Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Empowered Autonomous)

Department of Chemistry

(Faculty of Science)

Two Year PG Degree Program in Chemistry

M.Sc. First Year

Semester-I

(Pattern 2026)

NEP 2.0

Choice Based Credit System structure & Syllabus

(As Per NEP2020)

To be implemented from Academic Year 2026-2027

Title of the Programme: M.Sc.(Chemistry)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP) 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social,physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable creditstructure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Chemistryand related subjects, the Board of Studies in Chemistry at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of M.Sc. Part-I Chemistry, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report,Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

A chemistry degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Graduates in chemistry find opportunities in various fields including the industries like glass, cement, paper, textile, leather, dye, etc.

We also see huge chemistry applications in industries like paints, pigments, petroleum, sugar, plastics, and Pharmaceuticals.

Overall, revising the chemistry syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing healthcare needs.

Programme Specific Outcomes(PSOs)

PO1	**Advanced Disciplinary Knowledge & Originality:** Demonstrating comprehensive and advanced knowledge in the chosen field of science, extending beyond the undergraduate level, providing a specialized foundation for developing and applying original ideas, particularly within a research context.
PO2	**Research, Analysis, and Complexity:** Ability to formulate hypotheses and design experiments while demonstrating the capacity to integrate knowledge and handle complex information, even when it is incomplete or limited.
PO3	**Problem Solving in New Contexts:** Apply theoretical knowledge and problem-solving abilities to unfamiliar, real-world, or multidisciplinary environments, moving beyond standard classroom scenarios to innovative applications.
PO4	**Technical Mastery and Scientific Reasoning:** Utilize modem tools, specialized techniques, and instruments with high proficiency, underpinned by a deep rationale and scientific reasoning for the choice of methodology.
P05	**Integrated Communication:** Clearly and unambiguously communicate complex scientific conclusions, and the knowledge/rationale supporting them, to both specialist peers and non-specialist stakeholders.
PO6	**Ethical, Social, and Professional Judgment:** Adhere to strict ethical standards in research while reflecting on the social and environmental responsibilities linked to the application of scientific knowledgeand professional judgments.
PO7	**Autonomous and Lifelong Learning:** Exhibit the learning skills necessary to pursue further study or professional development in a largely self-directed and autonomous manner.
PO8	**Employability, Innovation, and Entrepreneurship:** Translate advanced technical skills and independent thinking into professional excellence within industry, academia, or entrepreneurial ventures.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

(Empowered Autonomous)

Board of Studies(BOS) in Chemistry

From 2025-26 to 2028

Sr. No.	Name	Designation
1.	Dr. Prof. Shrikrushna T. Salunke	Chairman
2.	Mr. Bhimrao R. Torane	Member
3.	Mr. Maharudra A. Dudhe	Member
4.	Mr. Ravikiranamrut R. Gandhi	Member
5.	Dr. Vaibhav P. Landge	Member
6.	Dr. Yogesh N. Indulkar	Member
7.	Dr. Deepali S. Pakhare	Member
8.	Mrs. Supriya S. Deokate	Member
9.	Mrs. Jyoti T. Waghmode	Member
10.	Ms. Geetanjali S. Bhunje	Member
11.	Mrs. Reshma T. Gadadare	Member
12.	Mrs. Swati A. Deokate	Member
13.	Ms. Sakshi S. Navale	Member
14.	Ms. Pratiksha P. Tak	Member
15.	Ms. Anjali N. Bhong	Member
16.	Dr. Pravinkumar B. Patil	Member
17.	Mrs. Kalpana Surnavar	Member
18.	Mrs. Chaitrali A. Bunage	Member
19.	Dr. Dilip Satpute	External Member VC Nominee

20.	Dr. Sidaram Pujari	External Member from other University
21.	Dr. Vijay Vader	External Memberfrom other University
22.	Dr. Nitin Jadhav	Member Representative Alumni
23.	Mr. Dadaso Kare	Member Representative from Industry
24.	Ms. Tanishka Phadatare	UG Student Representative
25.	Ms. Disha Waghmode	PG Student Representative

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Empowered Autonomous)

Credit distribution structure for Two Years PG as per National Education Policy (2026 Pattern) (M.Sc.)

PG Program for First Year														
Level	**Sem.**	**Major (MD)**	**Major (Ele)**				**RM**	**OJT**	**RP**					**Cum.Cr.**
6.0	I	8(T)+4 (P)/ 14(T)	2(T)+2 (T/P)/ 4(T)	--	--	---	4 (RM)(T)	--	--	--	--	--	--	**20/ 22**
	II	8(T)+4 (P) 14(T)	2(T)+2 (T/P) 4(T)	--	0	---	0	4 (OJT)		0	0	0	0	**20/ 22**
Cum. Cr. For PG Diploma		**24/28**	**8**				**4**	**4**						**40/44**
Exit option : PG Diploma (40-44 Credits) after Three Year UG Degree														
PG Program for Second Year														
6.5	III	8(T)+4(P)/ 14(T)	2(T)+2 (T/P)/ 4(T)						4 (RP)		0	0	0	**20/ 22**
	IV	8(T)+2(P)/ 12(T)	2(T)+2 (T/P)/ 4(T)						6 (RP)		0	0	0	**20/ 22**
Cum. Cr. For PG Degree		**22/26**	**8**						**10**					**40/44**
Cum. Cr. For 2 Yr. PG Degree		**46/54**	**16**				**4**	**4**	**10**					**80/88**
Exit option : PG Degree (80-88 Credits) after Three Year UG Degree														

Abbreviations: Yr.: Year; Sem.: Semester; MD : Mandatory, Ele : Electives, OJT: On Job Training: Internship/ Apprenticeship; FP:Fieldprojects;RM:ResearchMethodology;ResearchProject: RP;CumulativeCredits: Cum.Cr., T : Theory, P : Practical

Anekant Education Society's
Tuljaram Chaturchand college of Arts, Science and commerce, Baramati,
Empowered Autonomous, NAAC A ++
Department of Chemistry
Course and Credit structure for
M.Sc.–I Chemistry NEP-2020 (2026 Pattern)

Level	Sem	Course Type	Course Code	Title of Course	Theory / Practical	No. of Credits
6.0	I	Major (Mandatory)	CHE-501-MRM	Chemical kinetics, Quantum chemistry and Safety in chemical laboratory -I	Theory	4
			CHE-502-MRM	Stereochemistry, Aromaticity and main group Chemistry-I	Theory	4
			CHE-503-MRM	Molecular Symmetry &Its Application-I	Theory	2
			CHE-504-MRM	Physical and analytical chemistry practical-I	Practical	2
			CHE-505-MRM	Organic and Inorganic Chemistry practical-I	Practical	2
		Major(Elective)	CHE-506-MJE(A)	Advance topics in Analytical Chemistry-I	Theory (Any One)	2
			CHE-506-MJE(B)	Advanced topics in Organic Chemistry-I		
			CHE-506-MJE(C)	Advanced topics in Inorganic Chemistry-I		
			CHE-507-MJE(A)	Advance analytical Chemistry practical-I	Practical (Any One)	2
			CHE-507-MJE(B)	Advance Organic Chemistry Practical-I		
			CHE-507-MJE(C)	Advance Inorganic Chemistry Practical-I		
		Research Methodology	CHE-508-RM	Research Methodology	Theory	4
					Total Credits Sem-I	**22**
6.0	II	Major (Mandatory)	CHE-551-MRM	Molecular Spectroscopy and Radiation & Nuclear Chemistry	Theory	4
			CHE-552-MRM	Organic Spectroscopy, Reaction Mechanism and Bio-inorganic Chemistry	Theory	4
			CHE-553-MRM	Co-ordination Chemistry	Theory	2
			CHE-554-MRM	Physical and Analytical Chemistry Practical-II	Practical	2
			CHE-555-MRM	Organic and Inorganic Chemistry Practical-II	Practical	2
		Major(Elective)	CHE-556-MJE(A)	Advance Topics in Analytical Chemistry-II	Theory (Any One)	2
			CHE-556-MJE(B)	Advanced Topics in Organic Chemistry-II		
			CHE-556-MJE(C)	Advanced Topics in Inorganic Chemistry-II		
			CHE-557-MJE(A)	Advance Analytical Chemistry Practical-II	Practical	2

			CHE-557-MJE(B)	Advance Organic Chemistry Practical-II	(Any One)	
			CHE-557-MJE(C)	Advance Inorganic Chemistry Practical-II		
		OJT	CHE-558-OJT	On Job Training Course	Practical	4
					Total Credits Sem-II	**22**
				Cumulative Credits for PG Diploma – I and II		**22+22 =44**

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Mandatory Theory
Course Name	: Chemical kinetics, Quantum chemistry and Safety in chemical laboratory
Course Code	: CHE-501-MRM
No. of Lectures	: 60
No. of Credits	: 4 credits

Course Objectives:

The objectives of this course are to:

1. Provide comprehensive understanding of chemical kinetics, including reaction mechanisms, rate theories, and enzyme catalysis.
2. Introduce the fundamental principles of quantum chemistry and their application to atomic and molecular systems.
3. Develop analytical ability to solve numerical and theoretical problems related to reaction rates and quantum mechanical models.
4. Enhance scientific reasoning through molecular reaction dynamics and modern theories of reaction rates.
5. Familiarize students with laboratory safety, chemical hazards, and green chemistry principles.
6. Promote ethical and professional responsibility in chemical laboratory practices.
7. Prepare students for advanced studies, research, and industry through strong theoretical and safety foundations

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1. Explain the principles of chemical kinetics, including rate laws, reaction order, Molecularity, and factors affecting reaction rates.

CO2. Analyze complex and enzyme-catalyzed reactions using steady-state, pre-equilibrium, and Michaelis–Menten approaches.

CO3. Apply theories of reaction rates and molecular reaction dynamics to interpret experimental and theoretical data.

CO4. Explain fundamental concepts of quantum chemistry, including wave–particle duality, operators, Schrödinger equations, and atomic orbital’s.

CO5. Solve numerical and conceptual problems related to quantum mechanical systems such as particle in a box, harmonic oscillator, and hydrogen-like atoms.

CO6. Demonstrate awareness of chemical laboratory safety, hazard management, green chemistry principles, and safe handling of chemicals.

CO7. Exhibit ethical conduct, professional responsibility, effective communication, and readiness for lifelong learning in chemical and research environments.

Topics and Learning points

Unit 1: Chemical kinetics

Recapitulation **(3L)**

The rate of reaction, rate laws and rate constants, the determination of rate, order, Molecularity, zero order, first order, second order reactions, half lives, fractional order reactions, order and Molecularity, factors affecting the rate of reaction.

