Curriculum and Credit Framework
As per NEP 2020

For

Post Graduate Programme
(M.Sc.) in Chemistry

(To be effective from the Academic Session 2024-25)

Department of Chemistry

Gurugram University, Gurugram

(A State Govt. University Established Under Haryana Act 17 Of 2017)

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Background

- The Chemistry Department of Gurugram University, Gurugram, Haryana - India was established in 2020.
- Department has started a postgraduation programme M.Sc.-Chemistry w.e.f. 2020-2021.
- The vision of the Department of Chemistry is to promote excellence and innovation in teaching and research and to create an academically stimulating atmosphere for students.
- The Mission of the Department of Chemistry is to educate and train students to achieve excellence in science *via* chemistry, which will empower them to contribute to the development of the nation.
- The department aims to encourage critical thinking and develop research skill.
- Specialization in Organic chemistry, Inorganic Chemistry and Physical Chemistry is being provided to students.
- Intake in first session 2021-22 was 20 students.
- In session 2024-25 intake increased up-to 30 students.

Vision and Mission

Vision

1. To impart knowledge and skills in the area of chemistry, to promote excellence and innovation, instil curiosity and ignite interest in relevant areas to inspire young minds to make significant contributions for the betterment of humankind.
2. To develop a department that can effectively harness its strength to create an academically inspiring atmosphere by inculcating students with cultural and ethical values.

Mission

1. To promote, inspire and nurture the fundamentals of chemistry through courses offered to the students.
2. To provide high quality and innovative education with emphasis on both theory and practical training for transformation of young budding chemists into productive scientists, excellent teachers, entrepreneurs and creative independent researchers.
3. To support inter disciplinary research with focus on solving problems of global significance by working jointly with other universities and research Institutes.

Programme Outcomes

On completing M.Sc. (Chemistry) Programme, the students shall be able to realize following programme outcomes:

S. No.	Component	Description
PO-1	Basic Knowledge	Equipped to convey fundamental disciplinary knowledge acquired during the programme.
PO-2	In-depth Knowledge	Proficient in explaining advanced concepts and insights gained throughout the programme.
PO-3	Critical Thinking and Problem-Solving Abilities	Skilled in critically evaluating results and applying acquired knowledge to address and solve problems.
PO-4	Creativity and Innovation	Competent in identifying, formulating, investigating, and analysing scientific problems, and creatively designing and developing practical solutions.
PO-5	Research Aptitude and Global Competency	Capable of developing a strong research aptitude and applying knowledge to solve significant research challenges on a global scale.
PO-6	Holistic and Multidisciplinary Education	Able to acquire knowledge through a holistic and multidisciplinary approach across diverse fields.
PO-7	Skills Enhancement	Proficient in learning specific disciplinary or multidisciplinary skills and advanced techniques, and applying them for the benefit of society.
PO-8	Leadership and Teamwork Abilities	Effective in working within a team and demonstrating leadership abilities.
PO-9	Environmental and Human Health Awareness	Knowledgeable about key issues related to environmental and human health, and capable of developing eco-friendly technologies.
PO-10	Ethical Thinking and Social Awareness	Instilled with a professional and ethical mindset, with the ability to engage with and address social issues.

Programme Specific Outcomes

On completing M.Sc. Chemistry programme, the students shall be able to realize following outcomes:

S. No.	Description
PSO-1	To demonstrate in-depth knowledge and understanding of key concepts in organic, inorganic, physical, and analytical chemistry, enabling them to solve complex chemical problems and conduct innovative research.
PSO-2	To acquire advanced laboratory techniques and skills, including the ability to design, conduct, and analyze experiments using modern instrumentation and methodologies in chemistry.
PSO-3	To independently design and execute original research projects, critically analyze data, and effectively communicate their findings through scientific publications and presentations.
PSO-4	To develop strong problem-solving and critical-thinking abilities, allowing them to apply chemical principles to real-world issues, including those related to industry, healthcare, and environmental sustainability.
PSO-5	To integrate knowledge from various sub-disciplines of chemistry and related fields such as biology, physics, and materials science, fostering interdisciplinary collaboration and innovation.
PSO-6	To understand and adhere to professional and ethical standards in chemistry, demonstrating a commitment to lifelong learning, responsible conduct of research, and the societal impact of their work.

