Dolphin (PG) Institute of Biomedical & Natural Sciences
Dehradun, Uttarakhand-248007

(An Autonomous Institute)

NAAC Accredited A+ (2nd cycle)

(Affiliated with H.N.B. Garhwal University, Srinagar, Srinagar Garhwal)

Ordinance & Syllabus

of

M.Sc. CHEMISTRY

Two Year (4 Semester Programme)

BaseduponNEP-2020 and Curriculum frame work for
Post Graduate Programme-2024

Effective from

Academic Session

2024-2025

Department of Pharmaceutical Chemistry & Chemistry

Acknowledgement

We extend our heartfelt gratitude to management of Dolphin PG Institute of Biomedical & Natural Sciences who have contributed to the development of this comprehensive syllabus. Special thanks to our esteemed faculty members for their invaluable input and dedication. We also appreciate the support of our administrative staff, who have ensured the smooth compilation of this document.

We would like to acknowledge the contributions of our Board of Studies (BOS) members, whose expertise and guidance have been instrumental in shaping the curriculum. Our sincere appreciation goes to the students and alumni for their feedback and suggestions, which have been incorporated to make this syllabus more relevant and effective.

Dr. Deepak Kumar

(Chairperson, Board of Studies in Pharmaceutical Chemistry & Chemistry)

Board of Studies in Pharmaceutical Chemistry & Chemistry

	Name	Designation	Institute/Industry
Head of theDepartment			
1	Dr. Deepak Kumar	Chairperson	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
All Faculty Members of the Department			
1	Dr. Versha Parcha	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
2	Dr. Raju	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
3	Dr. Ritu Singh	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
Subject Expert nominated by Vice-Chancellor			
1	Prof. Anjana Srivastava	NominatedMember	Department of Chemistry, G. B. Pant University of Agriculture & Technology, Pantnagar
Subject experts			
1	Prof. V. K. Varshney	Nominated Member	HOD, Department of Chemistry, Forest Research Institute, Dehradun
2	Dr. Rakesh Joshi	Nominated Member	Department of Chemistry, Sri Dev Suman University, Rishikesh.
Representative from Industry/corporate sectors			
1	Dr. Vinod Tiwari	Nominated Member	Plant Head, Planet Herb Life Sciences Ltd. Dehradun
	Alumnus		
1	Mrs. Kavita	Nominated Member	Ms. PGT, Doon Haritage School, Dehradun

Vision, Mission and Core Values of the Institute

Vision

Lead the youth on a journey of knowledge and innovation, along with cultivating a sense of responsibility, perseverance, integrity and fellowship to fortify society on a global scale.

Mission

1. Steadfastly delivering holistic and ethical development of students with education.
2. Focusing on learning inside the classroom, and beyond, by nurturing qualities of leadership, teamwork, self-agency and ingenuity in all the lives we touch.

Core Values

With encouragement and enthusiasm in each tireless, dedicated step into a future that embodies the institute's novel motto of "**Honours Beyond Education**".

Vision and Mission of the Department

Our vision is to strengthen our standing as an outstanding centre for interdisciplinary research and teaching that draws the brightest students with its quality teaching and creative research to foster the development of new talents

Our mission is to equip our students to take on the challenges of both the academic and industrial sectors; we provide unique and pertinent graduate and postgraduate education in the chemical and pharmaceutical sciences. We conduct scholarly research and academic work related to the current problems facing society and industry

About the Programme

The Master of Science (M.Sc.) in Chemistry is an advanced degree programme designed to provide students with comprehensive knowledge and practical skills in both general chemistry and its applications. The programme bridges the gap between basic chemical principles and their application in the industry, preparing graduates for a wide range of professional opportunities in research, development, and industry.

Objectives of the Programme are as follows

1. **Comprehensive Understanding of Chemistry:**

Provide students with a thorough and well-rounded understanding of chemistry, encompassing essential concepts, principles, and theories to build a strong foundational knowledge.

2. **Proficiency in Problem-Solving:**

Cultivate students' proficiency in problem-solving, enabling them to confidently and expertly address both theoretical and practical challenges in chemistry and pharmaceutical sciences.

3. **Preparation for Advanced Studies and Career Opportunities:**

Equip students with the knowledge and skills necessary to pursue further studies in chemistry or related multidisciplinary fields, fostering avenues for self-employment, entrepreneurship, and diverse career opportunities.

4. **Holistic Cognitive Development:**

Foster the holistic cognitive development of students by creating an intellectually stimulating environment that promotes critical thinking, creativity, and lifelong learning.

5. **Integration of Theoretical Knowledge and Practical Applications:**

Deliver the latest advancements in chemistry in a manner that supports students' core competencies, encourages discovery learning, and integrates both theoretical knowledge and practical applications.