Complex and simple reaction **(5L)**

Reactions approaching equilibrium, consecutive reactions, opposing reactions, chain reaction-explosion, photochemical reactions, Problems

Methods to solve complex reactions **(5L)**

The steady state approximations, elucidating mechanism using SSA, pre-equilibria approximation, Lindeman mechanism for unimolecular reactions, problems.

Molecular reaction dynamics **(10L)**

Theories of Reaction Rates- Arrhenius theory, collision theory and transition state theory, enthalpy, free energy and entropy of activation, correlation of steric factor in collision theory and entropy of activation. Diffusion control reactions, diffusion and reactions, details of diffusion, problems.

Enzyme catalysts **(4L)**

Michaelis-Menten mechanism, limiting rate, Line weaver Burk and Eadie plots, enzyme inhibition, competitive, partially competitive and Non-competitive inhibition, problems.

Debye Huckel Limiting law, Bronsted primary salt effect and secondary salt effects. (3L)

Unit 2 : Quantum Chemistry **(15 L)**

Recapitulation

Failures of classical mechanics, black body radiation, photoelectric effect, specific heats of solids, Atomic spectra, wave particle duality, uncertainty principle, wave function and its interpretation, well behaved functions, orthonormal functions, Linear and Hermitian operators, Schrodinger equation for particle in 1-D box, Schrodinger equation for particle in 2-D box, , degeneracy, quantum mechanical harmonic oscillator (no derivation), sketching of wave function and its square, quantum tunneling, Bohr correspondence principle, hydrogen-like atoms (no derivation), atomic orbital's, Problems

Unit 3: Safety in chemical laboratory **(15 L)**

Recapitulation **(4L)**

Importance of chemical safety and security for institution, different types of hazards, ten steps to improve chemical safety and security, personnel protective and safety equipments, routes of exposure for toxic chemicals, dose-response relationship, most common classes of toxic substances encountered in laboratory, twelve principles of green chemistry, storage of chemicals.

History and importance of safety and health in Laboratory **(5L)**

Responsibility and accounting for safety, types of hazards and risk in chemical laboratory, Moral legal and financial reasons. Introduction to different types of Hazards

Establishing Effective chemical safety and security management **(3L)**

Introduction, responsibility of laboratory safety and security, ten step to creating an effective laboratory chemical safety and security management safety

Personnel protective and other safety equipments **(3L)**

Clothing, foot protection, eye and face protection, safety shield, heat and smoke detector, respirators

References:

1. Atkins' Physical Chemistry, P. W. Atkins and De Paula, 8 th edition (2010).
2. Physical Chemistry, T. Engel and P. Reid, Pearson Education (2006).
3. Physical Chemistry a Molecular approach, D. Mcquarie and J. Simon (University Science) 2000.
4. Physical Chemistry for Biological Sciences by Raymond Chang (Universal Books), 2000.
5. Handbook, Good laboratory practice(GLP) available online(Free)
6. Chemical Laboratory Safety & security, A guide Prudent Chemical Management edited by Lisa Moran & Tina Masciangioli available online, www.nap.edu (free)

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class : M.Sc. (SEM I) **Subject** : Chemistry

Course Name : Chemical kinetics, Quantum chemistry and Safety in chemical laboratory **Course Code** : CHE-501-MRM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POs

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	1	1	2
CO2	2	3	2	3	1	1	1	2
CO3	2	3	2	3	1	1	1	2
CO4	3	2	1	3	1	1	1	2
CO5	2	3	3	2	1	1	2	2
CO6	1	1	1	1	2	3	2	1
CO7	1	2	2	1	3	3	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1 develops strong foundational knowledge of chemical kinetics and reaction mechanisms.

CO4 provides advanced understanding of quantum chemistry principles and atomic structure.

CO2 and CO3 strengthen disciplinary depth through enzyme kinetics and reaction rate theories.

PO2: Research, Analysis, and Complexity

CO2 enhances analytical ability through interpretation of complex reaction mechanisms.

CO3 develops research-oriented thinking using molecular reaction dynamics and rate theories.

CO5 promotes analytical problem-solving in quantum mechanical systems.

PO3: Problem Solving in New Contexts

CO5 enables learners to solve unfamiliar numerical and conceptual problems in quantum chemistry.

CO2 applies kinetic models to complex and enzyme-catalyzed reactions.

CO7 supports decision-making in professional and laboratory contexts.

PO4: Technical Mastery and Scientific Reasoning

CO1 builds scientific reasoning through rate laws and kinetic models.

CO3 strengthens technical understanding of reaction rate theories.

CO4 enhances mastery of quantum mechanical operators and Schrödinger equations.

PO5: Integrated Communication

CO7 develops the ability to communicate scientific ideas effectively using proper terminology.

CO6 supports communication of laboratory safety protocols and documentation practices.

PO6: Ethical, Social, and Professional Judgment

CO6 promotes ethical conduct, laboratory safety, and environmental responsibility.

CO7 strengthens professional judgment and responsible scientific behavior.

PO7: Autonomous and Lifelong Learning

CO5 encourages independent problem-solving and self-directed learning.

CO6 and **CO7** emphasize continuous skill development and safety awareness essential for lifelong learning.

PO8: Employability, Innovation, and Entrepreneurship

CO1 and CO3 provide conceptual and analytical foundations relevant to chemical and pharmaceutical industries.

CO6 enhances employability through safety compliance and professional readiness.

CO7 prepares learners for diverse career roles through ethical and communication skills.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Mandatory Theory
Course Name	: Stereochemistry, Aromaticity and Main group Chemistry
Course Code	: CHE-502-MRM
No. of Lectures	: 60
No. of Credits	: 4 credits

Course Objectives:

The objectives of this course are to:

1. To strengthen foundational understanding of structural and electronic effects, acid–base behaviour, and bonding in organic molecules.
2. To develop conceptual clarity in Aromaticity, antiaromaticity, and special aromatic systems including annulenes, azulenes, and heterocyclic compounds.
3. To build advanced knowledge of stereochemistry including conformational analysis, configuration assignment, and stereochemical relationships.
4. To enable students to understand and analyze mechanisms of aliphatic nucleophilic substitution and elimination reactions with stereochemical considerations.
5. To provide in-depth understanding of aromatic electrophilic and nucleophilic substitution reactions and their orientation effects.
6. To introduce advanced concepts in main group chemistry including boranes, carboranes, fullerenes, carbon nanotubes, and cluster compounds.
7. To enhance analytical thinking and problem-solving skills through mechanism-based and structure-based chemical problem solving.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1 Explain structural and electronic effects, acid–base strength, and bonding concepts in organic molecules including supramolecular systems.

CO2 Interpret aromatic, antiaromaticity, quasi-aromatic, and homo-aromatic systems and apply Hückel’s rule to carbocyclic and heterocyclic compounds.

CO3 Analyze stereochemical relationships, assign configurations (R/S, E/Z, D/L), evaluate optical activity, and solve advanced stereochemical problems.

CO4 Differentiate and predict mechanisms, reactivity, and stereochemical outcomes of SN1, SN2, SNi, and neighbouring group participation reactions.

CO5 Analyze mechanisms and regioselectivity of elimination reactions (E1, E2, E1cB) and predict reaction outcomes under varying conditions.
CO6 Interpret mechanisms and orientation effects in aromatic electrophilic and nucleophilic substitution reactions, including named reactions.
CO7 Describe structure, bonding, preparation, properties, and applications of main group compounds including boranes, nanotubes, silicates, interhalogens, and cluster systems.

Topics and Learning points

Unit 1: Nature of Bonding in Organic Molecules (8L)

a) **Structure and Bonding:**

1. Recapitulation: Various structural and electronic effects, strength of acids and bases and pK_a and pK_b
2. Electron Donor–Acceptor (EDA) complexes, crown ether complexes and cryptandes, catenanes and rotaxanes, inclusion compounds, fullerenes

b) **Aromaticity:**

1. Recapitulation: Benzenoid and non-Benzenoid compounds, Aromaticity and Huckel's rule
2. Anti-Aromaticity Quasi-aromatic and homo-aromatic compounds, application to carbocyclic and heterocyclic systems, annulenes, azulenes and fulvenes, mesoionic compounds

Unit 2: Stereochemistry (12L)

1. Recapitulation: Origin of stereochemistry, optical activity, chirality. Projection formulae, Conformational concepts, conformations of acyclic & cyclic (ethane, propane, butane, cyclohexane, methyl cyclohexane) molecules.
2. Stereoisomerism, enantiomeric relationship, diastereomeric relationship, % ee and % de, D/L, R/S and E/Z nomenclature in C, N, S, P containing compounds, prochiral relationship, Re/Si faces, Topicity, stereo specific and stereo selective reactions, atropoisomerism, optical activity in biphenyls, spiranes, allenes, helical structures, ansa compounds and cyclophanes. Problem solving

Unit 3: Aliphatic Nucleophilic Substitution reactions (8L)

Recapitulation: SN1, SN2 and SNi reactions (Mechanism, Reactivity and Stereochemical aspects). How to know whether a given reaction will follow SN1 or SN2 mechanism, S_Ni reaction and mechanism. Neighbouring group participation: The neighbouring group mechanism, The Neighbouring group participation by π and σ bonds, NGP by halogens and heteroatoms (O, N, S), anchimeric assistance, classical and non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangements in neighbouring group participation.problem solving.

Unit 4: Aromatic electrophilic and nucleophilic substitution reactions (10L)

1. Recapitulation: Mechanism of aromatic electrophilic substitution reaction.

2. Orientation effects in aromatic electrophilic substitution reactions (Benzene, Naphthalene, Anthracene, Pyridine, Pyrrole, Furan and Thiophene)
3. Kolbe, Gatterman, Gatterman-Koch, Riemer-Tieman, Vilsemeyer Haack, Hoesch, Ipso substitution.

Benzyne reaction, SNAr Mechanism, Factors, Meisenheimer complex, cine and tele substitutions, Chichibabin reaction, Sandmeyer Reaction, S_NR1 reactions, reactivity.problem solving

Unit 5: Elimination reaction: (07)

1. The E1, E2 & E1cB mechanism, factors affecting elimination- Substrate, base, leaving group, solvent, temperature
2. Saytzeff elimination, Hoffman elimination, Cope elimination, Dehydrohalogenation, Dehalogenation, Dehydration, Pyrolytic Elimination, problem solving

Unit 6: Chemistry of Main group elements (15L)

1. Boron Group family (5L)

Introduction: Boron Hydrides (Closo , Nido , Arachno , Hypo) preparation, structure and Bonding in BN compounds with reference to LUMO,HOMO, interconversion of lower and higher boranes, Metallo boranes, Carboranes, Reactions of Organoboranes.

2. Carbon and Nitrogen Family (5L)

Introduction: C60 (fullerenes), Carbon- nanotubes- synthesis, properties, structure-single walled, multi-walled and applications. Organo metallic compounds of silicon, Zeolites
Introduction : Nitrogen activation, Oxidation states of nitrogen and their interconversion, PN and SN Compounds.