Postgraduate Attributes

A postgraduate MSC student from Department of Chemistry is envisaged to have the following attributes:

- Disciplinary Knowledge
- Creative and Critical Thinking
- Reflective Thinking
- Problem Solving
- Communication Skills
- Research Skills
- Life Skills
- Multidisciplinary Competence
- Moral and Ethical Values
- Inculcate the importance of Life-long Learning
- Global Competence

Qualification Descriptors

To be eligible for admission in M.Sc. Chemistry programme the candidates should have minimum 50% marks in their Bachelor degree from a recognized university like B.Sc. (Hons.) in Chemistry/B.Sc.(Pass)/B.Sc. (Life Sciences) with Chemistry as the main subject.

Scheme of Programme

M.Sc Chemistry (2 Year)

(Scheme PG A2: Postgraduate Programmes (Course work + Research**)**

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A01	**Inorganic Chemistry-I**	**241/CHE/CC/101**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A02	**Physical Chemistry-I**	**241/CHE/CC/102**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A03	**Organic Chemistry-I**	**241/CHE/CC/103**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
Discipline Specific Elective Courses														
DSE-01A	**Chemistry of Life Sciences**	**241/CHE/DS/101**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
DSE-01B	**Mathematics for Chemist**	**241/CHE/DS/102**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
Value-added Course(s)														
VAC-01	**Green Chemistry**	**241/CHE/VA/101**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
Multidisciplinary Course(s)														
MDC-01	From the Pool **Chemistry of Materials**	**241/CHE/MD/101**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
Total Credits									**22**					

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A07	**Inorganic Chemistry-II**	**241/CHE/CC/201**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A08	**Physical Chemistry-II**	**241/CHE/CC/202**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A09	**Organic Chemistry-II**	**241/CHE/CC/203**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
Discipline Specific Elective Course														
DSE-02	**Spectroscopic Methods in Chemistry-I**	**241/CHE/DS/201**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
Skill Enhancement Course(s)														
SEC-01	From the Pool **Industrial Chemistry**	**241/CHE/SE/201**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
Multidisciplinary Course(s)														
MDC-02	From the Pool	**241/CHE/MD/201**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**

	Drug Design and Discovery													
Total Credits									**22**					

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A13	**Inorganic/Physical/Organic Chemistry Special-I**	**241/CHE/CC/301**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A14	**Inorganic/Physical/Organic Chemistry Special-II**	**241/CHE/CC/302**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
CC-A15	**Inorganic/Physical/Organic Chemistry Special-III**	**241/CHE/CC/303**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
					4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
Discipline Specific Elective Course														
DSE-03	**Spectroscopic Methods in Chemistry-II**	**241/CHE/DS/301**	**2**			**2**			**2**	**15**	**35**	**-**	**-**	**50**
Multidisciplinary Course(s)														
MDC-03	**From the Pool Medicinal Chemistry**	**241/CHE/MD/301**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
Seminar														
Seminar									**2**					
Internship/Field Activity#														
									4					
Total Credits									**26**					

#04 credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Discipline Specific Elective Course (s)														
CC-A16	**Inorganic/Physical/Organic Chemistry Special-IV**	**241/CHE/CC/401**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
Discipline Specific Elective Course (s)														
CC-A17	**Inorganic/Physical/Organic Chemistry Special-V**	**241/CHE/CC/402**	**3**			**3**			**3**	**25**	**50**	**-**	**-**	**75**
Dissertation/Project Work														
Dissertation									**20**					
Total Credits									**26**					

CORE COURSES (CC)

