marks Teachers Assessment - 6 Marks Attendance - 12 Marks End Semester Exam - 70 marks

Course Objectives:

1. To equip students with modern computational skills for data processing, structural elucidation, and materials analysis.
2. To provide knowledge on computational methods in chemistry.
3. **Familiarize students with the synthesis and characterization techniques** used for the preparation and analysis of nanomaterials.

Detailed Syllabus:

Unit 1: Essential Software tools for Chemistry Research

Chemdraw: Chemical structure drawing and 3-D molecule clean-up. Origin Lab: Advanced data analysis and graphing software; critical for fitting kinetic models, plotting UV-Vis/PL spectra, and analyzing X-ray Diffraction (XRD) data. MestReNova (Mnova): Premier software for processing, visualizing, and analyzing NMR, LC/GC-MS, and UV-Vis data. ImageJ: Essential for processing and analyzing microscopy images (TEM, SEM, AFM). Gaussian: Standard software for predicting molecular energies, structures, and vibrational frequencies. Python: The core language for chemical data science.

Unit 2: Introduction to Computational Chemistry

Fundamentals of electronic structure: Basis function–hydrogen-like, Slater type and Gaussian type orbitals, classification of basis sets – minimal, double zeta. Semi empirical and Ab into methods: Approximation methods. Electronic properties: Dipole moment and electrostatic potential analysis. Introduction to simulation methods: Molecular mechanics and Monte Carlo simulations.

Text and Reference Books:

1. Jensen, F., “Introduction to Computational Chemistry”, John Wiley & Sons Ltd. 1999
2. Leach, A., “Molecular Modeling: Principles and Applications”, Prentice Hall. 2001
3. Cramer, C. J., “Essentials of computational chemistry: Theories and models”, John Wiley & Sons. 2002
4. Levine, I. N. “Quantum Chemistry”, 7th Ed., PHI Learning Pvt. Ltd., Delhi. 2013

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the fundamental concepts of computer application in chemistry
CO2.	**Explain** and understand the essential software tools used in chemistry research.
CO3.	**Apply** appropriate principles and techniques to understand the synthesis and characterization of computational chemistry

CO4.	Know the basic idea of computational chemistry.

BHC605: Environmental Science	
Teaching Scheme Lectures: 2 hrs/Week Tutorials: 0 hr/Week Credits: 2	**Examination Scheme** Class Test -6 Marks Teachers Assessment - 3Marks Attendance – 6 Marks End Semester Exam – 35 marks

Course Objectives:

1. **Develop awareness of environmental systems and sustainable development**, including ecosystems, natural resources, and human–environment interactions.
2. **Familiarize students with environmental pollution, resource conservation, energy sources, and major environmental challenges** such as climate change and global warming.
3. **Promote environmental responsibility and awareness** of environmental protection, legislation, public health, environmental education, and sustainable practices.

Unit-1 Definition, Scope & Importance, Need For Public Awareness- Environment definition, Eco system – Balanced ecosystem, Human activities – Food, Shelter, Economic and social Security. Effects of human activities on environment-Agriculture, Housing, Industry, Mining and Transportation activities, Basics of Environmental Impact Assessment. Sustainable Development
Unit-2 Natural Resources- Water Resources- Availability and Quality aspects, Water borne diseases, Water induced diseases, Fluoride problem in drinking water, Mineral Resources, Forest Wealth, Material cycles-Carbon, Nitrogen and Sulphur Cycles, Energy – Different types of energy, Electro-magnetic radiation, Conventional and Non-Conventional sources – Hydro Electric, Fossil Fuel based, Nuclear, Solar, Biomass and Bio-gas, Hydrogen as an alternative future source of Energy
Unit-3 Environmental pollution and their effects, Water pollution, Land pollution, Noise pollution, Public health aspects, Air pollution, Solid waste management, Current environmental issues of importance, Population Growth, Climate Change and Global warming- Effects, Urbanization, Automobile pollution, Acid Rain, Ozone Layer depletion, Animal Husbandry, Environmental Protection-Role of Government, Legal aspects, Initiatives by Non- governmental Organizations (NGO), Environmental Education, Women Education

Text and Reference Books:

1. P. VenugoplanRao, "Principles of Environmental Science and Engineering"--Prentice Hall of India.
2. Meenakshi, "Environmental Science and Engineering" --Prentice Hall India
3. Manahan S.E. (2005) Environmental Chemistry, CRC Press
4. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
5. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** fundamental concepts of ecosystems, natural resources, environmental pollution, and sustainable development.
CO2.	**Explain** the effects of human activities on ecosystems, natural resources, public health, and environmental quality.
CO3.	**Apply** environmental principles to identify issues related to pollution, resource management, energy use, and sustainable development.
CO4.	**Analyse** major environmental challenges such as climate change, global warming, air and water pollution, acid rain, and ozone depletion.
CO5.	**Evaluate** the effectiveness of environmental protection measures, renewable energy sources, waste management, and sustainable practices.
CO6.	**Develop** awareness-based approaches and sustainable solutions for environmental conservation and public health through education and community participation.

