Annexure – A

Chaudhary Ranbir Singh University, Jind

(Established by the State Legislature Act-28 of 2014)

Scheme and Syllabus of Examination
for
Post Graduate Programme

M.Sc (Chemistry)

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF
With effect from the session 2024-25 (in phased manner)

DEPARTMENT OF CHEMISTRY
FACULTY OF PHYSICAL SCIENCES

CHAUDHARY RANBIR SINGH UNIVERSITY, JIND -126102

HARYANA, INDIA

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Table-1

Course composition- Theory/ Theory +Tutorial

Course Credit	Internal Assessment marks	End term exam marks	Total marks
2	15	35	50
4	30	70	100

Table-2: Course composition- Theory + Practical

Course Credit	Theory		Practical		Total marks
Theory +Practical	Internal Assessment marks	End term exam marks	Internal Assessment marks	End term exam marks	
1+1	10	20	5	15	50
2+0	15	35	-	-	50
3+0	25	50	-	-	75
0+3	-	-	25	50	75
3+1	20	50	10	20	100
4+0	30	70	-	-	100
0+4	NA	NA	30	70	100

Table- 3

Total Internal Assessment Marks (Theory)	Class Participation	Seminar/Presentation/Assignment/Quiz/class test, etc.	Mid-Term Exam
10	4	0	6
15	4	4	-
20	5	5	10
25	5	10	10
30	5	10	15

Table -4

Total Internal Assessment Marks (Practicum)	Class Participation	Seminar/Demonstration/Viva-Voce/Lab record, etc.	Mid-Term Exam
5	0	5	0
10	5	5	0
25	5	10	10
30	5	10	15

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Chaudhary Ranbir Singh University, Jind

Scheme of Examination for Postgraduate Programme 2024-25
as per NEP 2020 Curriculum and Credit Framework for Postgraduate Programmes
(CBCS-LOCF) with effect from the session 2024-25 (in phased manner)
Framework-2
Scheme-P

Semester	Course Type	Course Code	Nomenclature of course	Theory (T)/ Practical (P)	Credits		Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Examination hours
						Total	L	T	P	Total				
1	CC-1	M24-CHE-101	Inorganic Chemistry- I	T	4	26	4	0	0	4	30	70	100	3
	CC-2	M24-CHE-102	Physical Chemistry - I	T	4		4	0	0	4	30	70	100	3
	CC-3	M24-CHE-103	Organic Chemistry- I	T	4		4	0	0	4	30	70	100	3
	CC-4	M24-CHE-104	General Spectroscopy	T	3		3	0	0	3	25	50	75	3
	PC-1	M24-CHE-105	Inorganic Chemistry Practical- I	P	3		0	0	6	6	25	50	75	6
	PC-2	M24-CHE-106	Physical Chemistry Practical- I	P	3		0	0	6	6	25	50	75	6
	PC-3	M24-CHE-107	Organic Chemistry Practical- I	P	3		0	0	6	6	25	50	75	6
	SEMINAR	M24-CHE-108	Seminar	S	2		0	0	0	2	0	50	50	

	CC-5	M24-CHE-201	**Inorganic Chemistry- II**	T	4	26	4	0	0	4	30	70	100	3
	CC-6	M24-CHE-202	**Physical Chemistry- II**	T	4		4	0	0	4	30	70	100	3
	CC-7	M24-CHE-203	**Organic Chemistry- II**	T	4		4	0	0	4	30	70	100	3
	CC-8	M24-CHE-204	**Green & Sustainable Chemistry**	T	3		3	0	0	3	25	50	75	3
2	PC-4	M24-CHE-205	**Inorganic Chemistry Practical-II**	P	3		0	0	6	6	30	70	75	6
	PC-5	M24-CHE-206	**Physical Chemistry practical- II**	P	3		0	0	6	6	30	70	75	6
	PC-6	M24-CHE-207	**Organic Chemistry Practical –II**	P	3		0	0	8	8	30	70	75	6
	CHM	M24-CHM-201	**Constitutional, Human and Moral values and IPR**	T	2		2	0	0	2	15	35	50	3
	Internship	M24-INT-200	An internship course of 4 Credits of 4-6 weeks duration during summer vacation after IInd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.								50	50	100	
	CC-9	M24-CHE-301	**Techniques in Chemistry**	T	4	26	4	0	0	4	30	70	100	3
	DEC-1	M24-CHE-302	**Inorganic Chemistry Special-I**	T	4		4	0	0	4	30	70	100	3
3		M24-CHE-303	**Physical Chemistry Special-I**	T	4		4	0	0	4	30	70	100	3
		M24-CHE-304	**Organic Chemistry Special- I**	T	4		4	0	0	4	30	70	100	3
	DEC-2	M24-CHE-305	**Inorganic Chemistry Special-II**	T	4		4	0	0	4	30	70	100	3

		M24-CHE-306	**Physical Chemistry Special-II**	T	4		4	0	0	4	30	70	100	3
		M24-CHE-307	**Organic Chemistry Special- II**	T	4		4	0	0	4	30	70	100	3
	PC-7	M24-CHE-308	**Inorganic Chemistry Special Practical- I**	P	4		0	0	8	8	30	70	100	4
		M24-CHE-309	**Physical Chemistry Special Practical- I**	P	4		0	0	8	8	30	70	100	4
		M24-CHE-310	**Organic Chemistry Special Practical- I**	P	4		0	0	8	8	30	70	100	4
	PC-8	M24-CHE-311	**Inorganic Chemistry Special Practical- II**	P	4		0	0	8	8	30	70	100	4
		M24-CHE-312	**Physical Chemistry Special Practical- II**	P	4		0	0	8	8	30	70	100	4
		M24-CHE-313	**Organic Chemistry Special Practical- II**	P	4		0	0	8	8	30	70	100	4
	OEC	M24-OEC-301	**Environmental Chemistry-I**	T	2		2	0	0	2	15	35	50	3
							OR							
	Dissertation/Project work	M24-CHE-PRO	**Project work**	D	12		0	0	0	12	0	300	300	
	OEC	M24-OEC-301	**Environmental Chemistry-I**	T	2		2	0	0	2	15	35	50	3
4	CC-10	M24-CHE-401	**Polymer Chemistry**	T	4	26	4	0	0	4	30	70	100	3