Course Code CC-A01			Course Title Inorganic Chemistry-I				Course ID 241/CHE/CC/101				
L	**T**	**P**	**L**	**T**	**P**	**Total Credits**	**MARKS**				
(Hrs)			**Credits**				**TI**	**TE**	**PI**	**PE**	**Total**
3			**3**			**3**	**25**	**50**	**-**	**-**	**75**
		4			**2**	**2**	**-**	**-**	**15**	**35**	**50**
Examination Duration:			**Theory**: 3 Hrs				**Practical**: 6 Hrs (Two sessions)				
Course Objectives			1. Define and use group theory concepts, symmetry elements, and point groups to analyse molecular symmetry. 2. Examine formation constants, stability factors, and the chelate effect in metal-ligand complexes. 3. Study substitution reactions in octahedral complexes and theories of the trans effect. 4. Apply VSEPR theory, Walsh diagrams, and bonding rules to predict molecular shapes and bonding. 5. Understand crystal field theory, its limitations, and molecular orbital theory for various metal-ligand complexes. 6. Conduct qualitative analysis and prepare inorganic compounds for spectroscopic studies.								
Course Outcomes:			After the completion of this course, the students will be able to: 1. Use group theory and character tables to describe molecular symmetry and predict optical activity. 2. Calculate and interpret metal-ligand formation constants and the chelate effect. 3. Describe and predict mechanisms of substitution reactions and the trans effect in metal complexes. 4. Predict molecular shapes and bonding using VSEPR theory and Walsh diagrams. 5. Explain bonding in metal-ligand complexes using crystal field and molecular orbital theories. 6. Perform qualitative analysis and synthesize inorganic compounds for spectroscopic analysis.								
COURSE SYLLABUS											
Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus. 2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks. 3. The question paper must be set in consonance with course outcomes.											
Unit No.			**Contents**								**Contact Hrs**
I			**Symmetry and Group Theory in Chemistry** Definitions of group, subgroup, relation between orders of finite groups and its subgroups. Conjugacy relation and classes. Symmetry								**12**

	elements and symmetry operations, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations. The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C_{2v}, C_{3v} and D_{2h} Character tables and their use. Molecular asymmetry, dissymmetry, and optical activity.	
II	**Metal-Ligand Equilibria in Solution-I** Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.	**11**
III	**Metal-Ligand Equilibria in Solution-II** Substitution reactions in octahedral complexes-acid hydrolysis, Base hydrolysis, racemization of tris chelate complexes, theories of trans effect with respect to Pt(II) complexes. Brief account of electron transfer reactions, inert and labile complexes.	**11**
IV	**Stereochemistry and Bonding in Main Group Compounds** VSEPR Theory, Walsh diagrams (tri-atomic molecules), d_π-p_π bonds, Bent rule and energetics of hybridization **Metal-Ligand Bonding** Crystal field theory and its limitation, Crystal field effects, Jahn Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π-bonding).	**11**
Practical Syllabus		**4**

Qualitative Analysis

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.

Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe-Mg, Fe-Ni etc.

1. Preparations:

Preparation of the following inorganic compounds and their spectroscopic studies.

I. $Hg[Co(SCN)_4]$
II. $[Cu(NH_3)_4]SO_4.H_2O$
III. Prussian Blue and Turnbull's Blue
IV. $Na[Cr(NH_3)_2(SCN)_4]$
V. $Mn(acac)_3$
VI. $[Ni(NH_3)_6]Cl_2$
VII. $VO(acac)_2$

All the students must submit the recrystallized product along with m.p. for all the stages of preparation.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:	1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley. 2. Inorganic Chemistry, J.E. Huheey, Harper & Row. 3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.

<table>
<tr><td></td><td colspan="2">4. Inorganic Chemistry: Principles of Structure and Reactivity; J.E. Huheey, E.A. Keiter, and R.L. Keiter (Indian Edition)
5. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
6. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons.
7. Inorganic Chemistry, A Modern Introduction; T. Moeller, John Wiley and Sons.</td></tr>
<tr><td>Practical</td><td colspan="2">1. A Text Book of Macro and Semi-micro quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel’s Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.</td></tr>
<tr><td></td><td colspan="2">Assessment and Evaluation</td></tr>
<tr><td rowspan="2">Theory</td><td>Internal Assessment: 25 Marks</td><td>• Class Participation: 05 Marks
• Seminar/Presentation/ Assignment: 05 Marks
• Mid Term Exam: 15 Marks</td></tr>
<tr><td>External Assessment: 50 Marks
(03 Hours)</td><td>• End Term Exam: 50 Marks</td></tr>
<tr><td rowspan="2">Practical</td><td>Internal Assessment: 15 Marks</td><td>• Class Participation: 05 Marks
• Seminar/Lab record: 10 Marks</td></tr>
<tr><td>External Assessment: 35 Marks</td><td>• End Term Practical Exam: 20 Marks
• Lab record: 05 Marks
• Viva Voce: 10 Marks</td></tr>
</table>