6. **Development of Responsibility and Civic Consciousness:**

Cultivate a sense of responsibility and civic consciousness in students, instilling essential domain-independent skills such as effective communication, analytical reasoning, and ethical decision-making

Possible career pathways

M.Sc. in Chemistry can pursue a variety of career paths, including but not limited to:

Chemical& Pharmaceutical Industry:

- Manufacturer Chemist
- Drug Development Scientist
- Quality Control/Quality Assurance Analyst
- Formulation Chemist
- Regulatory Affairs Specialist
- Manufacturer Chemist

Research and Development:

- Research Scientist in academic institutions such as universities, government research centers like. Council of Scientific and Industrial Research, Indian Space Research Organisation(ISRO,ONGC, DRDO, ARS, TRDDC CSIR, Indian Oil Corporation NASA or the National Institutes of Health (NIH) etc
- Laboratory Technician
- Project Manager in Research Labs
- Clinical Research Coordinator

Academia:

- Lecturer/Assistant Professor
- Laboratory Instructor
- Academic Researcher

Government and Regulatory Bodies:

- Patent Examiner
- Drug Inspector
- Environmental Chemist

Other Industries:

- Chemical Manufacturing
- Biotechnology Firms

- Cosmetic Industry

PROGRAMME OUTCOMES

PO-1 Complex Problem-Solving:

Students will demonstrate the ability to apply advanced chemical principles and techniques to solve complex scientific problems, design experiments, and analyze data critically.

PO-2 Critical Thinking:

Post graduates will develop strong critical thinking skills, enabling them to evaluate scientific literature, identify gaps in knowledge, and formulate hypotheses and theories based on empirical evidence.

PO-3 Creativity

Students will harness creativity to innovate and develop new chemical processes, materials, and technologies, contributing to advancements in the field of chemistry and related industries.

PO-4 Communication Skills

Students will possess excellent communication skills, allowing them to effectively convey complex chemical concepts and findings through written reports, presentations, and scientific publications. This will help them to secure good positions in industries& R& D organizations.

PO-5 Analytical Reasoning/Thinking:

Students will have advanced analytical reasoning skills, enabling them to interpret data, troubleshoot experimental issues, and draw sound conclusions from experimental results. Analysis of data will kead to innovations and research.

PO-6 Research-Related Skills:

Students will acquire robust research skills, including proficiency in modern laboratory techniques, data analysis, and the ability to conduct independent research projects in various subfields of chemistry. This will lead to their absorption as research& Development scientists in various organizations.

PO -7 Coordinating/Collaborating with Others:

Students will be adept at working in multidisciplinary teams, demonstrating strong collaboration and coordination skills to achieve common research and project goals.

PO-8 Learning How to Learn:

Students will adopt a curiosity-driven and self-directed approach to learning, developing the ability to ask insightful questions and explore new areas of knowledge independently

PO-9 Leadership Readiness/Qualities:

Students will be prepared for leadership roles in academic, industrial, and governmental settings, exhibiting qualities such as initiative, ethical decision-making, and the ability to inspire and guide others.

PO-10 Digital Literacy and Technological Skills:

Students will be proficient in utilizing digital tools and technologies for data analysis, research, and communication, staying abreast of the latest advancements in computational chemistry and related software.

PO-11 Multicultural Competence& Inclusive sprit :

Students will develop multicultural competence, understanding and respecting diverse cultural perspectives, and collaborating effectively in international and multicultural environments.

PO-12 Value Inculcation:

Students will embody professional and ethical values, maintaining integrity, responsibility, and accountability in their scientific endeavors and interactions with peers and society.

PO-13 Autonomy, Responsibility, and Accountability:

Graduates will demonstrate the ability to work autonomously, taking responsibility for their own learning and research, and being accountable for their professional conduct and contributions to the field.

PO-14 Environmental Awareness and Action:

Graduates will have a strong awareness of environmental issues and sustainability, applying green chemistry principles to minimize environmental impact and promote sustainable practices in their work.

PO-15 Community Engagement and Service

Post Graduates will actively engage with the community, applying their chemical expertise to address societal challenges, and participating in outreach and educational initiatives to promote science literacy.

PO-16 Empathy:

Graduates will develop empathy, understanding the social and ethical implications of their work, and considering the well-being of individuals and communities impacted by their scientific contributions.

Eligibility: B. Sc with Chemistry as one of the subject/B. Sc (Hon.) Chemistry or equivalent from any University with 45 % Marks.

Structure of PG programme

Minimum credits requirement =80

M. Sc. Chemistry

M. Sc. Chemistry 1st Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC101	Core	Fundamentals Concepts in Inorganic Chemistry	4	-	-	4
CHC102	Core	Stereochemistry & Organic Reaction Dynamics	4	-	-	4
CHC 103	Core	Quantum Mechanics and Thermodynamics	4	-	-	4
CHC 104	Core	Spectroscopy & Group Theory	4	-	-	4
CHC 105	Core	Lab-I	-	-	4	2
CHC 106	Core	Lab-II	-	-	4	2
					Total Credits	20

M. Sc Chemistry 2nd Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 201	Core	Advance Inorganic Chemistry	4	-	-	4
CHC 202	Core	Organic Reactions Dynamics: Substitution & Pericyclic Reactions	4	-	-	4
CHC203	Core	Advance Thermodynamics and Electrochemistry	4	-	-	4
CHC 204	Core	Spectroscopy & Separation Techniques	4	-	-	4
CHC 205	Core	Lab-I	-	-	4	2
CHC 206	Core	Lab-II	-	-	4	2
CHC 207	Core	Internship	4	-	-	4
Total Credits						24