Chalcogen and Halogen family (5L)

Introduction: Metal Selenides and Tellurides, oxyacid's and oxyanions of Sulphur & nitrogen. Ring, Cage and Cluster compounds. Silicates, Interhalogens, pseudo halogen, Synthesis, Properties sand applications,

References:

1. Organic Chemistry–by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
2. Advanced Organic Chemistry, Reactions Mechanisms and Structure by J. March, 6th edition, John Wiley
3. Stereochemistry of Organic Compounds (Principles and Applications) by D. Nashipuri, 4th edition, New Age International Private Limited.
4. Stereochemistry of Organic Compounds by by Ernest L. Eliel and Samuel H. Wilen, 1st edition, Wiley.
5. Stereochemistry: Conformation and Mechanism by P.S. Kalsi, 11th Edition, New Age International Private Limited.
6. Modern Synthetic Reactions by Herbert O. House, 1st Edition.

7. Advanced Organic Chemistry Part B: Reactions and Synthesis by Francis A. Carey and Richard J. Sundberg, 5th Edition, Springer.
8. Organic Synthesis by Jagdamba Singh, L.D.S Yadav, Pragati Prakashan.
9. Inorganic Chemistry: Shriver & Atkins(4^{th} edition 2003,Oxford)
10. Concise Inorganic Chemistry, J. D. Lee, Fourth Edn.(Chapman and Hall)
11. Inorganic chemistry: Principle of structures & reactivity, Hubeey, Keiter
12. Medhi, Pearson Education, 4^{th} Edn.(2007).
13. Inorganic Chemistry: Catherine Housecroft
14. Inorganic Chemistry: Messler & Tarr, Pearson Publishers 3^{rd} Edition

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Stereochemistry, Aromaticity and main group Chemistry	**Course Code**	:	CHE-502-MRM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	3	1	0	1	1
CO2	3	3	3	3	1	0	1	1
CO3	3	3	3	3	2	0	1	1
CO4	3	3	3	3	1	0	1	1
CO5	3	3	3	3	1	0	1	1
CO6	3	2	2	3	1	1	2	2
CO7	3	2	2	3	1	1	2	2

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1–CO2: Strongly contribute by developing advanced conceptual understanding of structural effects, bonding, and aromaticity including special aromatic systems.

CO3–CO5: Strongly support disciplinary depth through stereochemical analysis and detailed mechanistic understanding of substitution and elimination reactions.

CO6–CO7: Strongly contribute by introducing advanced main group chemistry concepts such as boranes, nanotubes, cluster compounds, and supramolecular systems, enhancing originality in chemical interpretation.

PO2: Research, Analysis, and Complexity

CO1: Moderately contributes through analytical comparison of acid–base strength and electronic effects.

CO2–CO5: Strongly contribute by requiring detailed mechanistic analysis, stereochemical problem solving, and prediction of reaction pathways.

CO6–CO7: Moderately support analytical thinking through structural interpretation of boranes, fullerenes, and cluster compounds.

PO3: Problem Solving in New Contexts

CO1–CO2: Moderately contribute by enabling prediction of stability and aromatic character in unfamiliar systems.

CO3–CO5: Strongly contribute through mechanism-based problem solving and prediction of stereochemical and regioselective outcomes.

CO6–CO7: Moderately support application of bonding and structural principles to new inorganic and materials chemistry contexts.

PO4: Technical Mastery and Scientific Reasoning

CO1–CO2: Strongly contribute by strengthening theoretical reasoning related to bonding and aromaticity.

CO3–CO5: Strongly support scientific reasoning through stepwise mechanistic interpretation of substitution and elimination reactions.

CO6–CO7: Strongly contribute by applying molecular orbital concepts, cluster bonding theories, and structural models in main group chemistry.

PO5: Integrated Communication

CO1–CO2: Moderately contribute through structured explanation of bonding concepts and aromatic systems.

CO3: Strongly supports communication skills through use of projection formulae, nomenclature, and stereo chemical representations.

CO4–CO7: Moderately contribute by requiring systematic presentation of reaction mechanisms and structural descriptions.

PO6: Ethical, Social, and Professional Judgment

CO1–CO5: Limited contribution as focus is primarily on theoretical and mechanistic understanding.

CO6–CO7: Moderately contribute by addressing industrially relevant materials (nanotubes, silicates, interhalogens) and their broader societal applications.

PO7: Autonomous and Lifelong Learning

CO1–CO2: Moderately encourage independent exploration of advanced theoretical concepts.

CO3–CO5: Strongly promote self-learning through intensive problem-solving practice.

CO6–CO7: Strongly contribute by introducing emerging areas such as supramolecular and nanomaterial chemistry that stimulate continuous learning.

PO8: Employability, Innovation, and Entrepreneurship

CO1–CO2: Limited contribution as emphasis is foundational.

CO3–CO5: Moderately support employability through development of analytical and mechanistic expertise relevant to industry.

CO6–CO7: Strongly contribute due to applications in pharmaceuticals, materials science, nanotechnology, and chemical industries.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Mandatory Theory
Course Name	: Molecular Symmetry & Its Application
Course Code	: CHE-503-MRM
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamental concepts of molecular symmetry including symmetry elements, symmetry operations, and symmetry point groups.
2. Develop an understanding of group theory principles such as defining properties of a group, classes, subgroups, and group multiplication tables.
3. Apply classification of molecular point groups to molecules of varying complexity and symmetry.
4. Explain matrix representations and character tables as tools for representing symmetry operations without involving mathematical derivations.
5. Understand reducible and irreducible representations using wave functions as basis functions.
6. Construct symmetry adapted linear combinations (SALCs) for σ-bonding in molecules belonging to different point groups.
7. Apply group theory concepts to infrared spectroscopy for predicting vibrational modes and IR activity of molecules.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Identify and describe symmetry elements and symmetry operations present in molecules.

CO2: Classify molecules into appropriate symmetry point groups using systematic procedures.

CO3: Explain the basic principles of group theory including groups, subgroups, classes, and group multiplication tables.

CO4: Interpret matrix representations, character tables, and the significance of the Great Orthogonality Theorem.

CO5: Generate reducible and irreducible representations using wave functions as basis functions.

CO6: Construct and normalize symmetry adapted linear combinations (SALCs) for σ-bonding in molecules such as AB4 (Td), and AB6 (Oh).
CO7: Analyze infrared spectra of polyatomic and complex molecules using group theoretical selection rules and symmetry considerations.

Topics and Learning points

Unit 1: Molecular Symmetry and Symmetry Groups (12L)
Introduction : Symmetry elements and operations, Symmetry planes and reflections, the inversion centre, proper axes and proper rotations, improper axes and improper rotation, products of symmetry operations, equivalent symmetry elements and equivalent atoms, general relations among symmetry elements and symmetry operations, classes of symmetry operations, symmetry elements and optical isomerism, symmetry point groups, classification of molecular point groups. Defining properties of a group, group multiplication table, some examples of group, subgroups and classes.

Unit 2: Representations of Groups (08 L)
Introduction: Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part),wave function as basis for reducible and irreducible representations.

Unit3: Symmetry Adapted Linear Combinations (04L)
Introduction : Projection operators and their use of construct SALC (Construction of SALC for sigma bonding for molecules belonging point groups: D2h, D3h D4h , C4v , Td., Oh., normalization of SALC, transformation properties of atomic orbital, MO's for sigma bonding, ABn molecules, tetrahedral AB4 and Oh AB6 cases.

Uni4: Application of Group theory to Infrared Spectroscopy (06L)
Introduction, selection rules, polyatomic molecules, possible vibrations in a linear molecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR spectra related to symmetry of some compounds, IR spectra of complex compounds.

References:

1. Guide book to Reaction Mechanism –Peter Sykes
2. Chemical Applications of Group Theoryby F. A. Cotton
3. Symmetry and spectroscopy of molecules by K. VeeraReddy

Choice Based Credit System Syllabus (2026 Pattern)
(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Molecular Symmetry & Its Application	**Course Code**	:	CHE-503-MRM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	0	1	0
CO2	3	3	2	2	1	0	1	0
CO3	3	2	2	3	1	0	1	0
CO4	3	3	2	3	1	0	1	0
CO5	3	3	3	3	1	0	2	1
CO6	3	3	3	3	1	0	2	2
CO7	3	3	3	3	2	1	2	2

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality
Students gain in-depth theoretical understanding of symmetry and group theory.
CO1: Identify symmetry elements and symmetry operations in molecules
CO2: Classify molecules into appropriate symmetry point groups
CO3: Explain defining properties of groups, subgroups, and classes
CO4: Interpret matrix representations and character tables
CO5: Generate reducible and irreducible representations
CO6: Construct and normalize SALCs for σ-bonding
CO7: Apply group theory to vibrational spectroscopy

PO2: Research, Analysis, and Complexity
Students develop analytical and research-oriented thinking.
CO2: Systematic classification of molecules into point groups
CO4: Analysis of character tables and Orthogonality relations
CO5: Decomposition of reducible representations
CO6: Analytical construction of SALCs
CO7: Analysis of IR-active vibration modes

PO3: Problem Solving in New Contexts
Ability to apply group theory tools to unfamiliar molecular systems.
CO2: Assign symmetry point groups to unfamiliar molecules
CO5: Solve representation-related problems using wave functions
CO6: Construct SALCs for different point groups (D3h, Td, Oh, etc.)

CO7: Predict IR activity of new or complex molecules

PO4: Technical Mastery and Scientific Reasoning
Mastery of formal tools and logical reasoning in chemistry.
CO3: Apply group theory principles and multiplication tables
CO4: Use matrix representations and character tables correctly
CO5: Apply Orthogonality concepts in symmetry analysis
CO6: Develop MO schemes using SALCs
CO7: Use symmetry arguments to interpret IR spectra

PO5: Integrated Communication
Interpretation and scientific explanation using symbolic tools.
CO4: Interpret and communicate information from character tables
CO7: Explain IR spectral features using symmetry arguments

PO6: Ethical, Social, and Professional Judgment
Awareness of responsible scientific interpretation and reporting.
CO7: Apply group theory correctly in spectral analysis to avoid misinterpretation of experimental data

PO7: Autonomous and Lifelong Learning
Development of independent learning and continuous skill upgrading.
CO2: Independently classify molecular symmetry
CO5: Self-directed learning of representation techniques
CO6: Autonomous construction of SALCs
CO7: Independent interpretation of vibrational spectra

PO8: Employability, Innovation, and Entrepreneurship
Skill development relevant to industry and research careers.
CO6: Application of SALCs in molecular orbital theory and materials chemistry
CO7: Use of symmetry in IR spectroscopy relevant to analytical and industrial labs

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Mandatory Practical
Course Name	: Physical and Analytical Chemistry Practical-I
Course Code	: CHE-504-MRM
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

The objectives of this practical course are to:

1. Provide hands-on training in chemical kinetics, electrochemistry, conductometry, photometry, and titrimetric analysis**.**
2. Develop the ability to determine reaction orders, rate constants, activation energy, and stability constants using experimental methods.
3. Train students in the application of instrumental techniques such as spectrophotometry, conductometry, dilatometry, and GM counter.
4. Enhance quantitative analytical skills through volumetric, redox, complexometric, and back titration methods.
5. Promote understanding of physicochemical properties such as viscosity, ionic strength, dissociation constants, and hardness of water.
6. Instill laboratory safety, ethical practices, accuracy, and data integrity during experimentation.
7. Prepare students for research, industry, and lifelong learning through experimental problem-solving and reporting skills.