DEC-3	M24-CHE-402	**Inorganic Chemistry Special-III**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-403	**Physical Chemistry Special-III**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-404	**Organic Chemistry Special-III**	T	4	4	0	0	4	30	70	100	3
DEC-4	M24-CHE-405	**Inorganic Chemistry Special-IV**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-406	**Physical Chemistry Special-IV**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-407	**Organic Chemistry Special- IV**	T	4	4	0	0	4	30	70	100	3
DEC-5	M24-CHE-408	**Inorganic Chemistry Special-V**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-409	**Physical Chemistry Special-V**	T	4	4	0	0	4	30	70	100	3
	M24-CHE-410	**Organic Chemistry Special-V**	T	4	4	0	0	4	30	70	100	3
PC-9	M24-CHE-411	**Inorganic Chemistry Special Practical- III**	P	4	0	0	8	8	30	70	100	4
	M24-CHE-412	**Physical Chemistry Special Practical- III:**	P	4	0	0	8	8	30	70	100	4
	M24-CHE-413	**Organic Chemistry Special Practical- III**	P	4	0	0	8	8	30	70	100	4
PC-10	M24-CHE-414	**Inorganic Chemistry Special Practical- IV**	P	4	0	0	8	8	30	70	100	4
	M24-CHE-415	**Physical Chemistry Special Practical- IV**	P	4	0	0	8	8	30	70	100	4

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		M24-CHE-416	Organic Chemistry Special Practical- IV	P	4	0	0	8	8	30	70	100	4
	EEC	M24-EEC-401	Skills in Chemistry	T	1	2	0	0	2	10	20	30	1
				P	1	0	0	0	2	5	15	20	2

N.B.

i) For seminar, the group size will be 10-15.

ii) In the third semester of the course, students will be provided with the option to opt among practical and project work.

iii) The department will announce the number of available seats for opting for project work at the end of the first semester, taking into account the availability of eligible faculty (regular or contractual).

iv) The department will assign project supervisors to students based on their performance in the first semester of the course. The results of the first semester will be considered if the number of students opting for projects exceeds the available seats.

v) An Assistant Professor, Associate Professor and Professor can supervise a maximum of four, six and eight students, respectively.

The Guidelines for project work will be decided in the next meeting of PGBOS.

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Guidelines for the Seminar, M.Sc. 1st Semester, session 2024-25

Committee of two-three members from the department may be constituted for assessment of seminars prepared by the students of M.Sc. 1st year in guidance of faculty assigned to respective group. Other interested faculty of the department are also welcome if they want to attend the Presentation.

Guidelines for the assigned faculty:

- The list of the students along with seminar topics be submitted in the office of the department within 10 days after the starting of academic session.
- Different topics should be assigned to every student of the group.
- The topics will then be assessed by the assessment committee constituted by the Chairperson. If any changes with respect to topic the same must be intimated to the concerned faculty within three days.
- After approval. the students with the help of assigned faculty will prepare the presentation.
- Faculty is directed to maintain and submit the progress report of the seminar every two weeks.
- Presentations will start after 1 month after the approval of seminar topics.
- Assigned faculty are directed to prepare a schedule (with name. roll no. topic and. date) for the presentations of the students in their allotted lecture as per timetable and submit in the office of the department. The final schedule will be displayed on the notice board of the department.

Guidelines for the presenter:

- Only Power Point presentation will be accepted.
- Content of the presentation should be relevant. clear. must showcase in-depth knowledge of the topic.
- Every week a presentation should be prepared and presented before the department committee.
- Students are directed to submitted a hard copy of the report on seminar topic at the time of their presentation.
- Presentations will start after 1 month of the approval of seminar topics.
- Time of 30 minutes will be given to each student for presentation.

Reviewing committee may assess the seminar based on following points:

- **Content Evaluation:** The content of the presentation should be relevant, organized, and discussed in depth.
- **Presenter Evaluation:** Presentation skills of the students will be evaluated on basis of delivery style and clarity.
- **Suggestions for Improvement:** Provide constructive feedback on what could be improved for future seminars. Committee may offer specific suggestions regarding content, and presentation style.

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Annexure – B

Session: 2024-25	
Part A - Introduction	
Name of Programme	M.Sc (Chemistry)
Semester	1st
Name of the Course	Inorganic Chemistry- I
Course Code	M24-CHE-101
Course Type	CC
Level of the course	400-499
Pre-requisite for the course (if any)	
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1. Analyze the formation and stability of metal-ligand complexes in different solvents. CLO 2. Describe the importance of chelating ligands in increasing the stability of complexes. CLO 3. Discuss examples of chelates and their applications in various fields. CLO 4. Explain the mechanisms involved in the formation and transformation of transition metal complexes. CLO 5. Apply kinetic analysis to understand reaction rates and mechanisms CLO 6. Describe the chemistry of allotropes of carbon and important compounds belonging to nitrogen and phosphorous group. CLO 7. Examine the role of transition metals in catalysis, both in industrial processes and biological systems.

Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

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Unit	Topics	Contact Hours
I	**Metal-Ligand Equilibria in solution** Stability of complexes: thermodynamic stability – stepwise and overall stability constants, their relationships, factors affecting the stability of the complexes, HSAB approach , chelate effect, importance of chelates. Macrocyclic ligands; types; schiff bases; crown ethers; cryptands; Chelating agents; types of EDTA titrations; direct and back titrations; replacement titrations; masking and demasking reagents. Determination of stability constants by spectrophotometric, polarographic and potentiometric methods which include Job's method of continuous variation, Logarithmic method, Bent and French mole ratio method	15
II	**Reaction Mechanism of Transition Metal Complexes-I** Basic principles of lability and Inertness, Mechanisms for ligand replacement reactions, Formation of complexes from aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, Base hydrolysis, electrophilic attack on ligands. **Reaction Mechanism of Transition Metal Complexes-II** Mechanism of ligand, displacement reactions in square planar complexes, the trans effect, theories of trans effect, mechanism of electron transfer reactions – types; outer sphere electron transfer mechanism and inner sphere electron transfer mechanism, electron exchange.	15
III	**Group chemistry** Carbon and silicon: fullerenes, nanotubes, graphene, silicates, aluminosilicates zeolites and their applications, shape selective catalysis General nitrogen chemistry, nitrogen oxides, Nitrogen compound applications in fertilizers, Ammonia, Haber Bosch Process. General phosphorus chemistry, Phosphorus based fertilizers, pesticides, cyclophosphazanes and cyclophosphazenes, synthesis and applications, Frustrated Lewis acid base pairs and applications.	15
IV	**Catalysis and Bio-inorganic Chemistry** Transition metal ion catalysts for organic transformations and their application in hydrogenation. Wilkinson's catalysis, Asymmetric	15

	hydrogenation, Hydroformylation or oxo process, Wacker's Process, Monsanto Acetic acid process, Cativa process. Alkenes metathesis, Alkyne metathesis, Alkene polymerization, Water-Gas reaction. Role of metal ions in biological systems.	
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
	30	➢ **Theory:**	70
➢ **Theory**	5	Written Examination	
• Class Participation:	10		
• Seminar/presentation/assignment/quiz/class test etc.:	15		
• Mid-Term Exam:			

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. J.D. Lee: Concise Inorganic Chemistry, Oxford University Press Publication, 5th edition (2008).
2. G.L. Miesseler and D.A. Tarr: Inorganic Chemistry, Prentice Hall; 3rd edition (2003).
3. H.J. Emeleus & A.G. Sharpe: Modern aspects of inorganic chemistry, Routledge & Kegan Paul Publication (1973).
4. B.N. Figgis: Introduction to ligand field, John Wiley & Sons Publication (1966).
5. R.H. Crabetree: The Organometallic Chemistry of the Transition Metals, Wiley-Blackwell publication, 6th edition (2014).
6. A.J. Elias, B.D. Gupta: Basic Organometallic Chemistry: Concepts, Syntheses, and Applications of Transition Metals CRC Press, 1st edition (2010).
7. D.A. Skoog, Principles of Instrumental methods of Analysis, Brooks/Cole 7th Edition (2017)
8. Willard Merrit, Dean and Settle, Instrumental methods of Analysis, CBS Publication, 7th Edition (2004).

Further Readings:

1. J.E. Huheey: Inorganic Chemistry: Principles of Structure &reactivity, Pearson publication, 4th edition (1997).
2. O.P. Aggarwal: Chemical bonding, Dhanpat Rai & Co (P) Ltd, 5th edition(2003).
3. Basolo Pearson: Inorganic Reaction Mechanism, John Wiley & Sons Publication, 2nd edition (1967).
4. M.N. Hughes: The inorganic chemistry of biological processes, Wiley Publication, 2nd edition (1981).
5. C. Masters: Homogeneous transition metal catalysis, Springer Publication(1981).
6. I. Bertini , Harry B. Gray, Stephen J. Lippard, Joan S. Valentine: Bioinorganic Chemistry,University Science Books, U.S. (1994).

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. (Chemistry)		
Semester	1st		
Name of the Course	Physical Chemistry- I		
Course Code	M24-CHE-102		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Formulate rate laws for opposing reactions involving first-order and second-order kinetics. CLO 2) Explain the basic principles of collision theory, critically analyze the limitations of collision theory, particularly in explaining complex reactions and deviations from ideal behavior. CLO 3) Understand the role of sphere models in explaining the reaction rates. CLO 4) Understand the general mechanisms underlying chain reactions (thermal and photochemical) with some examples CLO 5) Derive and understand the Michaelis-Menten equation for enzyme kinetics. CLO 6) Understand the implications of first and second Law of Thermodynamics through the use of entropy, free energy. CLO 7) Understand the basic principles of the Debye-Hückel theory for ion-ion interactions and the effect of various parameters on the properties . CLO 8) Describe the extension of the Debye-Hückel theory to account for the transport properties of ions.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the			

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compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Chemical Dynamics-I** Effect of temperature on reaction rates, Rate law for opposing reactions of 1st and 2nd order, Rate law for consecutive & parallel reactions of 1st order reactions, Collision theory of reaction rates and its limitations, steric factor, Activated complex theory, Ionic reactions: single and double sphere models, influence of solvent and ionic strength, the comparison of collision and activated complex theory.	15
II	**Chemical Dynamics – II** Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen -chlorine reactions). General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - bromine reactions), apparent activation energy of chain reactions, chain length, Rice-Herzfeld mechanism of organic molecules decomposition (acetaldehyde) Branching chain reactions and explosions (H_2 - O_2 reaction). Kinetics of (one intermediate) enzymatic reaction: Michaelis - Menten treatment, evaluation of Michaeli's constant for enzyme - substrate binding by Lineweaver - Burk plot and Eadie- Hofstee methods. Competitive and non-competitive inhibition.	15
III	**Thermodynamics-I** Brief overview of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes, variation of entropy with temperature . pressure and volume. entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; free energy, enthalpy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume, heat concept), Gibb's-Duhem equation. Clausius –Clapeyron equation; law of mass action and its thermodynamic derivation.	15
IV	**Electrochemistry-I** Ion - Ion Interactions: The Debye - Huckel theory of ion - ion	15