M. Sc Chemistry 3rd Semester (Organic)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 301	Core	Advance Spectral Techniques	4	-	-	4
CHC 302	Core	Organometallic Reagents and Organic Synthesis	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHC 303	Core	Lab-I	-	-	4	2
CHC 304	Core	Lab-II	-	-	4	2
					Total Credits	20

M. Sc Chemistry 3rd Semester (Physical)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 305	Core	Chemistry of Materials	4	-	-	4
CHC 306	Core	Spectroscopy, X-ray & Solid State	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHC 307	Core	Lab-I	-	-	4	2
CHC 308	Core	Lab-II	-	-	4	2
					Total Credits	20

M. Sc Chemistry 3rd Semester (Inorganic)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 309	Core	Organometallic Chemistry	4	-	-	4
CHC 310	Core	Spectroscopy, X-ray & Solid State (Inorganic)	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHE---	Elective	Choose from Pool	4	-	-	4
CHC 311	Core	Lab-I	-	-	4	2
CHC 312	Core	Lab-II	-	-	4	2
					Total Credits	20

M. Sc Chemistry 4th Semester (Organic)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 401	Core	Exploring Natural Products: Chemistry and Biological activity	4	-	-	4
CHE ---	Elective	Choose from Pool	4	-	-	4
CHC 402	Core	Lab-I	-	-	4	2
CHC 403	Core	Project	12	-	-	12
					Total Credits	22

M. Sc Chemistry 4th Semester (Physical)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 404	Core	Advanced Quantum Chemistry	4	-	-	4
CHE ---	Elective	Choose from Pool	4	-	-	4
CHC 405	Core	Lab-I	-	-	4	2
CHC 406	Core	Project	12	-	-	12
					Total Credits	22

M. Sc Chemistry 4th Semester (Inorganic)

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 407	Core	Inorganic Polymers	4	-	-	4
CHE ---	Elective	Choose from Pool	4	-	-	4
CHC 408	Core	Lab-I	-	-	4	2
CHC 409	Core	Project	12	-	-	12
					Total Credits	22

Note:

- **Atleast two additional courses from SWAYAM/NPTEL/MOOCs of 10 credits to be qualify under the supervision of advisor of the department during the entire program is mandatory.**
- **Elective pool courses emphasises the connection between chemistry & entrepreneur skills highlighting how students can apply their scientific knowledge to create and develop chemistry related businesses and start-ups.**

M. Sc. Chemistry 1st Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC101	Core	Fundamentals Concepts in Inorganic Chemistry	4	-	-	4
CHC102	Core	Stereochemistry & Organic Reaction Dynamics	4	-	-	4
CHC 103	Core	Quantum Mechanics and Thermodynamics	4	-	-	4
CHC 104	Core	Spectroscopy & Group Theory	4	-	-	4
CHC 105	Core	Lab-I	-	-	4	2
CHC 106	Core	Lab-II	-	-	4	2
					Total Credits	20

Course Name	Fundamentals Concepts in Inorganic Chemistry	L	T	P	C
Course Code	CHC101	4	0	0	4

Fundamental Concepts in Inorganic Chemistry

Course Objectives: Students should grasp the principles of chemical bonding in inorganic compounds, including ionic, covalent, and metallic bonding. They should understand how bonding influences the properties and reactivity of substances.

Course Outcome:

CO1. Analyzing VSEPR theory in determining the shape of molecules, Molecular orbital theory in constructing MO diagram of triatomic molecules & transition metal complexes.

CO2. To learn the application Irving William series for the construction of co-ordination compounds.

CO3. Understanding the metal ligand Equilibria, Substitution reaction & electron transfer reaction in coordination chemistry

CO4. To know the application of hybridization, MOT and wave mechanical treatment theories.

Course Content

Unit I. Bonding in Inorganic molecules 12 Hrs

VSEPR model and its shortcomings. Hybridization and three-center bonds. Bents rule and energetics of hybridization. Walsh's diagrams for tri and tetraatomic molecules. pπ-pπ and pπ-dπ bonding.

Unit II. Physicochemical Characteristics of metal complexes 15 Hrs

Thermodynamic and kinetic stability of complexes. Stepwise and overall formation constants and their interaction.Trends in K value. Irving-Willams series.Chelate effect and its thermodynamic origin. Factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand. Detection of complexes in solution. Determination of binary formation constants by pH-metry and spectrophotometric method.

Unit III. Reaction Mechanism of Transition Metal Complexes 18 Hrs

Energy profile of a reaction and reactivity of metal complexes. Inert and labile complexes. Ligand substitution reactions in octahedral complexes i.e. SN1, SN2 and SN1CB mechanism. Anation reactions without metal ligand bond cleavage. Electron transfer reactions (Redox reactions). Outer and inner sphere mechanism (OSM and ISM).Reactions of coordinated ligands. Substitution reactions in square-planer complexes.