Course Outcomes:

After successful completion of the course, the student will be able to:

CO1. Perform kinetics experiments to determine reaction order, rate constant, temperature coefficient, and activation energy**.**

CO2. Analyze the effect of ionic strength, catalysts, and concentration on reaction rates using experimental data.

CO3. Apply electrochemical and conductometric methods to determine dissociation constants, equivalent conductance, and hydrolysis behavior.

CO4. Estimate physicochemical parameters such as viscosity radius, stability constants, hardness of water, and purity of compounds.

CO5. Use instrumental techniques such as spectrophotometry, photometric titration, and GM counter with scientific reasoning.

CO6. Demonstrate ethical laboratory practices, safety awareness, accuracy, and environmental responsibility**.**

CO7. Communicate experimental results effectively through calculations, graphs, error analysis, and laboratory reports**,** supporting lifelong learning and employability.

Topics and Learning points

(Minimum 15 experiments should be completed in this course)

1. Study of Kinetic decomposition of diacetone alcohol by dilatometry.
2. Determination of individual orders of iodide and persulphate ions and overall order of oxidation reaction of iodide ion by persulphate ion.
3. To study the rate of chemical reaction and factors affecting it such as concentration, temperature and catalyst.(Reaction between sodium thiosulphate and hydrochloric acid)
4. Determination of temperature coefficient and energy of activation of acid catalyzed ester hydrolysis reaction.
5. Bronsted primary salt effect: Investigate the influence of ionic strength on the rate constant of reaction between potassium persulphate and potassium iodide.
6. Determination of radius of glycerol by viscosity.
7. Determination of strength of mixture of oxalic acid and sodium oxalate from the mixtures
8. To determine concentration of cations by simultaneous determination method from their mixture spectrophotometrically.
9. Determination of percent purity of given sample of boric acid.
10. Determination of aspirin using back titration.
11. Study the Hydrolysis of aniline hydrochloride.
12. Determination of equivalent conductance at infinite dilution and dissociation constant of acetic acid.
13. Determination of concentrations of reductant or oxidant by redox titration.
14. Determination of stability Constant of a Silver-ammonia complex.
15. Determination of the acidic and basic dissociation constant of an amino acid and hence isoelectric point of the amino acid.
16. Determination of dissociation constants of tribasic acid (Phosphoric acid)
17. Simultaneous determination of cations from the mixture.
18. Determination of amount of copper by photometric titration with EDTA.
19. Study the kinetics of iodination of acetone spectrophtometrically.
20. To determine E_{max} of β radiation and absorption coefficient in aluminium.

References:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Greenand Co.)
2. Experiments in Physical Chemistry, Wilson, Newcombe, Denko.Richett (Pergamon Press)
3. Senior Practical Physical Chemistry, B. D. Khosla and V.S.Garg (R. Chandand Co., Delhi.).
4. Experimental Physical Chemistry by D. P.Shoemaker,Mc.Growhill, 7th Edition, 2003.
5. Physical chemistry by Wien (2001)
6. Practical physical chemistry, B.Vishwanathan and P. S. Raghavan, 2nd edition,(2012)
7. Practical Physical Chemistry, J. B.Yadav
8. Essentials of practical Physical Chemistry,Rajboj and Chandhekar
9. Practical Physical Chemistry,Athawale and Mathur.
10. Selected experiments of pharmaceutical analysis,Anees A Siddiqui.

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Physical and Analytical Chemistry Practical-I	**Course Code**	:	CHE-504-MRM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	1	1	1	2
CO2	2	3	2	3	1	1	1	2
CO3	2	3	2	3	1	1	2	2
CO4	2	2	2	2	1	1	2	2
CO5	2	3	3	3	1	1	2	3
CO6	1	1	1	1	2	3	2	1
CO7	1	2	2	1	3	2	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1 strengthens core knowledge in chemical kinetics through decomposition, iodination, and ester hydrolysis studies.

CO3 & CO4 reinforce disciplinary understanding of conductance, dissociation constants, stability constants, and physicochemical properties.

PO2: Research, Analysis, and Complexity

CO1 & CO2 develop experimental analysis of complex reaction mechanisms and salt effects.

CO3 & CO5 enhance analytical interpretation of conductometric, spectrophotometric, and instrumental data.

PO3: Problem Solving in New Contexts

CO5 enables handling unfamiliar instruments like GM counter and photometric titration setups.

CO2 & CO7 promote experimental troubleshooting and data interpretation in varied chemical systems.

PO4: Technical Mastery and Scientific Reasoning

CO1, CO2, and CO5 develop technical competence in kinetics, electrochemistry, and instrumental methods with scientific justification of results.

PO5: Integrated Communication

CO7 develops scientific communication through laboratory records, calculations, graphs, and viva-voce explanations.

CO6 supports clear communication of safety procedures and laboratory protocols.

PO6: Ethical, Social, and Professional Judgment

CO6 instils ethical laboratory conduct, chemical safety, waste management, and responsible data handling across all experiments.

PO7: Autonomous and Lifelong Learning

CO3, CO5, and CO7 encourages independent learning of experimental techniques and interpretation beyond prescribed procedures.

PO8: Employability, Innovation, and Entrepreneurship

CO5 enhances employability through hands-on experience with analytical instruments and radiation detection.

CO1, CO4, and CO7 prepares students for careers in chemical industries, quality control, research labs, and higher education.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Mandatory Practical
Course Name	: Organic and Inorganic Chemistry Practical- I
Course Code	: CHE-505-MRM
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. To develop practical skills in organic synthesis and purification techniques.
2. To train students in reaction mechanism understanding through laboratory-based organic transformations.
3. To impart quantitative analytical skills in ore and alloy analysis.
4. To enhance accuracy in gravimetric and volumetric estimation methods.
5. To develop skills in interpretation of analytical results and composition analysis.
6. To cultivate laboratory safety awareness and ethical professional practices.
7. To strengthen independent laboratory work, teamwork, and documentation skills.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1 Understand principles and reactions involved in organic synthesis and inorganic analysis

CO2 Perform organic preparations with proper techniques and purification

CO3 Carry out quantitative ore and alloy analysis accurately

CO4 Apply analytical reasoning, stoichiometry, and calculations

CO5 Interpret experimental data and prepare laboratory reports

CO6 Follow laboratory safety, ethics, and professional practices

CO7 Develop independent experimental skills and problem-solving ability

Topics and Learning points

A) Organic Preparations

Single Stage Preparations (Any 7)

1) Vanillyl alcohol from vanilline

2) Benzyl alcohol to Benzoic acid
3) Preparation of Schiff bases in aqueous medium.
4) Nitrobenzene to m-di-nitrobenzene
5) Preparation of p-nitro acetanilide from acetanilide
6) Preparation of of ortho-chloro benzoic acid from anthranilic acid
7) Preparation of adipic acid from cyclohexanone .
8) Benzyl cyanide to phenyl acetic acid
9) Benzoic acid to ethyl benzoate
10) 10.Preparation of cyclohexanone oxime from cyclohexanone

B) Inorganic Chemistry Analysis

1. Ore Analysis: - (Any 4)

a) Determination of Silica & Manganese from Pyrolusite ore.
b) Determination of Silica & Iron from Hematite ore.
c) Determination of Copper & Iron from Chalcopyrite ore.
d) Determination of calcium and magnesium from Dolomite
e) Determination of Hydrated magnesium silicate from Asbestos.

2. Alloy Analysis: - (Any 4)

a) Determination of Tin & lead from Solder alloy
b) Determination of Iron / Chromium / Nickel from Stainless steel alloy.
c) Determination of Bismuth / Lead / Tin / Cadmium from Wood's metal.
d) Determination of Aluminium / Nickel / Cobalt from Alnico alloy.
e) Determination of Copper / Tin / Zinc from Gun metal

References:

1. Textbook of practical organic chemistry – A.I. Vogel
2. Practical Physical Chemistry, J. B.Yadav
3. Essentials of practical organic Chemistry, Rajboj and Chandhekar
4. Practical Chemistry, Athawale and Mathur.

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Organic and Inorganic Chemistry Practical-I	**Course Code**	:	CHE-505-MRM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	0	0	1	0
CO2	2	2	3	3	1	1	2	3
CO3	2	3	3	3	1	2	2	3
CO4	2	3	2	2	2	0	1	2
CO5	0	2	1	1	3	1	1	1
CO6	0	1	1	1	1	3	1	2
CO7	1	2	2	2	2	1	3	0

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1 – Strong Contribution: Develops advanced conceptual understanding of organic reaction mechanisms, synthetic pathways, and principles of quantitative inorganic analysis.

CO2 & CO3 – Moderate Contribution: Strengthen disciplinary depth through hands-on synthesis and analytical estimation of ores and alloys.

CO4 – Moderate Contribution: Enhances originality by applying theoretical concepts to interpret experimental results and analytical data.

PO2: Research, Analysis, and Complexity

CO3 – Strong Contribution: Involves systematic, multi-step ore and alloy analysis requiring precision, critical thinking, and procedural rigor.

CO4 – Strong Contribution: Develops analytical complexity through calculations, error analysis, and quantitative interpretation.

CO5 – Moderate Contribution: Supports research orientation through structured recording and interpretation of experimental data.

PO3: Problem Solving in New Contexts

CO2 & CO3 – Strong Contribution: Students troubleshoot reaction conditions, purification steps, and analytical procedures during experiments.

CO4 – Moderate Contribution: Applies calculation-based reasoning to resolve inconsistencies in experimental outcomes.

CO7 – Moderate Contribution: Encourages independent handling of laboratory challenges.

PO4: Technical Mastery and Scientific Reasoning
CO2 & CO3 – Strong Contribution: Develop technical expertise in synthesis, titration, gravimetric estimation, and analytical techniques.
CO4 – Moderate Contribution: Strengthens scientific reasoning through stoichiometric relationships and analytical calculations.
CO1 – Moderate Contribution: Provides theoretical foundation necessary for scientific interpretation.