Course Code CC-A02			Course Title Physical Chemistry-I				Course ID 241/CHE/CC/102				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		4			2	2	-	-	15	35	50
Examination Duration:			**Theory**: 3 Hrs				**Practical**: 6 Hrs (Two sessions)				

Course Objectives	1. Understand the foundational principles of quantum mechanics. 2. Explore the historical development and key experiments of quantum mechanics. 3. Solve the Schrödinger equation for various simple systems. 4. Apply quantum mechanical principles to the hydrogen atom and atomic orbitals. 5. Utilize perturbation theory for analyzing quantum systems. 6. Implement approximate methods in solving quantum mechanical problems. 7. Conduct practical experiments to reinforce theoretical concepts in Physical Chemistry.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Explain the historical experiments that led to the development of quantum mechanics. 2. Solve the Schrödinger equation for particles in one-dimensional and three-dimensional boxes. 3. Analyze the quantum mechanical behavior of the harmonic oscillator and rigid rotor. 4. Apply perturbation theory to solve problems involving simple quantum systems. 5. Utilize the variational principle to approximate solutions for complex systems. 6. Perform practical experiments on viscosity, conductometry, chemical kinetics, and adsorption. 7. Interpret experimental data and verify theoretical predictions in quantum mechanics.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs

I	**Basic Principles of Quantum Mechanics** Introduction to Quantum Mechanics, Historical background of quantum mechanics, Blackbody radiation and Planck's hypothesis, Photoelectric effect and Einstein's explanation, Compton effect, De Broglie hypothesis and matter waves, Heisenberg uncertainty principle, Wave-particle duality, Introduction to wave functions, Schrödinger equation: Time-dependent and time-independent forms, Interpretation of wave functions: Probability density and normalization	11
II	**Quantum Mechanics of Simple Systems** Particle in a one-dimensional box: Derivation and interpretation, Particle in a three-dimensional box, Harmonic oscillator: Schrödinger equation and solutions, Quantum mechanical treatment of the rigid rotor, Hydrogen atom: Schrödinger equation and solutions, Quantum numbers and their significance, Shapes of atomic orbitals, Spin angular momentum, Quantum mechanical tunnelling.	12
III	**Applications of Quantum Mechanics** Perturbation theory: Time-independent perturbation theory (first and second order), Applications of perturbation theory to simple systems, Quantum mechanical treatment of the helium atom, Time-dependent perturbation theory, Stark effect, Zeeman effect, Advanced perturbation techniques, Applications in molecular systems.	
IV	**Approximate Methods in Quantum Mechanics** Variational principle: Concept and applications, Perturbation theory: Time-independent perturbation theory (first and second order), Applications of perturbation theory to simple systems, Quantum mechanical treatment of the helium atom.	11
Practical Syllabus		**4**

Viscosity

[1] Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.

[2] Determination of molar mass of a polymer.

Conductometry

[3] Determine the strength of strong acid by conductometric titration with strong base.

[4] Determine the strength of weak acid by conductometric titration with strong base.

[5] Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.

[6] Study precipitation titration between KCl and AgNO3conductometrically. Determine the strength of given solution of AgNO3.

[7] Determine solubility and solubility product of sparingly soluble salts like PbSO4, BaSO4.

[8] Determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements.

Chemical Kinetics

[9] Study the hydrolysis of methyl acetate in presence of hydrochloric acid.

[10] Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.

Adsorption and others

[11] Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/oxalic acid on activated charcoal.