Unit IV. Theories of Coordination Compounds 15 Hrs

Crystal field theory, factors affecting the magnitude of $\Delta 0$. Consequences of crystal field splitting. merits and limitations of CFT Jahn-Teller distortion and its consequences on complex formation. Evidence of covalent character in Metal-Ligand bonding. Molecular orbital theory as applied to octahedral, tetrahedral and square planar complexes.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. Inorganic Chemistry, 3th Ed., G L Miessler and D.A. Tarr, Pearson Education,Inc. (2004). 2. Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).
2	II	1. Inorganic Chemistry, 3th Ed., G L Miessler and D.A. Tarr, Pearson Education,Inc. (2004). 2. Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000). 3. Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999).
3	III	1. Inorganic Chemistry, 3th Ed., G L Miessler and D.A. Tarr, Pearson Education,Inc. (2004). 2. Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000). 3. Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999).
4	IV	1. Inorganic Chemistry, 3th Ed., G L Miessler and D.A. Tarr, Pearson Education,Inc. (2004). 2. Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).

Course Name	Stereochemistry & Organic Reaction Dynamics	L	T	P	C
Course Code	CHC102	4	0	0	4

Stereochemistry & Organic Reaction Dynamics

Course Objectives: The objectives of an organic chemistry course aim to equip students with a comprehensive understanding of organic chemical principles and their applications, preparing them for careers in research, industry, medicine, and academia.

Course Outcomes:

Co1.To make students understand basic general principles of organic chemistry with special reference to resonance etc effects along with nature of bonding in organic molecules.

CO2.Identify the symmetry elements and symmetry operations in molecules by optical activity and the criteria for chirality and discuss axial, planar and helical chirality and the methods of determination of relative and absolute configuration and geometrical isomerism & stereochemistry of olefins, and the configuration in E and Z isomers.

CO3.Through insight into reaction mechanism pathways thermodynamics and kinetic controls of reactions along with SAR related to resonance and other effects.

CO4.Analyzing the nucleophilic substitution reactions in aliphatic substrates and factors affecting substitution reactions.

CO5.Students to learn substitution reactions involve the replacement of a hydrogen atom on an aliphatic compound by an electrophile.

Course Content

Unit I. Nature of Bonding in Organic Molecules 12 Hrs

Nature of Bonding in Organic Molecules Hyperconjugation, Resonance, Mesomeric and inductive effect, tautomerism. Aromaticity in benzenoid and non benzenoid compounds, alternant and non alternant hydrocarbons. Huckel's rule, annulenes, antiaromaticity, homo-aromaticity. crown ether complexes and cryptands, inclusion compounds, cyclodextrin, catenanes and rotaxanes.

Unit II. Stereochemistry 12 Hrs

Chirality, molecules with more than one chiral center, threo and erythro isomers. R and S configuration (Cahan Ingold Prelog sequence rule). Enantiomers, Regioselectivity, stereospecificity. Asymmetric synthesis, Optical activity in the absence of chiral carbon (atropisomerism) biphenyls, allenes and spiranes, and their nomenclature. Conformational

analysis of cyclohexanes and decalins. Effect of conformation on reactivity

Unit III. Reaction Mechanism 13 Hrs

Types of reactions and mechanisms, thermodynamic and kinetic requirements. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Effect of structure on reactivity -resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Unit IV. Substitution Reaction 12 Hrs

Aliphatic Nucleophilic Substitution

The SN_2, SN_1, mixed SN_2 and SN_1, and SET mechanisms. The SN_i mechanism. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. The neighbouring group mechanism, neighbouring group participation by Pi (π) and Sigma bonds (σ). Classical and nonclassical carbocations, norbornyl system, carbocation rearrangements.

Unit V. Aliphatic Electrophilic Substitution 11 Hrs

Bimolecular mechanism- SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shift. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. Advanced Organic Chemistry - Reaction, Mechanism and Structure, Jerry March, John Wiley. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
2	II	1.Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
3	III	1. Advanced Organic Chemistry - Reaction, Mechanism and Structure, Jerry March, John Wiley. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.

		3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
4	IV	1. Advanced Organic Chemistry - Reaction, Mechanism and Structure, Jerry March, John Wiley. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
5	V	1. Advanced Organic Chemistry - Reaction, Mechanism and Structure, Jerry March, John Wiley. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

Course Name	Quantum Mechanics and Thermodynamics	L	T	P	C
Course Code	CHC103	4	0	0	4

Quantum Mechanics and Thermodynamics

Course Objectives: Collectively aim to provide students with a robust foundation in the fundamental principles of physical chemistry and equip them with the skills necessary for advanced study, research, and careers in chemistry-related fields.

Course outcomes:

CO1. To give student understanding the basic concepts of Quantum mechanics including shapes of atomic orbitals, tunneling effect etc.

CO2. To make students aware of various theories related to Quantum mechanics and apply them in appropriate fields related to Quantum mechanics.

CO3. To provide students proper insight about electronic structure of atoms in relation with physical concepts.

CO4. To understand the angular momentum concept of Quantum Chemistry.