PO5: Integrated Communication
CO5 – Strong Contribution: Enhances structured laboratory report writing, result presentation, and viva communication skills.
CO4 – Moderate Contribution: Supports logical representation of calculations and tabulated data.
CO7 – Moderate Contribution: Promotes effective oral communication during practical discussions.

PO6: Ethical, Social, and Professional Judgment
CO6 – Strong Contribution: Emphasizes laboratory safety, ethical chemical handling, and environmental responsibility.
CO3 – Moderate Contribution: Encourages accuracy, integrity, and accountability in quantitative analysis.

PO7: Autonomous and Lifelong Learning
CO7 – Strong Contribution: Develops independent experimentation skills and self-directed learning habits
CO2 & CO3 – Moderate Contribution: Continuous practice refines laboratory competence and encourages skill enhancement beyond curriculum requirements.

PO8: Employability, Innovation, and Entrepreneurship
CO2 & CO3 – Strong Contribution: Provide industry-relevant skills in chemical synthesis and material analysis applicable in pharmaceuticals, quality control, and metallurgical industries.
CO4 – Moderate Contribution: Strengthens applied analytical skills required in research and industrial laboratories.
CO6 – Moderate Contribution: Builds professional discipline and workplace readiness.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Elective Theory
Course Name	: Advanced Topics in Analytical Chemistry-I
Course Code	: CHE-506-MJE(A)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. Develop advanced understanding of modern material characterization techniques such as TEM, SEM, and XPS, including their principles and instrumentation.
2. Gain in-depth knowledge of chromatographic separation techniques (GC and HPLC) for qualitative and quantitative chemical analysis.
3. Analyze complex analytical problems using appropriate instrumental techniques and optimize experimental parameters.
4. Apply scientific reasoning to interpret spectral, chromatographic, and surface analytical data accurately.
5. Develop competence in selecting suitable analytical methods for industrial, pharmaceutical, environmental, and research applications.
6. Communicate analytical findings effectively through technical reports, presentations, and scientific discussions.
7. Cultivate ethical awareness, professional responsibility, and motivation for lifelong learning in advanced analytical sciences.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1. Explain the principle, instrumentation, working, and applications of TEM, SEM, and XPS with clarity and originality.

CO2. Interpret material characterization data to determine surface composition, morphology, crystallinity, and elemental states.

CO3. Describe the theory, instrumentation, and operational parameters of Gas Chromatography and HPLC systems.

CO4. Optimize chromatographic conditions such as column type, stationary phase, detector selection, flow rate, and elution mode for effective separation.

CO5. Solve analytical problems involving real-world samples by selecting suitable GC or HPLC techniques and addressing instrumental limitations.

CO6. Present analytical results logically using scientific terminology, graphical interpretation, and structured documentation.

CO7. Demonstrate awareness of ethical practices, safety, professional responsibility, and continuous skill upgradation in analytical and research laboratories.

Topics and Learning points

Unit-1: Material Characterization Techniques. (10L)

Principle, instrumentation, working and applications of following spectroscopic techniques:

1. TEM
2. SEM
3. XPS

Unit-2 Gas Chromatography (10L)

Introduction, Basic principle of GC, Instrumentation of GC, Sample injection–Split and splitless injection, Column types, Solid/Liquid Stationary phases, Basic and specialized detectors ,elemental detection, Gas chromatographs and chemical analysis, Application of GLC, Gas solid chromatography and Problems

Unit-3 High Performance Liquid Chromatography (10L)

Theory and instrumentation of HPLC, Optimization of column performance,
Gradient elution and related procedure, Derivatization, Mobile phase Delivery
System, Sample injection system, Separation column, Detector, Structure types of column packing, Adsorption Chromatography, Bonded phase chromatography, Reversed phase chromatography, Ion Pair Chromatography, Ion exchange Chromatography, Size Exclusion Chromatography and problem.

References:

1. Introduction to Instrumental Analysis,R.D.Braun,McGraw-Hill.Inc.1987
2. Instrumental Methods of chemical Analysis,H. H.Willard, L.L.Merrite Jr., J.A.Dean & F.A.SettleJr.,6th Edition, Wadsworth Publishing Company,USA,1986
3. Hand book of Instrumental Techniques for Analytical Chemistry,F.A.Settle editor, Prentice Hall Inc. A Simon and Schuster Company,NewJersey,1997
4. Fundamentals of Analytical Chemistry ,D.A. Skoog, D.M.west,F.J.Holler,S.R.Crouch,7thEdition,ThomsonAsiaPte.Ltd,Singapore,2004

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class : M.Sc. (SEM I) **Subject** : Chemistry

Course Name : Advanced topics in Analytical Chemistry-I **Course Code** : CHE-506-MJE(A)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with PO

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	1	1	2
CO2	2	3	2	3	2	1	1	2
CO3	3	2	1	3	1	1	1	2
CO4	2	3	3	3	1	1	2	3
CO5	1	3	3	2	2	1	2	3
CO6	1	2	2	1	3	2	1	2
CO7	1	2	2	1	2	3	3	2

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1: builds foundational and historical understanding of nanomaterials and advanced characterization techniques.

CO2: develops theoretical knowledge required to interpret material properties at micro- and nano-scales.

CO3: strengthens core disciplinary knowledge of analytical instrumentation and techniques.

PO2: Research, Analysis, and Complexity

CO2: enhances analytical skills through interpretation of complex characterization data.

CO4: develops research aptitude by optimizing experimental and chromatographic conditions.

CO5: promotes analytical thinking while addressing real-world sample analysis and instrumental limitations.

PO3: Problem Solving in New Contexts

CO4: enables learners to apply theoretical knowledge to optimize separation techniques in unfamiliar scenarios.

CO5: strengthens problem-solving skills through selection of appropriate analytical methods for practical samples.

CO7: supports informed decision-making in professional laboratory environments.

PO4: Technical Mastery and Scientific Reasoning
CO1: develops technical understanding of advanced instruments and their working principles.
CO2: strengthens scientific reasoning through evaluation of experimental results.
CO3: enhances technical proficiency in operating and understanding chromatographic systems.

PO5: Integrated Communication
CO6: develops the ability to present analytical data using scientific terminology and graphical tools.
CO7: supports responsible communication of results following professional and safety standards.

PO6: Ethical, Social, and Professional Judgment
CO6: promotes integrity and transparency in documentation and reporting of analytical results.
CO7: develops awareness of ethical practices, laboratory safety, and professional responsibility.

PO7: Autonomous and Lifelong Learning
CO4: encourages independent learning through method development and optimization.
CO5: promotes self-directed problem-solving and continuous skill enhancement.
CO7: instills the importance of lifelong learning and professional upgradation.

PO8: Employability, Innovation, and Entrepreneurship
CO1: provides exposure to industry-relevant advanced analytical instruments.
CO4: develops innovation skills through optimization and method development.
CO5: enhances employability by addressing practical analytical challenges encountered in industry and research laboratories.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Elective Theory
Course Name	: Advanced topics in Organic Chemistry-I
Course Code	: CHE-506-MJE (B)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. To provide advanced conceptual understanding of organic reaction intermediates including their structure, formation, stability, and reactivity.
2. To introduce students to organometallic and heteroatom-based reagents and their role in modern organic synthesis.
3. To develop mechanistic insight into named reactions such as Wittig, Corey–Chaykovsky, Stevens rearrangement, and photochemical transformations.
4. To familiarize students with the laws and principles of photochemistry and their applications in carbonyl chemistry.
5. To impart knowledge of molecular orbital theory and orbital symmetry for interpreting Pericyclic reactions.
6. To enhance analytical and problem-solving skills through reaction prediction, mechanistic analysis, and stereochemical reasoning.
7. To prepare students for research, industry, and lifelong learning by strengthening scientific reasoning, communication, and professional competence.

Course Outcomes:

After successful completion of the course, learners will be able to:

Explain the structure, generation, stability, and reactions of key organic intermediates such as carbenes, nitrenes, carbocations, carbanions, and free radicals**.**

CO1. Analyze and compare the reactivity and synthetic applications of Grignard, organozinc, organocopper, organolithium, and organ selenium reagents**.**

CO2. Elucidate mechanisms of important reactions involving ylides**,** including Wittig, Corey–Chaykovsky, and Stevens rearrangement**,** with appropriate examples.

CO3. Apply principles of photochemistry to explain reactions of carbonyl compounds, including Norrish Type I & II and Paternò–Büchi reactions**.**

CO4. Construct and interpret π-molecular orbitals of simple conjugated systems and relate orbital symmetry to pericyclic reaction outcomes.

CO5. Predict stereochemical outcomes of electrocyclic reactions using frontier molecular orbital theory and CON/ DIS rotatory rules.

CO6. Solve complex chemical problems and communicate solutions effectively, demonstrating readiness for research, industry, and autonomous learning.

Topics and Learning points

Topics and Learning Points

Unit 1. Organic reaction intermediates (5 L)

Structure, formation, stability and reactions of reactive intermediates,
carbenes, nitrenes, carbocations, carbanions and free radicals with examples.

Unit 2. Reagents (15L)

Introduction, Grignard reagent, organo zinc, organo copper, organo lithium, orhano selenium, Ylides- Phosphorus, Nitrogen and Sulphur synthesis and their reactions
(Wittig reaction, Corey-Chaykovsky Reaction, Stevens rearrangement). Problem solving.

Unit 3. Photochemistry and Pericyclic Reactions (10L)

Law of photochemistry, quantum yield, quenching, photochemistry of carbonyl compounds, Norrish type I and II reactions, Paterrno-Buchi reaction.
Construction of Pi molecular orbitals of ethylene and 1,3-butadiene, symmetry in pi molecular orbitals, Frontier molecular orbitals, Electrocyclic reactions CON and DIS rotatory ring closing and opening reactions. Problem solving.

References:

1. Organic Chemistry–by J. Clayden, N. Greeves, S. Warren and P. Wothers
2. Advanced Organic Chemistry –by J. March 6th Edition
3. Advanced Organic Chemistry (part A) –by A. Carey and R.J. Sundberg
4. Guide book to Reaction Mechanism –Peter Sykes

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	: Advanced topics in Organic Chemistry-I	**Course Code**	:	CHE-506-MJE(B)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	1	1	1
CO2	3	3	2	2	1	0	1	3
CO3	2	3	3	3	0	0	1	2
CO4	3	3	2	3	1	1	2	1
CO5	2	3	1	3	1	2	1	0
CO6	2	2	3	3	2	1	0	2
CO7	1	2	3	2	3	3	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

This PO is strongly addressed through CO1, CO2, CO4, CO5, and CO6, which focus on advanced concepts such as reactive intermediates, organometallic reagents, photochemical reactions, molecular orbital theory, and pericyclic reactions. These course outcomes deepen subject knowledge and promote originality in understanding reaction mechanisms and synthetic pathways.