	interactions; potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye - Huckel limiting law of activity coefficients and its limitations, ion-size effect on potential, ion -size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions. Debye - Huckel -Onsager treatment for aqueous solutions and its limitations.	
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
	30	➢ **Theory:**	**70**
➢ **Theory**		Written Examination	
• Class Participation:	5		
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. K.J. Laidler: Chemical Kinetics, Pearson Publication, 3rd edition (2003).
2. W. Moore & G.Pearson: Kinetics & Mechanism, Wiley, 3rd edition (1981).
3. S. Glasstone: Thermodynamics for chemists, Macmillan Publisher 2nd edition (2008).
4. J.O.M. Bockris and A.K.N. Reddy: Modern electrochemistry Vol.1: Ionics, 2nd edition (1998).
5. Peter Atkins, Julio De Paula, James Keeler, Atkin's Physical chemistry, Oxford University Press; 11th edition (2018).
6. H. Eyring, M. Eyring: Modern chemical kinetics, Reinhold Publishing Corp., New York, New Impression Edition (1963).
7. F. Daniels and R.A. Alberty: Physical Chemistry, John Wiley and Sons, Inc. (1987).

Further Readings:

1. K.J. Laidler, H.Eyring & S. Glasstone: The theory of Rate processes, McGraw-Hill, New York (1941).
2. G.M. Barrow: Physical Chemistry Mcgraw Hill education, 5th edition (2006).
3. R.C. Srivastava, S.K. Saha & A.K. Jain: Thermodynamics: A core Course, Prentice Hall India Learning Private Limited; 3rd edition (2007).
4. S. Glasstone: Theoretical Chemistry, Van Nostrand Reinhold Inc.,U.S. (1944).
5. R. Puri, S. Pathania, R. Sharma: Principles of Physical Chemistry, Vishal Publishing Co. (2019).
6. D.R. Crow: Principles and Applications of Electrochemistry, Chapman and Hall, London, 4th edition (1994).

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. (Chemistry)		
Semester	1st		
Name of the Course	Organic Chemistry- I		
Course Code	M24-CHE-103		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Gain knowledge of interconversion of stereoisomers CLO 2: Understand the configurational and conformational analysis CLO 3: Know about stereo selective/asymmetric synthesis of chiral compounds CLO 4: Aware about aromaticity in organic compounds CLO 5: Know about the generation and stability of carbocation, carbanion, carbenes and nitrenes. CLO 6: Understand the synthesis and chemical properties of free radicals		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**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 of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. elementary	15

	ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.	
II	**Stereochemistry –II** Methods of resolution, optical purity, 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. Molecular dissymmetry and chiroptical properties.	15
III	**Nature of Bonding in Organic Molecules** Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule level of n-molecular orbitals, annulenes, antiaromaticity, homoaromaticity. Bonds weaker than covalent, crown ether complex and cryptands, inclusion compounds, cylodextrins, catenanes and rotaxanes. **Reaction mechanism and Reactive Intermediates** Linear free energy relationships and their applications (Hammett equation and modifications).Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbene and nitrenes..	15
IV	**Reactions of free radicals** Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations using NBS, oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.	15
Total Contact Hours		60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	30	➢ **Theory:**	70
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		

• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. D. Nasipuri: Stereochemistry of Organic Compounds, NEW AGE; 3rd edition (2018).
2. P.S. Kalsi: Stereochemistry of Organic Compounds, New Age International Private Limited, 2nd edition (2016).
3. P.S. Kalsi, Organic Reactions and their Mechanisms, 2nd edition, New Age International Publishers, (2000).
4. J. March: Advanced Organic Chemistry-Reactions Mechanism and Structure, Wiley Publication, 6th edition (2007).
5. Peter Sykes: A guide Book to Mechanism in Organic Chemistry, Pearson Education; 6th edition (2003).
6. S.H. Pine, J.B. Hendrickson, D.J. Cram, G.S. Hammond, Organic Chemistry, McGraw-Hill Inc., Tokyo, (1980).

Further Readings:

1. R.T. Morrison and R.N. Boyd: Organic Chemistry, Pearson India; Sixth Edition (2016).
2. P.S. Kalsi, Stereochemistry: Conformation and Mechanism, 2nd edition, Wiley Eastern Limited, (1993).
3. S.M. Mukherji and S.P. Singh: Reaction Mechanism in Organic Chemistry, Laxmi Publications; 3rd edition (2007).
4. S.P. Bhutani: Carbohydrate, Ane Books Pvt. Ltd (2010).
5. I.L. Finar: Organic Chemistry, Pearson Education India; 6th edition (2002).
6. H.O. House: Modern Synthetic Reactions, Benjamin-Cummings Publishing Co., Subs. of Addison Wesley Longman, US; 2nd Revised edition (1972).
7. Organic Chemistry by Clayden, Oxford University Press; 2nd edition (2014).

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc (Chemistry)		
Semester	1st		
Name of the Course	General Spectroscopy		
Course Code	M24-CHE-104		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the interaction of electromagnetic radiation with molecules CLO 2: Understand the Rotational, vibrational and electronic spectra for di atomic and polyatomic molecules CLO 3: Know about Raman Effect and its applications CLO 4: Gain the knowledge of NMR spectra analysis for organic and Inorganic compounds CLO 5: General awareness about the IR, UV-vis principles		
Credits	Theory	Practical	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Electromagnetic radiation, interaction of electromagnetic radiation with matter, regions of the Spectrum the width and intensity of spectral transitions. Resolving power. **Rotational Spectra** The rotation of molecules, The Born-Oppenheimer Principle, rotational spectra of diatomic molecules, Selection rule for rotational/microwave spectrum, determination of bond-length, intensity of spectral lines, effects of isotopes on rotational spectra, Non-rigid rotator, Stark effect, Nuclear spin interactions, rotational spectra of linear and symmetric top	11