CO5. To analyze the laws of classical thermodynamics and it's applications.

Course Content

Unit I. Basic principles of quantum mechanics 10 Hrs

Postulates; operator algebra; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spinangular momenta; tunneling.

Unit II. Approximate methods of quantum mechanics 12 Hrs

Variational principle; perturbation theory up to second order in energy; applications.

Unit III. Quantum Chemistry: Electronic structure of atoms 12 Hrs

Electronic Structure of Atoms Electronic configuration, Russell-Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the pπ configuration, term separation energies for the dπ configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self consistent field, the viral theorem.

Unit IV. Quantum Chemistry: Angular Momentum 12 Hrs

Ordinary angular momentum, generalized angular momentum, eigenfunctions for angular momentum, eigenvalues of angular momentum, operator using ladder operators, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.

Unit V. Thermodynamics: Classical Thermodynamics 14 Hrs

Brief resume of concepts of laws thermodynamics, free energy, chemical potential and entropies. Partial molar properties: partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient. Debye-Huckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2	II	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3	III	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
4	IV	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
5	V	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

Course Name	Spectroscopy & Group Theory	L	T	P	C
Course Code	CHC104	4	0	0	4

Spectroscopy & Group Theory

Course Objectives: Students develop a comprehensive understanding of spectroscopic techniques and group theory principles, enabling them to apply these tools effectively in analysis and various applications.

Course outcomes

CO1. To understand the basic principles and theory of atomic electronic spectroscopy
CO2. To Demonstrate the microwave spectroscopy concept for determining the structures of organic molecules.
CO3. To analyze the concept of Infrared Spectroscopy and it's applications.
CO4. To apply the group theory in the applications of spectroscopic technique for determine the qualitative analysis.

Course Content

Unit I. Atomic Electronic Spectroscopy 12 Hrs

Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Unit II. Microwave Spectroscopy 14 Hrs

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, Stark effect, nuclear and electron spin interaction and effect of external field. Applications of Microwave Spectroscopy.

Unit III. Infrared Spectroscopy 14 Hrs

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, Zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, virbration-rotation spectroscopy; P,Q,R branches. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region.

Unit IV. Group Theory in Chemistry 18 Hrs

Symmetry elements and symmetry operation, Point group, Schonflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. group to be worked out explicitly). Character tables and their use in spectroscopy.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
2	II	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
3	III	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
4	IV	1.Physical Chemistry, Puri Sharma and Pathania.

Course Name	Lab-I	L	T	P	C
Course Code	CHC105	0	0	4	2

Lab – I

Course Objectives: Laboratory course objectives aim to provide students with practical skills, critical thinking abilities, and scientific knowledge. These objectives ensure that students not only understand chemical principles but also gain hands-on experience in applying those principles to real-world laboratory settings.

Course Outcomes:

CO1. To analyze acid and basic radicals including interfering radicals from the given inorganic mixture qualitatively.

CO2. To finding the organic compounds on the basis of elemental analysis and functional group analysis.

CO3. To understanding the various analyzing concept of physical chemistry experiments like pH meter, conductometric and potentiometric titration.

Course Content

30 Hrs

I. Inorganic Chemistry

To identify the given cation, anion and interfering radicals (total six including one interfering radical) from the given inorganic mixture.

II. Organic Chemistry

Separation, purification and identification of compounds of binary mixture (solid-solid or liquid and solid) using TLC and Paper Chromatography, Chemical tests and spectroscopic analysis.

III. Physical Chemistry

1. Determination of the velocity constant of hydrolysis of an ester.
2. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics of the reaction

Books Suggested

S. No.	Books Suggested
1	1. Advanced practical book, Jagdamba Singh, 2014. 2. Advanced inorganic chemistry practical book, O.P. Agarwal 2003. 3. Advanced physical chemistry practical book, J.B. Yadav, 1975.

Course Name	Lab-II	L	T	P	C
Course Code	CHC106	0	0	4	2

Lab – II

Course Objectives: To Gain proficiency in basic and advanced laboratory techniques relevant to the specific discipline (e.g., titrations, distillation, chromatography, spectroscopy, synthesis techniques).

Course Outcomes:

CO1. To learn the concept of inorganic ions separation by chromatographic techniques.

CO2. To explore the knowledge regarding synthesis of organic compounds.

CO3. To understanding the various analyzing concept of physical chemistry experiments like conductometric and potentiometric titration.

Course Content

30 Hrs

I - Inorganic Chemistry

Chromatographic Separation of inorganic ions (cations and anions) by

i. Paper chromatography

ii. Thin layer chromatography

II - Organic Chemistry

Organic synthesis

i. To prepare phthalimide from phthalic anhydride

ii. To prepare picric acid from phenol.

iii. To prepare benzyl from benzoin.