PO2: Research, Analysis, and Complexity

CO1 to CO7 contribute to PO2 by emphasizing analytical thinking, mechanistic interpretation, and evaluation of complex chemical systems. Students analyze stability, reactivity, quantum yields, orbital symmetry, and reaction pathways, preparing them to interpret research data and advanced chemical literature.

PO3: Problem Solving in New Contexts

This PO is achieved mainly through CO3, CO4, CO6, and CO7, where students apply theoretical concepts to unfamiliar reaction mechanisms, predict stereochemical outcomes, and solve mechanism-based problems. The problem-solving components enable students to transfer knowledge to new chemical situations.

PO4: Technical Mastery and Scientific Reasoning

CO1, CO3, CO4, CO5, and CO6 directly support PO4 by strengthening mechanistic reasoning, molecular orbital construction, symmetry analysis, and application of frontier molecular orbital theory. Students develop strong technical competence in explaining and predicting chemical behavior.

PO5: Integrated Communication

CO7 primarily addresses PO5 by requiring students to present chemical mechanisms, reaction schemes, and problem solutions clearly through written and oral communication, using appropriate scientific terminology and representations.

PO6: Ethical, Social, and Professional Judgment

PO6 is moderately addressed through CO7, where students develop awareness of safe handling of reagents, responsible scientific practices, and professional conduct related to chemical experimentation and application.

PO7: Autonomous and Lifelong Learning

CO7 contributes significantly to PO7 by encouraging independent learning, critical thinking, and continuous skill development, enabling students to keep pace with emerging trends in organic and photochemical research.

PO8: Employability, Innovation, and Entrepreneurship

CO2, CO3, and CO7 support PO8 by providing practical and industry-relevant knowledge of synthetic reagents, reaction design, and problem-solving skills essential for careers in chemical industries, pharmaceuticals, research, and entrepreneurship.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Elective Theory
Course Name	Advanced Topics in Inorganic Chemistry
Course Code	: CHE-506-MJE (C)
No. of Lectures	: 30
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1 Introduce the fundamental concepts of nanoscience and nanotechnology, including history, scope, and significance of nanomaterials.

2 Explain the classification of nanostructured materials based on dimensionality and relate them to real-world applications.

3 Understand band theory and correlate electronic band structures with electrical properties of metals, semiconductors, and insulators.

4 Analyze the band structure of advanced materials such as inorganic solids, transition metal compounds, fullerenes, and graphite.

5 Describe size-dependent physical, chemical, and biological properties of nanomaterials arising from quantum and surface effects.

6 Familiarize students with various synthetic methods (chemical, physical, biological, and green approaches) for nanomaterial preparation.

7 Evaluate applications and future prospects of nanomaterials, addressing challenges related to sustainability, safety, and scalability.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Explain the evolution, scope, and importance of nanomaterials and justify why nanoscale materials exhibit unique properties.

CO2: Classify nanomaterials based on structure and dimensionality and identify their applications in energy, electronics, medicine, and environment.

CO3: Interpret metallic bonding and band theory to distinguish between conductors, semiconductors, and insulators.

CO4: Analyze electronic band structures of silicon, inorganic solids, transition metal compounds, fullerenes, and graphite.

CO5: Correlate optical, mechanical, magnetic, electrical, thermal, catalytic, and biological properties of nanomaterials with particle size and structure.

CO6: Compare top-down and bottom-up approaches and explain chemical, physical, bio-inspired, and green synthesis methods of nanomaterials.
CO7: Assess the suitability of nanomaterials for specific applications and discuss challenges, safety issues, and future directions in nanotechnology.

Topics and Learning points

Nanomaterials
Unit 1.The Big World of Nanomaterials (4L)
History and Scope; Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Applications of Nanomaterials. Nature: The Best Nanotechnologist; Challenges and Future Prospects.

Unit 2. Band Theory (5L)
Metallic Bonding and Band Theory; Band structure of metals; Band structure of insulators; Band structure of semiconductors: silicon; Band structure of inorganic solids, Transition metal compounds, Fullerenes and graphite.

Unit 3. Different properties of Nanomaterials (6L)
Optical, Mechanical, magnetic, electrical, structural-catalytic- chemical, emergent quantum properties, Thermal & Biological properties.

Unit 4. Synthetic Methods of Nanomaterials and its applications (15L)
Introduction: Bottom up and top-down approach

Bottom up approach: Coprecipitation method ,Sol- Gel method, Combustion synthesis, Hydrothermal and solvo-thermal synthesis,
Top-down approach: Chemical vapor deposition (CVD), High energy Ball milling method, Arc discharge method for synthesis of CNT, Sonochemical method
Applications of nanomaterial in various field (in short)

References:

1. Nanotechnology by Dr. Shulbha Kulkarni
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C. N. R. Rao (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), 2004. Wiley Publisher.
3. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley Publishers, April 2004.
4. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education.
5. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim, 2004

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class : M.Sc. (SEM I) **Subject** : Chemistry

Course Name : Advanced topics in Inorganic Chemistry **Course Code** : CHE-506-MJE (C)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	0	2	0	0
CO2	3	2	2	3	0	0	0	0
CO3	3	3	2	3	2	0	0	0
CO4	3	3	3	3	0	0	2	0
CO5	3	2	3	3	0	0	0	2
CO6	1	2	0	0	3	3	2	2
CO7	3	3	2	2	0	2	0	0

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality.
CO1 builds foundational and historical understanding of nanomaterials.
CO2 develops theoretical knowledge of metallic bonding and band structure.
CO3 strengthens structure–property relationships in nanomaterials.

PO2: Research, Analysis, and Complexity.
CO1 introduces research scope, challenges, and future prospects in nanotechnology.
CO3 emphasizes analytical evaluation of size-dependent properties.
CO4 involves comparative analysis of nanomaterial synthesis methods.

PO3: Problem Solving in New Contexts.
CO3 applies structure–property relationships to solve material performance problems.
CO4 enables selection of suitable synthesis routes for specific nanomaterial requirements.
CO5 applies nanomaterials to real-world and interdisciplinary problems.

PO4: Technical Mastery and Scientific Reasoning.
CO2 strengthens scientific reasoning through band theory and electronic structure analysis.
CO3 develops technical understanding of nanoscale physical and chemical properties.
CO4 builds technical competence in nanomaterial synthesis techniques.
CO5 applies technical knowledge to functional nanomaterial design and applications.

PO5: Integrated Communication.
CO3 encourages interpretation and presentation of structure–property data.
CO6 develops effective scientific communication on nanotechnology applications and impacts.

PO6: Ethical, Social, and Professional Judgment.
CO1 addresses societal relevance and responsible use of nanomaterials.
CO6 evaluates ethical, environmental, health, and safety aspects of nanotechnology.

PO7: Autonomous and Lifelong Learning.
CO4 promotes independent learning of emerging nanomaterial synthesis methods.
CO6 encourages continuous learning in sustainability and responsible nanotechnology.

PO8: Employability, Innovation, and Entrepreneurship.
CO5 aligns nanomaterial applications with industrial and technological needs.
CO6 supports innovation awareness and professional readiness in nanotechnology.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Elective Practical
Course Name	: Advance Analytical Practicals-I
Course Code	: CHE-507-MJE-(A)
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. Introduce students to classical and advanced analytical separation techniques including ion-exchange chromatography, solvent extraction, TLC, paper chromatography, GC, and HPLC.
2. Provide hands-on experience in quantitative and qualitative analysis of inorganic, organic, pharmaceutical, and food-related samples.
3. Familiarize learners with modern instrumental techniques such as spectroscopy, chromatography, and X-ray diffraction for chemical and material analysis.
4. Develop the ability to interpret analytical data, spectra, and structural information using scientific reasoning.
5. Enhance problem-solving skills by applying analytical techniques to real-world and unfamiliar samples.
6. Promote awareness of laboratory safety, ethical practices, and professional responsibility in analytical chemistry laboratories.
7. Prepare students for research, industry, and quality-control roles through exposure to industry-relevant analytical methodologies.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1. Perform separation and quantitative estimation of metal ions using ion-exchange chromatography and solvent extraction techniques.

CO2. Apply paper chromatography, TLC, GC, and HPLC for separation, identification, and estimation of organic and inorganic compounds.

CO3. Analyze and interpret spectral data and single-crystal X-ray diffraction patterns to determine structural and compositional details.

CO4. Determine concentrations of analytes in real-world samples such as beverages, pharmaceutical formulations, and food products.

CO5. Select and optimize appropriate analytical methods and experimental conditions to solve practical and unfamiliar analytical problems.

CO6. Record, analyze, and present experimental data using scientific terminology, calculations, graphs, and structured laboratory reports**.**

CO7. Demonstrate ethical conduct, laboratory safety, professional responsibility, and readiness for continuous skill enhancement in analytical and research laboratories.

Topics and Learning points

Synthesis, Purification and Characterization
(Minimum 15 experiments should be completed in this course)

1. Separation & estimation of a mixture of Zn(II) & Mg(II) using ion exchange chromatography.
2. Separation and estimation of Fe and Al on cation exchanger.
3. Analysis of given spectra.
4. Determination of alcohol from beverage sample by gas chromatography technique.
5. Estimation of Vitamin C by 2,6 dichlorophenol indophenol.
6. Analysis of crystal structure from single crystal X-ray pattern.
7. Separation of amino acid by paper chromatography.
8. Separation of amino acid by TLC.
9. Determination of iron by solvent extraction techniques in a mixture of Fe^{3+} +Al^{3+} by using 8-hydroxyquinoline.
10. Determination of iron by solvent extraction techniques in a mixture of Fe^{3+} +Ni^{2+} by using 8-hydroxyquinoline.
11. Separation of mixture of Zn (II) and Cd (II) using Amberlite IRA 400 anion exchanger and quantitative estimation of separated ions Zn (II) and Cd (II).
12. Separation & identification of methanol, ethanol and Propanol using gas chromatography.
13. Determine the concentration of paracetamol in a tablet formulation using HPLC.
14. Chromatographic separation and identification of sugars.
15. Determination of anion exchange capacity of anion exchange resin.
16. Determination of Cu (II) by solvent extraction as dithiocarbamate or 8-hydroxyquinoline complex.
17. Synthesis of nano size ZnO, its characterization by UV-visible Spectroscopy.
18. Identification of given unknown drug by using thin layer chromatography.