[12] Determination of critical solution temperature of phenol-water system.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

<table>
<tr><th colspan="3">Suggested Books</th></tr>
<tr><td>Theory</td><td colspan="2">1. Introduction to Quantum Mechanics by David J. Griffiths, 2nd Edition, Pearson
2. Principles of Quantum Mechanics by R. Shankar, 2nd Edition, Springer
3. Quantum Chemistry by Ira N. Levine, 7th Edition, Pearson
4. Molecular Quantum Mechanics by P.W. Atkins and R.S. Friedman, 5th Edition, Oxford University Press
5. Quantum Chemistry by Donald A. McQuarrie, 1st Edition, University Science Books
6. Quantum Chemistry by R.K. Prasad, 4th Edition, New Age International Publishers</td></tr>
<tr><td>Practical</td><td colspan="2">1. Advanced Practical Physical Chemistry by J.B. Yadav, 20th Edition, Goel Publishing House
2. Experiments in Physical Chemistry by Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th Edition, McGraw-Hill Education
3. Experimental Physical Chemistry by Farrington Daniels and J.H. Mathews, 7th Edition, McGraw-Hill Education
4. Practical Physical Chemistry by Alexander Findlay, 9th Edition, Longmans, Green and Co.
5. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 6th Edition, Pearson
6. Experimental Physical Chemistry by Arthur M. Halpern and George C. McBane, 3rd Edition, W.H. Freeman and Company</td></tr>
<tr><td></td><td colspan="2">Assessment and Evaluation</td></tr>
<tr><td rowspan="2">Theory</td><td>Internal Assessment: 25 Marks</td><td>• Class Participation: 05 Marks
• Seminar/Presentation/ Assignment: 05 Marks
• Mid Term Exam: 15 Marks</td></tr>
<tr><td>External Assessment: 50 Marks
(03 Hours)</td><td>• End Term Exam: 50 Marks</td></tr>
</table>

Practical	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Lab record: 10 Marks
	External Assessment: 35 Marks	• End Term Practical Exam: 20 Marks • Lab record: 05 Marks • Viva Voce: 10 Marks

<table>
<tr><td colspan="3">Course Code
CC-A03</td><td colspan="6">Course Title
Organic Chemistry-I</td><td colspan="5">Course ID
241/CHE/CC/103</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total Credits</td><td colspan="5">MARKS</td></tr>
<tr><td colspan="3">(Hrs)</td><td colspan="3">Credits</td><td>TI</td><td>TE</td><td>PI</td><td>PE</td><td>Total</td></tr>
<tr><td>3</td><td></td><td></td><td>3</td><td></td><td></td><td>3</td><td>25</td><td>50</td><td>-</td><td>-</td><td>75</td></tr>
<tr><td></td><td></td><td>4</td><td></td><td></td><td>2</td><td>2</td><td>-</td><td>-</td><td>15</td><td>35</td><td>50</td></tr>
<tr><td colspan="3">Examination Duration:</td><td colspan="6">Theory: 3 Hrs</td><td colspan="5">Practical: 6 Hrs (Two sessions)</td></tr>
<tr><td colspan="3">Course Objectives</td><td colspan="8">1. To understand the principles of reaction mechanisms in organic chemistry, focusing on the influence of structure, thermodynamic and kinetic requirements, and the behaviour of intermediates.
2. To provide a comprehensive understanding of the mechanisms, stereochemistry, and factors influencing nucleophilic aliphatic substitution and elimination reactions.
3. To provide a foundational understanding of stereochemistry, focusing on nomenclature, conformational analysis, and chirality in various organic systems.
4. To provide an advanced understanding of stereochemistry concepts, including topicity, stereospecific and stereoselective reactions, and the stereochemistry of sugars and decalins.
5. To equip students with hands-on experience in essential laboratory techniques, including crystallization, distillation, solvent extraction, and chromatography.
6. To provide practical exposure to key organic synthesis reactions, enabling students to prepare, purify, and characterize important organic compounds.</td></tr>
<tr><td colspan="3">Course Outcomes:</td><td colspan="8">After the completion of this course, the students will be able to:
1. Analyse and predict reaction mechanisms using theoretical concepts; determine the stability and reactivity of intermediates.
2. Able to analyse and explain the detailed mechanisms of SN^1, SN^2, E1, and E2 reactions, including the effects of nucleophiles, solvents, and substituents on reactivity and stereochemistry.
3. Able to analyse and interpret the stereochemical properties and configurations of organic molecules, including simple, cyclic, and acyclic systems.
4. Accurately analyse and determine the stereochemistry of complex molecules, including sugars and decalins, using concepts like chirogenicity and pseudoasymmetry.
5. Proficiently perform crystallization, distillation, solvent extraction, and chromatography, demonstrating accurate execution and understanding.
6. Successfully synthesize, purify, and characterize organic compounds, submitting recrystallized products along with their melting points for all stages of preparation.</td></tr>
<tr><td colspan="11">COURSE SYLLABUS</td></tr>
<tr><td colspan="11">Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.</td></tr>
</table>