	polyatomic molecules, application of microwave spectroscopy.	
II	**Vibrational and Vibrational- Rotational Spectra** The vibrating diatomic molecule; simple harmonic vibrations, anharmonicity of vibrations, the diatomic vibrating rotator, the interaction of rotations and vibrations the vibrations of polyatomic molecules, analysis by infrared technique. **Electronic Spectra** Electronic spectra of diatomic molecules, vibrational course structure, and rotational fine structure of electronic band. The Frank- Condon principle, intensity of vibrational-electronic band, dissociation energy, the Fortrat diagram.	11
III	**Raman Spectroscopy** Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications. **Introduction to Organic Spectroscopy:** Principles and Applications of UV, IR and NMR Spectra in the structure elucidation of Organic Compounds	11
IV	**NMR Spectra for Organic Compounds** Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect. **NMR spectra for Inorganic Compounds** Applications of spin-spin coupling to structure alignment of inorganic compounds, evaluation of reaction rates of fast exchange reactions. The double resonance technique. Application of infra-red spectroscopy to the determination of inorganic compounds.	12
	Total Contact Hours	45

Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
➢ **Theory**	**25**	➢ **Theory:**	**50**
• Class Participation:	5	Written Examination	

• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	10	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. R.S. Drago: Physical Methods in Inorganic Chemistry, affiliated east-west press pvt. Ltd.-New Delhi (2012).
2. C.N.Banwell: Fundamentals of Molecules Spectroscopy, McGraw Hill Education; 4th edition (2017).
3. D.L. Pavia, G.M. Lampman, G.S. Kriz and J.R. Vyvyan: Introduction to Spectroscopy, Cengage Learning India Private Limited; 5th edition (2015).

Further Readings:

1. R.M. Silverstein, G.C. Bassler, and T.C. Morrill: Spectrometric Identification of Organic Compounds, John Wiley, 6th edition, (2002).
2. K. Nakamoto: Infrared Spectra of Inorganic and Coordination Compounds, Wiley, 6th edition (2009).
3. D.N. Sathyanarayan: Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NRR, I. K. International Publishing House Pvt. Ltd (2009).
4. W.E. Addison: Structural Principles in Inorganic Compounds, Prentice Hall Press (1963).

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Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	1st		
Name of the Course	Inorganic Chemistry Practical- I		
Course Code	M24-CHE-105		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Students will be able to perform and interpret standard titrations for quantitative analysis. CLO 2) Students will demonstrate the ability to execute and analyze gravimetric measurements for element quantification. CLO 3) Understand and adhere to environmental regulations and guidelines relevant to the synthesis of inorganic compounds.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course	
Practicals	**Contact Hours**
1. Volumetric Analysis (a) Potassium iodide titrations Determination of iodide and antimony (III) (b) Potassium bromate titrations (i) Determination of antimony (III) (by Direct Method) (ii) Determination of Aluminium, and Magnesium (by Oxine Method) (c) EDTA titrations (i) Determination of Calcium, Copper, Barium, Zinc (ii) Back titration (iii) Titration of mixtures using masking **2. Green methods of Preparation of the following** (i) Bis (acetylacetonato) copper (II)	90

		(ii) Tris (acetylacetonato) iron (III) (iii) Tris (acetylacetonato) manganese (III) (iv) $[Cu(NH_3)_4]\ SO_4.\ H_2O$ (v) $K_3[Fe(C_2O_4)_3]$ (vi) $[Ni(en)_3]\ S_2O_3$	

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practicum**	**25**	➢ **Practicum**	**50**
• Class Participation:	5	Lab record 10, Viva-Voce 10, write-up and execution of the practical 30	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. A.I. Vogel: A text Book of Quantitative Inorganic Analysis, Longman Publication, 5th edition (1989).
2. O.P. Vermani: Applied Analytical Chemistry, New Age International Publication, 2nd edition (2017).

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	1st		
Name of the Course	Physical Chemistry Practical- I		
Course Code	M24-CHE-106		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Describe and perform conductometric titrations and data analysis. CLO 2) Understand the importance of calibration, standardization, and maintenance for accurate and reliable measurements. CLO 3) Understand how to interpret data from various instrumental techniques to draw meaningful conclusions.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course

Practicals	Contact Hours
1. Conductometry (i) To determine cell constant of conductivity cell. (ii) NaOH vs. HCl titration. (iii) NaOH vs. Oxalic acid titration. (iv) NaOH vs CH_3 COOH titration (v) Ba $(NO_3)_2$ vs. Na_2 SO_4 titration **3. Thermochemistry: Determination of heat of neutralization of the followings:-** (i) NaOH vs. HCl (ii) NaOH vs. CH_3COOH (iii) NaOH vs. Oxalic acid **3. Refractometry** (i) To determine molar refractivity of the given liquid. (ii) To determine percentage composition of liquids in the given binary mixture. (iii) To determine concentration of sugar in a given solution. **4 Surface Tension** To determine interfacial tension of two immiscible liquids.	90

	5. Adsorption To study the adsorption of Oxalic acid and Acetic acid on charcoal.	

Suggested Evaluation Methods			
Internal Assessment: 25		End Term Examination: 50	
➢ **Practicum**	**25**	➢ **Practicum**	**50**
• Class Participation:	5	Lab record 10, Viva-Voce 10, write-up and execution of the practical 30	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. J.B. Yadav: Advanced Practical Physical Chemistry, K Prakashan Media (P) Ltd (2015).
2. B.D. Khosla, V.C. Garg and A. Khosla: Senior practical physical chemistry, R. Chand & Co., New Delhi (2011).