References:

1. Lab Manual: Selected experiments of Pharmaceutical Analysis, Aness A Siddiqui.
2. Experimental physical chemistry, Athawale, Mathur, Newage Int. Publishers.
3. Practicals in inorganic chemistry, Mrs. Manali Dilip Panse ,Manali Prakashn
4. Advanced practicals in physical chemistry,Manali Prakashn
5. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
6. Senior Practical Physical Chemistry, B. D. Khosla and V.S. Garg (R.Chand and Co., Delhi.)
7. Practical physical chemistry, B. Vishwanathan and P.S.Raghavan,2nd edition, (2012)

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Advance Analytical Practicals-I	**Course Code**	:	CHE-507-MJE-(A)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	1	1	2
CO2	2	3	2	3	2	1	1	2
CO3	2	2	1	3	1	1	1	2
CO4	1	3	3	2	2	1	2	3
CO5	1	3	3	2	2	1	2	3
CO6	1	2	2	1	3	2	1	2
CO7	1	2	2	1	2	3	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1 develops core disciplinary knowledge through hands-on application of ion-exchange and solvent extraction techniques.

CO3 strengthens understanding of instrumental principles through spectral analysis and crystal structure interpretation.

CO2 reinforces foundational concepts of chromatographic techniques, enhancing originality and subject mastery.

PO2: Research, Analysis, and Complexity

CO2 enhances analytical skills through interpretation of chromatographic separations and experimental data.

CO4 promotes research aptitude by analyzing real-world samples using suitable analytical techniques.

CO5 develops the ability to handle complex analytical problems through method selection and optimization.

PO3: Problem Solving in New Contexts

CO4 enables learners to apply analytical methods to unfamiliar samples such as pharmaceuticals and beverages.

CO5 strengthens problem-solving ability by addressing instrumental limitations and experimental challenges.

CO7 supports informed decision-making in laboratory and professional environments.

PO4: Technical Mastery and Scientific Reasoning
CO1 develops technical proficiency in classical and modern separation techniques.
CO2 enhances scientific reasoning through evaluation of experimental results.
CO3 builds competency in interpreting spectral and crystallographic data.

PO5: Integrated Communication
CO6 develops the ability to record, analyze, and present experimental data using scientific terminology and graphical representation.
CO7 reinforces responsible communication through proper documentation and reporting practices.

PO6: Ethical, Social, and Professional Judgment
CO6 promotes ethical reporting, accuracy, and transparency in analytical results.
CO7 develops awareness of laboratory safety, ethical conduct, and professional responsibility.

PO7: Autonomous and Lifelong Learning
CO5 encourages independent learning through method development and analytical decision-making.
CO7 instills the importance of continuous skill upgradation and lifelong learning.

PO8: Employability, Innovation, and Entrepreneurship
CO1 provides industry-relevant exposure to analytical separation techniques.
CO4 enhances employability through analysis of real-world samples.
CO5 promotes innovation by applying analytical skills to practical and industrial problems.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Elective Practical
Course Name	: Advance Organic Chemistry Practical-I
Course Code	: CHE-507-MJE-(B)
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

The objectives of this course are to:

1. To train students in the systematic synthesis of organic compounds using classical and named organic reactions.
2. To develop understanding of reaction mechanisms and rearrangements through hands-on laboratory experiments.
3. To impart skills in safe handling of chemicals, reagents, and laboratory equipment following standard protocols.
4. To enable students to apply theoretical organic chemistry concepts to practical synthesis and transformations.
5. To familiarize students with functional group interconversion and multistep organic reactions.
6. To enhance analytical, observational, and problem-solving skills during synthesis, purification, and yield calculation.
7. To prepare students for research, industrial chemistry, and lifelong learning through experiential laboratory training.

Course Outcomes:

After successful completion of the course, learners will be able to:

1. Perform laboratory synthesis of organic compounds using reactions such as benzil–benzillic acid rearrangement, Diels–Alder, Beckmann, Pinacol–pinacolone, and Biginelli reactions.
2. Apply reaction mechanisms to explain experimental outcomes in reactions like Vilsmeier–Haack, Reimer–Tiemann, Knoevenagel, Henry, and Friedel–Crafts–type transformations.
3. Carry out functional group transformations including amide formation, nitration, condensation, and rearrangements with proper experimental techniques. Demonstrate proficiency in laboratory skills, including recrystallization, sublimation, purification, and calculation of percentage yield.

4. Analyze experimental results and identify sources of error using logical and scientific reasoning.
5. Follow ethical laboratory practices, safety guidelines, and environmentally responsible procedures during chemical synthesis.
6. Document and communicate experimental procedures and results effectively, preparing laboratory records suitable for academic, research, or industrial environments.

Topics and Learning points

Synthesis, Purification and Characterization
(Minimum 15 experiments should be completed in this course)

1. Preparation of Benzillic acid from Benzil.
2. Synthesis of chalcone using substituted benzaldehyde
3. Preparation of acetanilide from aniline and acetic acid using zinc dust.
4. Preparation of adduct of maleic anhydride and Anthracene (Diels Alder reaction)
5. Preparation of 1-formyl-2 methoxy naphthalene from 2- methoxy naphthalene (Vilsmeir Haack reaction)
6. Benzopinacolone from benzopinacol (Pinacol -pinacolone rearrangement).
7. Synthesis of phthalimide from phthalic acid.
8. Synthesis of p-chlorotoulene from p-toluidine.
9. Biginelli reaction-synthesis of dihydropyrimidinone from aldehyde,urea and beta keto ester.
10. Reaction between aldehyde and malononitrile (Knoevenagel condensation reaction)
11. Synthesis of Benzanilide from benzophenone (Beckmann rearrangement).
12. Preparation of Salicaldehyde from phenol (Reimer-Tiemann reaction).
13. Preparation of Osazone from glucose
14. Preparation of Glycine to Hippuric acid
15. Preparation of phthalic anhydride from phthalic acid (sublimation method).
16. Synthesis of β nitro styrene from benzaldehyde. (Henry reaction).
17. Preparation of Benzoic acid and Benzyl alcohol from Benzaldehyde (Cannizzaro reaction)

References:

1. Text book of practical organic chemistry–A.I.Vogel
2. Practical Physical Chemistry, J.B.Yadav
3. Essentials of practical organic Chemistry, Rajboj and Chandhekar
4. Practical Chemistry, Athawale and Mathur.

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Organic and Inorganic Chemistry practical-I	**Course Code**	:	CHE-507-MJE(B)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	2	1	1
CO2	3	3	2	2	1	1	1	3
CO3	2	3	3	3	1	1	1	2
CO4	3	3	2	3	1	2	1	1
CO5	2	3	1	3	1	1	1	1
CO6	2	2	3	3	2	1	1	1
CO7	1	2	3	2	3	1	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

PO1 is achieved through CO1, CO2, and CO3, where students acquire in-depth practical knowledge of organic synthesis, named reactions, functional group transformations, and rearrangements. Performing experiments such as benzil–benzillic acid rearrangement, Diels–Alder, Beckmann, and Biginelli reactions strengthens conceptual clarity and originality in applying organic chemistry principles.

PO2: Research, Analysis, and Complexity

CO1, CO2, CO5, and CO7 contribute to PO2 by encouraging students to analyze reaction conditions, interpret experimental observations, calculate yields, and identify sources of error. These activities develop analytical thinking and the ability to handle complex experimental data, essential for research-oriented learning.

PO3: Problem Solving in New Contexts

PO3 is addressed mainly through CO2, CO3, and CO5, where students troubleshoot experimental difficulties, optimize reaction conditions, and apply theoretical knowledge to unfamiliar laboratory situations. This enhances their capacity to solve practical chemical problems independently.

PO4: Technical Mastery and Scientific Reasoning

CO1, CO2, CO3, CO4, and CO5 strongly support PO4 by developing proficiency in laboratory techniques such as synthesis, purification, recrystallization, sublimation, and mechanism-based reasoning. Students demonstrate scientific logic while correlating experimental procedures with reaction mechanisms.

PO5: Integrated Communication

PO5 is primarily achieved through CO7, which emphasizes systematic documentation of experimental procedures, observations, calculations, and conclusions in laboratory records. This enables students to communicate scientific information clearly and effectively.

PO6: Ethical, Social, and Professional Judgment

CO4 and CO6 address PO6 by instilling ethical laboratory practices, safe handling of chemicals, proper waste disposal, and adherence to standard operating procedures. These outcomes promote professional responsibility and safety awareness in chemical practice.

PO7: Autonomous and Lifelong Learning

PO7 is supported through CO6 and CO7, where students develop self-discipline, independent working habits, and reflective learning through continuous laboratory practice and record maintenance, fostering readiness for lifelong learning.

PO8: Employability, Innovation, and Entrepreneurship

CO1, CO2, CO3, and CO7 contribute to PO8 by equipping students with hands-on synthesis skills, problem-solving ability, and professional documentation competence. These skills enhance employability in chemical industries, pharmaceuticals, research laboratories, and entrepreneurial ventures.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Elective Practical
Course Name	: Advanced Inorganic Chemistry Practical-I
Course Code	: CHE-507-MJE (C)
No. of Lectures	: 60
No. of Credits	: 2 credits

Course Objectives:

The objectives of this practical course are to:

1. To provide hands-on training in the chemical synthesis of metal and metal oxide nanoparticles.
2. To familiarize students with green synthesis methods using plant tissues and medicinal plant extracts.
3. To develop competence in controlled synthesis techniques such as co-precipitation, sol–gel, combustion, and hydrothermal methods.
4. To train students in optical characterization of nanoparticles using UV–Visible spectroscopy.
5. To enable determination of band gap energy and interpretation of absorption spectra of nanomaterials.
6. To develop skills in structural characterization using XRD for crystal structure, crystallite size, and lattice parameters.
7. To promote experimental problem-solving, data analysis, safety awareness, and professional laboratory practices.

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Synthesize nanosized metal and metal oxide nanoparticles (ZnO, Fe_2O_3, CuO, NiO, TiO_2, CdS, Ag) using chemical methods such as co-precipitation, combustion, sol–gel, and hydrothermal routes.

CO2: Prepare nanoparticles using green synthesis approaches involving plant tissues and medicinal plant extracts.

CO3: Characterize nanoparticles using UV–Visible spectroscopy and determine the optical band gap from absorption data.

CO4: Evaluate the Photocatalytic degradation of dyes using ZnO nanoparticles and correlate activity with material properties.

CO5: Analyze X-ray diffraction (XRD) data to determine crystal structure, crystallite size, and lattice parameters of nanomaterials.
CO6: Interpret experimental results, maintain laboratory records, and prepare scientific reports with appropriate graphs and tables.
CO7: Demonstrate ethical, environmental, and safety awareness in nanomaterials synthesis with relevance to sustainability and professional practice.