III - Physical chemistry

i. Determination of solubility and solubility product of sparingly soluble salts (e.g., PbSO4, BaSO4) conductometrically.

ii. Determination of the strength of strong and weak acids in a given mixture conductometrically.

iii. To study the effect of solvent on the conductance of AgNO3/CH3COOH and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Huckel-Onsager theory

Books suggested:

S. No.	Books Suggested
1	1. Advanced practical book, Jagdamba Singh, 2014. 2. Advanced inorganic chemistry practical book, O.P. Agarwal 2003. 3. Advanced physical chemistry practical book, J.B. Yadav, 1975.

M. Sc Chemistry 2nd Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
CHC 201	Core	Advance Inorganic Chemistry	4	-	-	4
CHC 202	Core	Organic Reactions Dynamics: Substitution & Pericyclic Reactions	4	-	-	4
CHC203	Core	Advance Thermodynamics and Electrochemistry	4	-	-	4
CHC 204	Core	Spectroscopy & Separation Techniques	4	-	-	4
CHC 205	Core	Lab-I	-	-	4	2
CHC 206	Core	Lab-II	-	-	4	2
CHC 207	Core	Internship	4	-	-	4
					Total Credits	24

Course Name	Advance Inorganic Chemistry	L	T	P	C
Course Code	CHC201	4	0	0	4

Advance Inorganic Chemistry

Course Objectives: Develop a thorough understanding of advanced topics such as coordination chemistry, organometallic chemistry, bioinorganic chemistry. Solve complex problems involving inorganic chemistry concepts, including predicting reaction mechanisms and understanding the role of inorganic compounds in various chemical processes.

Course Outcomes:

CO1. Apply knowledge of electronic spectra to the design and optimization of new transition metal complexes for various applications, including catalysis, materials science, and biological systems.

CO2. Understand the various chemical reactions that organometallic compounds can undergo, including oxidative addition, reductive elimination, and ligand exchange.

CO3. Explore how metal clusters can be used to develop new functional materials with tailored properties for specific applications.

CO4. Develop the use of silicates as catalysts or catalyst supports in industrial chemical reactions, including their role in hydrocracking and polymerization processes.

Course Content

Unit I. Electronic Spectra of Transition Metal Complexes 16 Hrs

Types of absorption spectra. Spectral terms. Russell-Saunders states. Selection rules for electronic transitions in complexes. Width of absorption spectral bands, Terms generated in ligand fields. Orgel and Tanabe-Sugano correlation diagrams for d^1 to d^9 states. Charge transfer spectra.

Unit II. Organometallic Compounds 18 Hrs

Metal carbonyl complexes. Preparation, properties and uses. Nature of bonding in metal carbonyls and carbon monoxide analogs i.e. nitrosyls and dinitrogen complexes. Evidence for back bonding in complexes. Nature of M-C bond Synthesis, bonding and uses of organometallic compounds, two electron ligands (olefinic and acetylenic complexes), three electron ligands (allylic complexes), four electron ligand (butadiene and cyclobutadiene complexes), five electron ligand.

Unit III. Metal Clusters 16 Hrs

Polyhedral boranes and boran anions. Synthesis, reactivity, bonding and topology of boranes.. Wade's rules. Carboranes, metalloboranes and metallocarboranes. Metal carbonyls and halides as clusters. Metal carbonyl hydrides.

Unit IV. Silicates and its applications 10 Hrs

Principles of silicates. Structure and classification of silicates. Asbestos and Zeolites. Silicates in technology (applications of silicates).

S. No.	Unit	Books Suggested
1	I	1.Inorganic Chemistry, 3th Ed., G L Miessler and D.A.Tarr, Pearson Education,Inc. (2004) 2.Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999). 3.Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).
2	II	1.Inorganic Chemistry, 3th Ed., G L Miessler and D.A.Tarr, Pearson Education,Inc. (2004) 2.Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999). 3.Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).
3	III	1.Inorganic Chemistry, 3th Ed., G L Miessler and D.A.Tarr, Pearson Education,Inc. (2004) 2.Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999). 3.Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).
4	IV	1.Inorganic Chemistry, 3th Ed., G L Miessler and D.A.Tarr, Pearson Education,Inc. (2004) 2.Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999). 3.Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).

Course Name	Organic Reactions Dynamics: Substitution & Pericyclic Reactions	L	T	P	C
Course Code	CHC202	4	0	0	4

Organic Reactions Dynamics: Substitution & Pericyclic Reactions

Course Objectives: The main aim to provide students with a comprehensive understanding of substitution and pericyclic reactions, prepare them for practical applications in organic chemistry, and equip them with the skills necessary for advanced research and professional development.

Course Outcomes:

CO1. Identify and optimize the conditions under which aromatic electrophilic substitution reactions proceed efficiently, including the choice of electrophile, solvent, and temperature.

CO2. To develop multistep synthesis strategies that incorporate ANS alongside other functional group transformations.

CO3. Learn how radicals are generated, either through homolytic bond cleavage or other methods and analyze factors affecting radical stability, including resonance stabilization, hyperconjugation, and substituent effects.

CO4. Apply elimination reactions in the synthesis of complex organic molecules, including pharmaceuticals, agrochemicals, and materials.

CO5. To create synthetic strategies utilizing addition reactions to build complex molecules, including pharmaceuticals, agrochemicals, and materials.