Further Readings:

1. B. Vishwanathan and P.S. Raghav: Practical Physical Chemistry, Viva Books (2014).
2. P.S. Sindhu: Practical in Physical Chemistry, Macmillan Publishers India (2005).
3. A Thawale and P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	1st		
Name of the Course	Organic Chemistry Practical- I		
Course Code	M24-CHE-107		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Identify and confirm the presence of functional groups in organic compounds CLO 2) Prepare comprehensive lab reports detailing methods, results, and interpretations of qualitative tests CLO 3) Understand and explain the principles of separation techniques.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course		
Practicals		**Contact Hours**
	1. Quantitative Analysis. Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.	90

Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practicum**	**25**	➢ **Practicum**	**50**
• Class Participation:	5	Lab record 10, Viva-Voce 10, write-up and execution of the practical 30	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS; 4th Revised edition (2007).
2. A. R. Tatchell, Peter W.G. Smith, A.J. Hannaford, B.S. Furniss: Vogel's Textbook of Practical Organic Chemistry, Pearson Education; 5th edition (2003).
3. D. Pasto, C. Johnson and M. Miller: Experiments and Techniques in Organic Chemistry, Prentice Hall; Instructor's edition (1992).

Further Readings:

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1. K.L. Williamson, & K.M. Masters: Macroscale and Microscale Organic Experiments, Cengage Learning; 6th edition (2010).
2. H. Middleton: Systematic Qualitative Organic Analysis, Edward Arnold & Co. (1948).

Session: 2024-25	
Name of the Programme	M.Sc (Chemistry)
Semester	1st
Name of the Course	Seminar
Course Code	M24-CHE-108
Course Type: (CC/DEC/PC/Seminar/CHM/OEC/EEC)	Seminar
Level of the course	400-499
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLOs
Credits	Seminar
	2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour

Instructions for Examiner:

Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc (Chemistry)		
Semester	2nd		
Name of the Course	Inorganic Chemistry- II		
Course Code	M24-CHE-201		
Course Type	CC		
Level of the course	400-499 or 500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Limitations of VBO theory and the advantage of Crystal field theory, Ligand field theory and MO theory over VBO. CLO 2) Treatment of Crystal field theory, Ligand field theory and MO theory for application in polyatomic systems CLO 3) Describe how spin and orbital angular momentum couple in transition metal ions and their impact on spectral terms. CLO 4) Describe the significance of Orgel and Tanabe-Sugano diagrams for predicting electronic transitions. CLO 5) Explain how the nephalauxetic and charge transfer effect influences electronic spectra and coordination chemistry. CLO 6) Understand the fundamental principles of magnetochemistry and learn to calculate magnetic moments by taking various factors i.e., orbital contribution, magnetic exchange etc. CLO 7) Understand the structure and bonding in higher boranes. CLO 8) Understand the molecular orbital (MO) theory applied to carbonyl ligands. CLO 9) Learn about the preparation, properties, and structural characteristics of mononuclear and polynuclear carbonyl complexes.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each			

unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**BONDING MODELS** Valence bond theory, electroneutrality principle and its limitations. Crystal field theory,splitting of d-orbitals in octahedral, tetragonal, square planar and tetrahedral ligand environments. Ligand field theory, molecular orbital theory. MO treatment of simple diatomic (homo & hetero) and polyatomic systems. Spectroscopic electronegativity, concept of chemical hardness (η). Walsh diagrams (triatomic systems).	15
II	**Electronic Spectra of Transition Metal Complexes** Spectroscopic ground states, correlation and spin-orbit coupling in free ions for 1st series of transition metals, Orgel and Tanabe -Sugano diagrams for transition metal complexes (d^1 – d^9 states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Teller effect, Spectrochemical and nephalauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.	15
III	**Magnetic Properties of transition metal complexes** Elementary theory of magneto - chemistry, Guoy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, spectral and magnetic properties of transition and inner transition metals. Magnetic exchange coupling and spin state cross over. **Metal Clusters** Structure and bonding in higher boranes, Wade's rules, Carboranes, Metal Carbonyl clusters-Low Nuclearity Carbonyl clusters, total electron count (TEC), HNCC, structure of Zintl ions.	15
IV	**Metal- π Complexes** Molecular orbital diagram of carbonyl, classification of metal carbonyls, Metal carbonyls, structure and bonding, preparation and properties of mononuclear and polynuclear carbonyl complexes, vibrational spectra of metal	15

	carbonyls for bonding and structure elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.	
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ Theory	30	➢ **Theory:**	70
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. F.A. Cotton & G. Wilkinson: Advanced Inorganic Chemistry, Wiley Publication, 6th edition (1999).
2. J.E. Huheey: Inorganic Chemistry: Principles of Structure &reactivity, Pearson publication, 4th edition (1997).
3. B. N. Figgis and M. A. Hitchman, Ligand Field Theory and Its Applications, Wiley-India (2010)
4. J. E. House, Inorganic Chemistry, Academic Press (2008)
5. G.L. Miessler and D.A. Tarr: Inorganic Chemistry, Prentice Hall; 3rd edition (2003).
6. N.N. Greenwood & A. Earnshaw: Chemistry of the Elements, Butterworth-Heinemann publication, 2nd edition (1997).
7. D. F. Shriver, P.W. Atkins and C.H. Landgord, Inorganic Chemistry, Oxford University Press,3rd Edition. (1998).

Further Readings:

1. R. Gopalan & R. Ramalingam: Concise Co-ordination Chemistry, Vikas Publication House , 1st edition (2008).
2. R.L. Carlin: MagnetoChemistry,Springer-Verlag Berlin Heidelberg publication, 1st edition (1986).
3. J.D. Lee: Concise Inorganic Chemistry, Oxford University Press publication ; 5th edition (2008).
4. A. Earnshaw: Introduction to Magneto Chemistry, Elsevier (2013).