BHC651: Physical & Organic Chemistry Lab	
Teaching Scheme	**Examination Scheme**
Practical: 2 hrs/Week Credits: 2	Attendance - 5 Marks Teachers Assessment - 10 Marks End Semester Exam - 35 Marks

Course Objectives:

1. **Develop practical skills** in conducting experiments related to colorimetry.
2. **Analyze** the functional groups in organic compounds.
3. **Familiarize students with standard experimental techniques** for determining physical constants.
4. **Develop skills in experimental data analysis**, including measurements, calculations, error estimation, and interpretation of results.

List of Experiments:

Student has to perform the following experiments:

1. **Sec A:**

• Colorimetry

• Verification of Lambert-Beer's Law

• Determination of pK (indicator) for phenolphthalein or methyl red

• Study the formation of a complex between ferric and thiocyanate (or salicylate) ions.

• Record the U.V. spectrum of a given compound (acetone) in cyclohexane

(a) Plot transmittance versus wavelength.

(b) Plot absorbance versus wavelength.

Sec B:

1. Tests for following functional groups
   Identification of the functional groups, C-C and C-N triple bonds, sp3, sp2 and sp hybridized C-H bonds by IR spectroscopy (IR spectra to be provided)

2. Qualitative analysis of following types of unknown organic compounds

(a) Carbohydrates

(b) Primary, secondary and tertiary amines

(c) Nitro compounds

(d) Amides

(e) Aryl Halides hydrocarbons

Text and Reference Books:

1. Geeta Sanon, B.Sc. Practical Chemistry, 1st Edition (2007), R. Chand & Co.
2. B. L. Worsnop and H. T. Flint, Advanced Practical Chemistry, Asia Publishing House, New Delhi.

Course Outcomes:

After completing the course, students will be able to:

CO1.	**Recall** the basic principles and complete knowledge of colorimetry.
CO2.	**Explain** the working principles of the experimental methods and instruments used for identification of functional groups

CO3.	**Analyse** experimental observations and relationships between measured quantities using suitable Chemical principles and calculations.
CO4.	**Evaluate** experimental results using appropriate data analysis, error estimation, and comparison with standard values.
CO5.	**Develop** proficiency in designing and performing systematic experiments to investigate the chemical properties of materials and fundamental chemical constants.

BHC652: Project Work	
Teaching Scheme	**Examination Scheme**
Credits: 6	Internal Assessment - 50 Marks End Semester Exam - 100 Marks

Course Objectives:

1. **Provide students with an opportunity to undertake an independent or guided project** in theoretical, experimental, computational, or interdisciplinary areas of Chemistry.
2. **Develop research skills** including literature review, problem formulation, methodology selection, data collection, analysis, and interpretation of results.
3. **Develop scientific communication skills** through systematic project documentation, report writing, oral presentation, and defence of the project work.
4. **Familiarize students with research ethics and academic practices** and prepare them for higher studies, research, and professional careers.

Scope / Guidelines:

1. Each student, or a small group as decided by the Department, shall undertake a project under the supervision of a faculty member in an area of Chemistry or an interdisciplinary field.
2. The project may be **experimental, theoretical, computational, or interdisciplinary**, and shall involve appropriate components such as literature survey, problem formulation, methodology, data collection or theoretical derivation, analysis, results, discussion, and conclusions.
3. Students shall submit a **project proposal/synopsis** at the beginning of the semester and present their progress periodically before the supervisor or departmental committee.
4. Students shall maintain appropriate records of their project work and follow accepted standards of **academic integrity, research ethics, and scientific documentation**.
5. A **final project report** in the prescribed format shall be submitted at the end of the semester, followed by a seminar/presentation and viva-voce examination.

Evaluation Scheme:

1. Internal Assessment (50 Marks): progress reviews, regularity, project synopsis and the supervisor's assessment of the work carried out.

2. End Semester Examination (100 Marks): submission of the project report, an open seminar/presentation, and a viva-voce examination before a departmental committee.

Course Outcomes:

After completing the course, students will be able to:

1. Formulate a research problem in Chemistry and carry out a systematic literature survey.

2. Plan and execute an experimental, theoretical or computational investigation using an appropriate methodology.

3. Analyse and interpret data/results and draw valid scientific conclusions.

4. Prepare a well-structured project report and defend the work through an oral presentation and viva-voce.

CO1.	**Recall** relevant concepts, principles, and scientific literature related to a selected project

	topic in Chemistry.
CO2.	**Explain** the background, objectives, methodology, and scientific significance of the selected project problem.
CO3.	**Apply** appropriate theoretical, experimental, computational, or analytical methods to investigate a defined problem.
CO4.	**Analyse** experimental data, computational results, or theoretical findings using suitable scientific and mathematical techniques.
CO5.	**Evaluate** the results critically, draw valid scientific conclusions, and identify limitations and possible future scope of the work.
CO6.	**Develop** a structured project report and effectively communicate and defend the project findings through scientific presentation and viva-voce.