CO6. **To** Identify and optimize reaction conditions, including temperature, pressure, and light, that influence the rate and selectivity of pericyclic reactions.

Course Content

Unit I. Aromatic Electrophilic Substitution 8 Hrs

Orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrate and electrophiles. Diazonium coupling, Vilsmeir Haak reaction, Gattermann-Koch reaction.

Unit II. Aromatic Nuecleophilic Substitution 10 Hrs

The SN_{Ar}, SN_1, benzyne and SRN1 mechanisms. Reactivity- effect of substrate structure, leaving group and attacking nucleopile. The von Rictor, Sommelet-Hauser, and Smiles rearrangements.

Unit III. Free radical reactions 10 Hrs

Types of free radical reactions, free radical substitution mechanism, mechanism of an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-

oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Unit IV. Elimination Reactions 10 Hrs

The E_2, E_1 and E_{1cB} mechanisms and their stereochemistry. Orientation of the double bond. Reactivity- effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit V. Addition to Carbon-Carbon Multiple Bonds 10 Hrs

Mechanism and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Unit VI. Pericyclic reactions 12 Hrs

Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann. Correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and suprafacial additions, 4n, and 4n+2 systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements- suprafacial and antarafacial shiffs of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and aza- Cope rearrangements. Fluxional tautomerism. Ene reaction.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1.Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
2	II	1.Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
3	III	1.Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.

		3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
4	IV	1. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
5	V	1. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackwell. 2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
6	VI	1. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press. 2.Advance organic chemistry, claydon.

Course Name	Advance Thermodynamics and Electrochemistry	L	T	P	C
Course Code	CHC203	4	0	0	4

Advance Thermodynamics and Electrochemistry

Course Objectives: The main aim to provide students with an advanced understanding of thermodynamics, surface chemistry and electrochemistry, equipping them with the skills needed for both theoretical analysis and practical applications in these fields.

Course Outcomes:

CO1. Explore the application of chemical kinetics in industrial processes, including reaction optimization and process design.

CO2. Analyze the role of adsorption in catalytic processes, including heterogeneous catalysis and the role of catalysts in industrial reactions.

CO3. Apply electrochemical methods to research problems and understand the role of electrochemistry in advancing scientific knowledge and technological innovation.

CO4. To understand experimental data using statistical thermodynamic principles to interpret results and validate theoretical models.

Course Content

Unit I. Chemical Dynamics 18 Hrs

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov-Zhabotinsky reaction), homogeneous catalysis, kinetics of enzymes reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrierless chemical reactions in solution, dynamics of unimolecular reactions (Lindemann-Hinshelwood theories of unimolecular reactions).

Unit II. Surface Chemistry: Adsorption 15 Hrs

Surface tension, capillary actions, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces.

Unit III. Electrochemistry 12 Hrs

Electrochemistry of solutions, Debye-Huckel, Onsager treatment and its extension, ion solvent interactions.Thermodynamics of electrified interface equations. Structure of

electrified interfaces. Guoy Chapman, Stern. Over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot. Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Electrocatalyis – influence of various parameters. Hydrogen electrode. Bioelctrochemistry, threshold membrane phenomena. Polarography theory, Ilkovic equation, half wave potential and its significance.

Unit IV. Statistical Thermodynamics 15 Hrs

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws- (using Lagrange's method of undetermined multipliers). Partition functions- translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Applications of partition functions. Heat capacity behaviour of solids- chemical equilibria and chemical equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law and applications to metal. Bose-Einstein statistics – distribution law and application to helium.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2	II	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3	III	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
4	IV	1.Physical Chemistry, Puri Sharma and Pathania. 2. Physical Chemistry, P.W. Atkins, ELBS. 3. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

Course Name	Spectroscopy & Separation Techniques	L	T	P	C
Course Code	CHC204	4	0	0	4

Spectroscopy & Separation Techniques

Course Objectives: Develop skills in analyzing both qualitative and quantitative data obtained from spectroscopy and separation techniques.

Course Outcomes:

CO1. Understand how Raman spectroscopy can be used in conjunction with other analytical techniques, such as IR spectroscopy, X-ray diffraction, and microscopy, to provide a comprehensive analysis.

CO2. Apply NMR spectroscopy to in various fields, including pharmaceuticals (drug development and quality control), materials science (characterization of materials), and environmental science (detection of pollutants).

CO3. To provide students with both theoretical knowledge and practical skills needed to proficiently apply chromatographic methods in various scientific and industrial contexts.

CO4. Use radio-analytical techniques in medical diagnostics and therapy, including the analysis of radiopharmaceuticals and patient samples.

Course Content

Unit I. Raman Spectroscopy 14 Hrs

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-roatational Raman spectroscopy, selection rules, mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS).

Unit II. Nuclear Magnetic Spectroscopy 17 Hrs

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurement, factor influencing chemical shift, deshielding, spin-spin interaction, factors influencing coupling constant 'J'. Classification (ABX, AMX, ABC, A_2B_2 etc.), spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton 13C, 19F and 31P. FT NMR, advantages of FT NMR, use of NMR in medical diagnostics.