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. (Chemistry)		
Semester	1st		
Name of the Course	Physical Chemistry- II		
Course Code	M24-CHE-202		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Understand the role of operators in the calculation of various observables. CLO 2) Derive the time-dependent Schrödinger equation from fundamental principles and use the outcome to calculate the energy of various states CLO 3) Derive and learn the basics about Langmuir and Gibbs adsorption isotherm. CLO 4) Learn the various basics about surface reactions. CLO 5) Understand the basics of symmetry and its application in spectroscopy. CLO 6) Understand various ensembles and the derivation of Maxwell-Boltzmann law using the principle of statistical thermodynamics.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Quantum Mechanics-I** Postulates of Quantum Mechanics; derivation of Schrodinger wave equation; Max-Born interpretation of wave functions (Ψ) and the Heisenberg's uncertainty principle; Quantum mechanical operators and their commutation relations, Hermitian operators, (elementary ideas, quantum mechanical operator for linear momentum, angular momentum	15

	and energy as Hermitian operator). The average value of the square of Hermitian operators; commuting operators and uncertainty principle (x & p; E &t); evaluation of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, Schrodinger wave equation for a particle in one dimensional box; pictorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, lowest energy of the particle.	
II	**Surface Chemistry and Catalysis** Gibbs adsorption equation, Langmuir adsorption isotherm and its derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its derivation and applications. Study of surfaces by STM, SEM. Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. Comparison of uncatalyzed and catalyzed reaction rates	15
III	**Symmetry and Group Theory** Symmetry elements and symmetry operation group and its properties. Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. Groups to be worked out explicity). Irreducible representation of groups. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy	15
IV	**Statistical Thermodynamics-I** Concept of distribution, Thermodynamic probability and most probable distribution; Canonical, grand canonical and micro canonical ensembles. Maxwell - Boltzmann statistics, Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean	15

	square velocity; Law of equipartition of energy; Partition function and its factorization, relationship of atomic and molar partition function to thermodynamic properties (i) internal energy (ii) entropy (iii) Gibb's free energy (iv) heat constant (v) work function (vi) pressure and heat capacity at constant volume and pressure. Derivation of equation of state for a mono atomic ideal gas.	
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. R. Chandra: Introductory Quantum Chemistry, McGraw Hill Education; 4th edition (2017).
2. D.A. McQuarrie: Quantum Chemistry, Viva Books student edition (2016).
3. A. Vincent: Molecular symmetry and group theory, Wiley, 2nd edition (2013).
4. S. Swarnlakshmi, T. Saroja & R.M. Ezhilarasi: A simple approach to group theory in Chemistry, Universities Press (India) Private Limited (2019).

Further Readings:

1. B. Bagchi:, Statistical Mechanics for Chemistry and Material Science, CRC Press, 1st edition (2018)
2. L.K. Nash: Elements of Statistical Thermodynamics, Dover Publications; 2nd edition (2006).
3. Levine: Quantum Chemistry, Pearson publication, 7th edition (2013).
4. A. Nass Bauim: Applied group theory for Chemists, Physicists and Engineers, Prentice Hall (1971).
5. F.A. Cotton, Chemical Applications of Group Theory, Wiley Interscience: N.Y (1990).
6. D.M. Bishop, Group Theory and Chemistry, Clarendon Press: Oxford, U.K. (1973).

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc (Chemistry)		
Semester	1st		
Name of the Course	Organic Chemistry- II		
Course Code	M24-CHE-203		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Differentiate between classical and non-classical carbocations CLO 2: Understand the reactivity effects of substrate, attacking, leaving group and reaction medium CLO 3: Know about the regio-and chemoselectivity of Carbon-Carbon Multiple Bonds CLO 4: Undertand the importance of elimination reaction mechanism for multiple bond synthesis		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Aliphatic Nucleophilic Substitution** The S_N2, S_Ni mechanisms. The S_Ni and SET mechanism. The anchimeric assistance, neighbouring group participation by π and σ bonds, classical and non-classical carbocations, phenoniumions, nonbornyl system, Common carbocation rearrangements. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, ambident nucleophile, regioselectivity. Bimolecular mechanism-SE2 and SE1. Effect of substrates, leaving group and the solvent polarity on the	15

	reactivity.	
II	**Aromatic Nucleophilic Substitution** The ArS_N, ArS_N1, benzyne and ArS_N2 mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser, and Smiles rearrangements. **Aromatic Electrophilic Substitution** The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.	15
III	**Addition to Carbon-Hetero Multiple Bonds** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction. Mechanism of condensation reactions involving enolates, enamines, lithium enolates and silyl enol ethers. Reaction and mechanism of Aldol, Knoevenagel, Claisen, Reformatksy, Cannizaro, Etard, Mannich, Benzoin, Perkin and Stobbe reactions	15
IV	**Addition to Carbon-Carbon Multiple Bonds** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation. **Elimination Reactions** The E1, E2 and EIcB mechanisms and their spectrum. Orientation of the double bond. Reactivity - effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.	15
	Total Contact Hours	60
	Suggested Evaluation Methods	
	Internal Assessment: 30	**End Term Examination: 70**

➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Jerry March: Advanced Organic Chemistry -Reactions, Mechanism and Structure, John Wiley Publication, 6th edition (2007).
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Longman Publication, 6th edition, (1989).
3. H.O. House: Modern Synthetic Reactions, Benjamin-Cummings Publishing Co. Subs. of Addison Wesley Longman US, 2nd edition (1972).
4. W. Carruthers, L.Coldham, Modern Methods of Organic Synthesis Cambridge University Press, South Asia Edition (2015).
5. S.H. Pine, J.B. Hendrickson, D.J. Cram, G.S. Hammond, Organic Chemistry, McGraw-Hill Inc., Tokyo, (1980).