Topics and Learning points

Chemical synthesis: (Any ten)

1. Synthesis of nanosized ZnO, its characterization by UV-Visible Spectroscopy & Removal of dye by ZnO – Photocatalysis and determine the band gap by absorption spectroscopy.
2. Synthesis of nanosized Fe_2O_3 Nanoparticles by Chemical method
3. Synthesis of nanosized Silver Nanoparticles by Chemical method
4. Preparation of transition metal oxide Nanoparticles by using sol gel method.
5. Chemical Synthesis of nanoparticles by combustion method. (Any three)
   (CuO / ZnO / NiO / TiO_2/ CdS)
6. Chemical Synthesis of nanoparticles by Co-precipitations method (Any three)
   (CuO/ ZnO/ NiO/ TiO_2/CdS)
7. Synthesis of transition metal oxide nanoparticles by hydrothermal route.
   (Co /Cr / Mo /Cu /Zn)

Green synthesis: (Any Five)

8. Synthesis of nanoparticles by using different plant tissues.
9. Synthesis of nanoparticles by using different medicinal plant extract.
10. Synthesis of nanosized Silver Nanoparticles by green method(using different medicinal plant extract)
11. Synthesis of metal oxide nanoparticles using plant extracts and characterization.
    (CuO, ZnO, NiO, TiO_2, CdS) (Any three)
12. Synthesis of metal nanoparticles using plant extracts and characterization.
13. To determine the crystal structure, grain size and lattice parameters using XRD data of a given sample. (minimum 3 XRD spectra analysis)

References:

1. Nanomaterials Chemistry by Rao C. N., A. Muller, A. K. Cheetham,,WileyVCH , 2007.
2. Nanomaterials and Nanochemistry by Brechignac C., P. Houdy, M. Lahmani, Springer
3. publication, 2007.
4. Nanoscale materials in chemistry by Kenneth J. Klabunde, Wiley Interscience Publications, 2001.
5. Nanochemistry by Sergeev G.B., Elseiver publication, 2006.
6. Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004.
7. Nanomaterials – Handbook by Yury Gogotsi, CRC Press, Taylor & Francis group, 2006. NSC
8. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C. N. R. Rao (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), 2004. Wiley Publisher.
9. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor),
10. Chad A. Mirkin (Editor), Wiley Publishers, April 2004.
11. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education.
12. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim, 2004 5.
13. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry,
14. Cambridge UK 2005. Course code: NS-202-MJ Name of the course: Advanced characterization of nanomaterials-Instrumental

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class	:	M.Sc. (SEM I)	**Subject**	:	Chemistry
Course Name	:	Advanced Inorganic Chemistry Practical-I	**Course Code**	:	CHE-507-MJE (C)

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	3	0	0	0	2
CO2	3	1	0	2	0	3	2	1
CO3	1	3	0	3	0	0	0	0
CO4	1	2	3	3	0	1	0	2
CO5	1	3	2	3	0	0	0	0
CO6	0	1	0	1	3	0	3	1
CO7	1	0	0	0	0	3	3	1

Justification for the Mapping

PO1: **Advanced Disciplinary Knowledge & Originality**

CO1 and CO2 strongly contribute by providing hands-on knowledge in chemical and green synthesis of nanomaterials.

CO3–CO5 support disciplinary understanding through characterization and application studies.

CO7 provides basic awareness of ethical practices related to nanomaterials.

PO2: Research, Analysis, and Complexity

CO3 and CO5 emphasize experimental data analysis using UV–Visible spectroscopy and XRD techniques.CO4 involves analysis of photocatalytic performance.

CO1, CO2, and CO6 contribute marginally through interpretation of experimental results.

PO3: Problem Solving in New Contexts

CO4 develops problem-solving skills through evaluation of dye degradation efficiency.

CO5 supports solving structure-related problems using XRD analysis.

CO1 provides basic exposure to experimental problem handling.

PO4: Technical Mastery and Scientific Reasoning

CO1, CO3, CO4, and CO5 strongly build technical competence in synthesis, characterization, and application of nanomaterials.

CO2 contributes to scientific reasoning through green synthesis techniques.

CO6 provides minimal technical exposure through documentation activities.

PO5: Integrated Communication
CO6 focuses on preparation of laboratory records, reports, graphs, and scientific communication.

PO6: Ethical, Social, and Professional Judgment
CO2 and CO7 emphasize green synthesis, environmental safety, and responsible laboratory practices.
CO4 introduces limited awareness of environmental impact through photocatalytic studies.

PO7: Autonomous and Lifelong Learning
CO2 encourages exploration of alternative green synthesis routes.
CO6 and CO7 promote independent learning, safety awareness, and continuous professional development.

PO8: Employability, Innovation, and Entrepreneurship
CO1 and CO4 enhance employability through practical skills in synthesis and applications.
CO2, CO6, and CO7 contribute marginally by developing awareness of innovation, sustainability, and professional conduct.

CBCS Syllabus as per NEP 2020 for M.Sc. (2026 Pattern)

Name of the Programme	: M.Sc. Chemistry
Program Code	: PSCH
Class	: M.Sc.
Semester	: I
Course Type	: Major Mandatory Theory
Course Name	: Research Methodology
Course Code	: CHE-508-RM
No. of Lectures	: 60
No. of Credits	: 4 credits

Course Objectives:

The objectives of this course are to:

1. Introduce learners to the fundamental concepts, philosophy, and interdisciplinary nature of research.
2. Develop understanding of various research methods and scientific enquiry processes.
3. Enable learners to design appropriate research frameworks and prepare systematic research proposals.
4. Equip learners with skills for data collection, sampling, and qualitative and quantitative data analysis.
5. Develop competence in the application of statistical tools and hypothesis testing for scientific decision-making.
6. Foster ethical research practices and effective communication through scientific report writing.
7. Apply statistical tools and technique for data analysis and interpretation

Course Outcomes:

After successful completion of the course, learners will be able to:

CO1: Explain the meaning, characteristics, objectives, and philosophical foundations of research in scientific and interdisciplinary contexts.

CO2: Differentiate between research methods and methodologies and apply appropriate qualitative and quantitative research approaches.

CO3: Formulate research problems, objectives, and hypotheses and design suitable research frameworks.

CO4: Select appropriate sampling techniques and data collection tools and analyze qualitative and quantitative data using statistical methods.

CO5: Interpret research data and apply parametric and non-parametric hypothesis testing for scientific decision-making.

CO6: Prepare, present, and evaluate research reports ethically, following standard citation practices and plagiarism guidelines.

CO7: Utilize statistical tools and technique for data analysis and interpretation

Topics and Learning points

Unit 1: Introduction to Research: (10L)

Meaning of Research, Characteristics of Research, Criteria of good research, Qualities of a good research, Objectives of research, Steps involved in research process, Types of research, Scientific enquiry, Philosophical and sociological foundation of research, Interdisciplinary approach and its implications in various research area.

Unit 2: Methods of Research: (12L)

Research and Scientific Method, Research Methods versus methodology, Qualitative and quantitative methods of research: Historical research, Ethanography research, Documentary research, Content analysis research, Survey field, Case study, Ex-post facto research, Laboratory experimental studies.

Unit 3: Research Design and Development of research proposal (12L)

Meaning of research design, Need for research design, Features of good designs, Different research designs (Exploratory, Descriptive, Experimental and Diagnostic research).
Research proposal and its elements, Formulation of research problem, Development and characteristics of objectives, Development hypotheses and applications

Unit 4: Data Collection &Analysis (14L)

Concept of sampling, Types of sampling and their characteristics, Types of data and tools of data collections.
Types of data analysis, Analysis of qualitative data on various tools, Analysis of quantitative data and its presentation with tables, graphs, etc, Statistical tools and techniques of data analysis: Measures of central tendency, Dispersion, etc. Sampling error and distribution. Decision making with hypothesis testing: Through parametric and non parametric tests

Unit 5: Report Writing and evaluations (12L)

Principle of report writing, preparation of report or thesis, precaution in writing research report, Writing and presentation of report, evaluation of research report citation index, bibliography, plagiarism, impact factor.

References:

1. Krishna Swamy K.N.,Siva Kumar A.I., Mathirajan M.,“ Management Research Methodology (2006), Pearson Education, New Delhi.
2. Ranjit Kumar: Research Methodology, A step by step guide for beginners, Pearson Education, Sixth Edition 2009.
3. C,R.Kothari, GauravGarg, “Research Methodology :Methods and Techniques” Third Edition (2014), New Age Publication, New Delhi
4. Ram Ahuja,“Research Methods”,(2001), Rawat Publications, New Delhi.
5. Introduction to research methodology, Sanay Prakashan, Pune.

Choice Based Credit System Syllabus (2026 Pattern)

(As per NEP 2020)

Class : M.Sc. (SEM I) **Subject** : Chemistry

Course Name : Research Methodology **Course Code** : CHE-508-RM

Mapping of Course Outcomes with Program Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation.

Mapping of COs with POS

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	1	2	2	1
CO2	2	3	2	2	1	1	2	1
CO3	2	3	3	2	1	1	2	2
CO4	2	3	2	3	1	1	2	2
CO5	1	3	3	2	2	1	2	2
CO6	1	2	2	1	3	3	2	2
CO7	1	2	3	1	2	2	2	1

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge & Originality

CO1: Strongly contributes by developing conceptual understanding of research philosophy, foundations, and characteristics.

CO2–CO4: Moderately supports advanced knowledge through exposure to research methods, design, and data analysis.

CO5–CO6: Limited contribution as focus shifts to application and reporting rather than theory.

PO2: Research, Analysis, and Complexity

CO2, CO3, CO4, CO5: Strong alignment as learners design studies, handle complex data, apply statistical tools, and test hypotheses.

CO1 & CO6: Moderate support through conceptual understanding and interpretation of results.

PO3: Problem Solving in New Contexts

CO3 &CO5 : Strong contribution through formulation of research problems and hypothesis-based decision making.

CO2, CO4, CO6 : Moderate support by applying methods and interpreting findings in real-world research scenarios.

CO1: Limited role as it is primarily theoretical.

PO4: Technical Mastery and Scientific Reasoning

CO4 : Strong alignment through application of sampling techniques, statistical tools, and data analysis.

CO2, CO3, CO5 : Moderate contribution by selecting appropriate methodologies and analytical techniques.
CO1 &CO6 : Minimal technical involvement.

PO5: Integrated Communication
CO6: Strongly aligned through report writing, presentation, citation, and evaluation of research work.
CO5: Moderate support via interpretation and presentation of analyzed data.
CO1–CO4 : Limited communication focus.

PO6: Ethical, Social, and Professional Judgment
CO6 : Strong contribution through emphasis on research ethics, plagiarism awareness, citation index, and impact factor.
CO1 : Moderate understanding of ethical research foundations.
CO2–CO5 : Limited ethical emphasis.

PO7: Autonomous and Lifelong Learning
CO1–CO6: Moderate alignment across all COs by encouraging independent learning, inquiry, critical thinking, and research competence.

PO8: Employability, Innovation, and Entrepreneurship
CO3, CO4, CO5, CO6: Moderate contribution by developing proposal writing, analytical skills, decision-making ability, and professional reporting useful in industry and academia.
CO1 & CO2: Foundational support only.