Unit III. Advance Chromatographic Techniques 20 Hrs

Principle, instrumentation and applications of gas liquid chromatography and HPLC. Ion exchange chromatography: cationic and anionic exchanges and their applications. Van-Deemter equation (no derivation), concept about HEPT-plate theory and rate theory. Applications.

Unit IV. Radio Analytical Methods 9 Hrs

Basic principles and types of measuring instruments, isotope dilution techniques: principle of operations and uses.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
2	II	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
3	III	1.Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern). 2. Fundament of Molecular Spectroscopy CN Banwell. 3. Spectroscopy, H. Kaur
4	IV	Advance Inorganic Chemistry, Gurudeep Raj and Chatwal.

Course Name	Lab-I	L	T	P	C
Course Code	CHC205	0	0	4	2

Lab-I

Course Objectives: The main aim of the lab course is designed to provide students with both practical skills and a deeper understanding of the theoretical concepts in chemistry and cover a range of goals aimed at enhancing students' hands-on experience and scientific knowledge.

Course Outcomes:

CO1. To Develop skills in analyzing data from gravimetric and complexometric titration experiments, including calculating yields, purity, and concentrations based on mass measurements.

CO2. To Understand the importance of ethical practices in organic synthesis, including data integrity, safety, and the responsible use of chemicals.

CO3. Apply to laboratory safety protocols, including proper handling of chemicals, use of personal protective equipment etc.

Course Content

30 Hrs

Unit – I Inorganic Chemistry

i. Complexometric titration
ii. Gravimetric analysis

Unit – II Organic Chemistry

i. Photochemical Reaction

Benzophenone ------→Benzpinacol ----------→Benzpinacolone

ii. Benzilic acid rearrangement: Benzilic acid from benzoin

Benzoin ---------→ Benzil --------→ Benzilic acid

Unit – III Physical Chemistry

i. Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.

ii. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Books Suggested

S. No.	Books Suggested
1	1. Advanced practical book, Jagdamba Singh, 2014. 2. Advanced inorganic chemistry practical book, O.P. Agarwal 2003. 3. Advanced physical chemistry practical book, J.B. Yadav, 1975. 4. Advanced organic chemistry practical book, O.P. Agarwal 2003.

Course Name	Lab-II	L	T	P	C
Course Code	CHC206	0	0	4	2

Lab - II

Course Objectives: The main course objectives for laboratory courses in Inorganic Chemistry, Organic Chemistry, and Physical Chemistry. Each of these courses is designed to provide students with specific skills and knowledge relevant to the respective field of chemistry.

Course Outcomes:

CO1. Apply theoretical concepts from inorganic chemistry to the design and execution of synthesis experiments.

CO2. To understand the reactions involved in the estimation methods, such as bromination or acetylation, and their impact on amine or phenol quantification.

CO3. To analyze potentiometric data to determine the strength (concentration) of halide ions in the mixture and interpret the results in the context of chemical analysis.

Course Content

30 Hrs

Unit – I Preparation of selected inorganic compounds:

i. cis-$K[Cr(C_2O_4)_2\ (H_2O)_2]$
ii. $Na[Cr(NH_3)_2(SCN)_4]$
iii. Prussian Blue, Tumbull's Blue

Unit – II Organic Chemistry

i. Determination of iodine values of an oil sample
ii. Determination of saponification values of an oil sample
iii. Estimation of amines/phenols using bromated, bromide solution/or acetylation method.

Unit – III Physical Chemistry

i. Determination of strengths of halides in a mixtures potentiometrically.
ii. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
iii. Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.

Books Suggested

S. No.	Books Suggested
1	1. Advanced practical book, Jagdamba Singh, 2014. 2. Advanced inorganic chemistry practical book, O.P. Agarwal 2003. 3. Advanced physical chemistry practical book, J.B. Yadav, 1975. 4. Advanced organic chemistry practical book, O.P. Agarwal 2003.

Course Name	Internship	L	T	P	C
Course Code	CHC207	4	0	0	4

Internship

Course objective:

The purpose of Internship is to expose students to real work of environment experience at industry and at the same time, to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics, communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the pharmaceutical industry.

Course Outcome:

On completion of this course, the students will be able to

CO1. To know the various types of industries.

CO2. To learn the procedure of identifying, approaching, applying and getting approval of internship from a leading industry.

CO3. To witness the entire work area of the industry.

CO4. To understand the nature of job involved in the various sector of the industry.

CO5. To adapt with the working people.

Course Content

Requirements

Students wishing to receive credit for internship are required to find, apply for, and be selected for a Chemistry or materials related internship position with an organization of their choice. They will then need to seek permission from the Department to register for the appropriate internship course.

The student must complete at least 90 hrs of work during the semester for each hour of academic credit awarded, and these work hours must be completed during the term (odd or even semester vacation) in which the student is registered for the internship course.

After the student has completed the internship, the student must submit the final evaluation report of the internship experience and 20 minute presentation to department at conclusion of semester. The Department head and class coordinator will allot the mark for the internship evaluation report.