2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Reaction Mechanism: Structure and Reactivity** Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.	**11**
II	**Mechanism of Nucleophilic Aliphatic Substitution** The limiting cases SN^1 and SN^2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, competition between nucleophilicity and basicity, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution. SN^i, $SN^{1'}$, $SN^{2'}$ and $SN^{i'}$ mechanisms. **Mechanism of Elimination Reactions** The El, ElcB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Pyrolytic eliminations.	**12**
III	**Stereochemistry-I** Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes.	**11**
IV	**Stereochemistry-II** Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule. Stereochemistry of sugars-C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins,	**11**
Practical Syllabus		**4**

ISOLATION AND PURIFICATION TECHNIQUES

Laboratory Safety
Crystallization, recrystallization and sublimation
Distillation: Simple, Steam and Vacuum
Solvent Extraction
Drying of ethanol/ acetone/ diethylether/THF
Paper Chromatography
Thin Layer Chromatography

Two-step Preparation of some important organic compounds involving the reactions out of the followings representative reactions)

1. Acetylation (Synthesis of Aspirin, Paracetamol)
2. Esterification and saponification
3. Oxidation
4. Reduction or Hydrogenation
5. Partial Reduction
6. Nucleophilic substitution
7. Aromatic electrophilic substitution reaction
8. Condensation reactions
9. Hoffman's Bromamide reaction
10. Heterocyclic synthesis
11. Any other reaction as per requirement

All the students must submit the recrystallized product along with m.p. for all the stages of preparation.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:	1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley. 2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum. 3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. 4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press. 5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall. 6. Modern Organic Reactions, H. O. House, Benjamin. 7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional. 8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan. 9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International. 10. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International. 11. Stereochemistry of Organic compounds, E.L. Eliel, Mc Graw Hills, 1962.
Practical	1. A Hand book of Organic Analysis-Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975. 2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhenet. al., Longman-Group Ltd. 3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959. 4. Elementary Practical Organic Chemistry by Arthur I. Vogel, EX CBS Publishers and Distributors.

	5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955. 6. College Practical Chemistry by V. K. Ahluwalia, S. Dhingra and A. Gulati.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Lab record: 10 Marks
	External Assessment: 35 Marks	• End Term Practical Exam: 20 Marks • Lab record: 05 Marks • Viva Voce: 10 Marks

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

Course Code DSE-01A			Course Title Chemistry of Life Sciences				Course ID 241/CHE/DS/101		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
2	-	-	2	-	-	2	15	35	50
Examination Duration:							3 Hrs		
Course Objectives	1. To provide a comprehensive understanding of the structure and biological functions of carbohydrates, emphasizing their roles in biological recognition and physiological processes. 2. To equip the students with complete understanding of cell structure, and lipid biochemistry, focusing on the functions of intracellular organelles and key metabolic pathways. 3. To understand the structure, hydrolysis, sequencing, and secondary structure of amino acids, peptides, and proteins, along with the principles of protein denaturation. 4. To understand the structure, hydrolysis, sequencing, and secondary structure of amino acids, peptides, and proteins, along with the principles of protein denaturation.								
Course Outcomes:	After the completion of this course, the students will be able to: 1. Describe the structures and functions of important carbohydrates and glycoconjugates and explain their significance in biological systems and cellular recognition. 2. Demonstrate knowledge of cell structures and their functions, as well as an understanding of metabolic pathways and lipid biochemistry, including carbohydrate metabolism and lipid aggregates. 3. Able to analyse protein structure and sequence using methods like Sanger and Edman degradation and explain protein denaturation. 4. Demonstrate the ability to analyse protein structure and sequence using methods like Sanger and Edman degradation and explain protein denaturation.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Carbohydrates** Structure and biological functions of important monosachharides (excluding detailed conformational analysis) and derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-*N*-acetylmuramic acid and sialic acid. Disaccharides- sucrose, lactose and maltose. Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen).	**12**

	Heteropolysaccharides-glucosaminoglycans/mucopolysaccharides. Glycoconjugates-glyco proteins and glycolipids.	
II	**Cell Structure and Metabolism** Intracellular organelles and their functions. Overview of metabolic processes-catabolism and anabolism. ATP - the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle. **Lipids** Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids. Lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism-β-oxidation of fatty acids.	**11**
III	**Amino-acids, Peptides and Protein** Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides, Sanger method and Edman degradation method for amino acid sequencing. Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins. Denaturation of Proteins.	**11**
IV	**Nucleic Acids and Genetic Code** Structure and functions of nucleotides, nucleosides, DNA (Watson-Crick model, Chargaff's rules) and RNA (m RNA, r-RNA and t-RNA). Genetic code and its characteristics, codon-anticodon pairing (Wobble hypothesis). **Replication, Transcription and Translation (Prokaryotes only)** Replication of DNA: Maselson-Stahl experiment, mechanism of replication (Initiation, Elongation and Termination). Transcription: Promoters site, Initiation, Elongation, Termination. Translation: Activation of amino acids, Initiation, Elongation, Termination.	**11**
Suggested Books	1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers. 2. Biochemistry, L.Stryer, W.H.Freeman. 3. Biochemistry, J. David Rawn, Neil Patterson. 4. Biochemistry, Voet and Voet, John Wiley. 5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.	
Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 05 Marks
	External Assessment: 35 Marks (03 Hours)	• End Term Exam: 35 Marks

Course Code DSE-01B			Course Title Mathematics for Chemists				Course ID 241/CHE/DS/102		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
2	-	-	2	-	-	2	15	35	50
Examination Duration:							3 Hrs		

Course Objectives	1. To provide students with a fundamental understanding of vector mathematics and its applications in spectroscopy and quantum chemistry. 2. To provide a fundamental understanding of matrices and determinants, and their application in solving linear equations and problems in chemistry. 3. To understand and apply logarithms and graphical methods for solving chemical problems and analysing data with precision. 4. To provide students with a comprehensive understanding of algebraic, trigonometric, differential, and integral calculus concepts and their applications in solving chemical problems.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Demonstrate proficiency in performing vector operations, including addition, subtraction, multiplication, and differentiation, and apply these concepts to problems in spectroscopy and quantum chemistry. 2. Able to perform matrix operations and use determinants to solve linear equations, applying these concepts to relevant chemical problems. 3. Proficiently use logarithms and graphical techniques to solve chemical problems and analyse experimental data. 4. Able to apply calculus techniques to analyse and solve mathematical problems in chemistry, demonstrating proficiency in differentiation, integration, and differential equations.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Vectors** Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product, concept of normalization, orthogonality and complete set of unit vectors. Illustration of applications to spectroscopy and quantum chemistry.	11
II	**Matrices and Determinants**	11

	Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition of determinant, properties of determinants, evaluation of determinants. Illustration or applications to group theory, problems in chemistry.	
III	**Logarithm** Need for logarithm in chemistry. Theory and application of logarithms for solving general and chemical problems. **Graphical Representation of Equations** Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines, points of intersection, distance between two points, change of origin. Examples from problems in chemistry, curve fitting for least squares method. Data analysis, mean and standard deviation, Absolute and Relative errors	**11**
IV	**Elements of Algebraic and Trigonometric Functions** The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities, polar coordinates in trigonometric functions. **Differential Calculus** Theory, graphical significance of differentiation, rules of differentiation, Algebraic simplification, Partial differentiation, Exact and inexact differential with their application to thermodynamic principles. **Integral Calculus** Integral theory, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, integration between limits, curve sketching, integral as area, , Illustration of application in chemistry. **Differential Equation** Simple differential equations, separable variables, homogeneous equations, exact differential equations, linear differential equations, partial differential equations, application to physico-chemical problems.	**12**
Suggested Books	1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill. 2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company. 3. Mathematical Methods for Science Students, G. Stephemen, ELBS. 4. Chemical Thermodynamics, R.C. Reid.	
Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 05 Marks
	External Assessment: 35 Marks (03 Hours)	• End Term Exam: 35 Marks