Further Readings:

1. C.K. Ingold: Structure and Mechanism in Organic Chemistry, CBS Publication, 2nd edition (2000).
2. R.T. Morrison and R.N. Boyd: Organic Chemistry, Prentice Hall Publication, 6th edition (1992).
3. F.A. Carey, R.J. Sundberg: Advanced Organic Chemistry, Plenum Publication, 3rd edition (1990).
4. R.O.C. Norman and J.M. Coxon: Principles of Organic Synthesis. Springer publication, 3rd edition (1993).
5. S.M. Mukherji and S.P. Singh: Reaction Mechanism in Organic Chemistry, Macmillan Publication (1985).

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Session: 2024-25	
Part A - Introduction	
Name of Programme	M.Sc (Chemistry)
Semester	2nd
Name of the Course	Green Chemistry
Course Code	M24-CHE-204
Course Type	CC
Level of the course	400-499
Pre-requisite for the course (if any)	
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) To foster an understanding of the principles and practices of green chemistry. CLO 2) To apply green chemistry principles in practical scenarios, promoting innovation in sustainable chemical processes. CLO 3) Students will gain a comprehensive understanding of non-conventional energy resources and waste management techniques, including their classification, advantages, disadvantages, and applications in sustainability. CLO 4) Students will develop an understanding of the industrial applications of various solvents and catalysts, along with the fundamentals of intellectual property rights, particularly in relation to patenting inventions in the chemical field. CLO 5) Understand the concept of supramolecules, which are complexes formed through non-covalent interactions between molecules. CLO 6) Explore different types of interactions, including hydrogen bonding, van der Waals forces, ionic interactions, and π-π stacking that stabilize supramolecular structures. CLO 7) Learn principles of underlying molecular devices and their potential applications in electronics and computing.

Credits	Theory	Practical	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each

unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Green Chemistry** Definition, need and goals. Green chemistry and its interdisciplinary nature, atom economy, twelve principles of green chemistry and its applications. Elementary idea of green reagent, green solvent, green catalyst. Introduction to biocatalysts, role of biocatalysts in green synthesis- enzyme catalyzed oxidation, reduction and hydrolytic reactions, synthesis involving basic principle of green chemistry- synthesis of adipic acid and BHC.	11
II	**Sustainable energy resources:** Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations. **Waste management: production, problem and prevention** Introduction, source of waste from chemical industry, waste minimization techniques, onsite waste treatment, design for degradation of DDT & surfactant, polymer recycling.	20 11
III	**Industrial Solvent:** Industrial uses of Aqueous Solvents, Super Critical Fluids, and Ionic liquids **Homogenous and Heterogenous Catalysis:** Phase Transfer Catalysis (PTC), Hydroformylation, Metathesis, Zeolite usage in Menthol synthesis, Caprolactam synthesis. Brief introduction to IPR, need for patenting, conditions for invention to be patentable.	12
IV	**Supramolecules** Molecules and Supramolecules, supermolecules, nature of supramolecular interactions, host-guest chemistry, solvation and hydrophobic effect, Utilisation of H-bonds to create supramolecular structures, Thermodynamic and Kinetic selectivity, Chelate and macrocyclic effects, Template synthesis	11

	Application of Supermolecules Molecular device, reading signal from molecular device, molecular electronic and photonic devices, molecular computers and molecular machines.	
		Total Contact Hours 45

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Theory**	25	➢ **Theory:**	50
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. P.T. Anastas and J.C. Warner. Green Chemistry- Theory and Practical, Oxford University Press (1998).
2. A.S. Matlack, Introduction to Green Chemistry, Marcel Dekker (2001).
3. J. W. Steed and J. L. Atwood, Supramolecular Chemistry Wiley, 2nd edition (2009).
4. M. Lancaster, Green Chemistry: An introduction text, RSC, 3rd edition (2016).
5. R. A. Sheldon, I. Arends and V. Hanefield, Green Chemistry and Catalysis, Wiley-VCH (2007).
6. P. Bansal, IPR Handbook for Pharma Students and Researchers, BSP Books Private Limited (2015).

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	2nd		
Name of the Course	Inorganic Chemistry Practical- II		
Course Code	M24-CHE-205		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) To understand the criteria for selecting appropriate methods for the separation of metal ions. CLO 2) Familiarize with various analytical techniques for metal ion analysis. CLO 3) Analyze data quantitatively to determine the concentration of separated metal ions. CLO 4) Understand principles of gravimetric methods including precipitation, filtration, and weighing.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course

Practicals	Contact Hours
1. Quantitative Inorganic Analysis Separation and determination of two metal ions such as i) Silver- Copper ii) Copper-Nickel iii) Copper-Zinc iv) Nickel-Zinc v) Copper-Iron Involving volumetric and gravimetric methods **2. Determination by Cerimetry** i) Ferrous ii) Oxalate iii) Nitrite	90

Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practicum**	**25**	➢ **Practicum**	**50**

•Class Participation:	5	Lab record 10, Viva-Voce 10, write-up and execution of the practical 10
•Seminar/Demonstration/Viva-voce/Lab records etc.:	10	
•Mid-Term Exam:	10	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. A.I. Vogel: A Text Book of Quantitative Inorganic Analysis, Longman Publication, 3rd edition ([illegible]).
2. G.D. Christian: Applied Analytical Chemistry, New Age International Publication, 2nd edition (2019).

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	2nd		
Name of the Course	Physical Chemistry Practical- II		
Course Code	M24-CHE-206		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Demonstrate the ability to set up a potentiometric measurement system. CLO 2) Understand the importance of pH measurement in various chemical processes. CLO 3) Understand how to interpret rate laws and mechanisms for chemical reactions. CLO 4) Demonstrate the ability to set up and perform distribution law experiments.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course

Practicals	Contact Hours
1. Potentionmetry (i) NaOH vs. HCl titration. (ii) NaOH vs. Oxalic acid titration. (iii) NaOH vs. CH_3COOH titration. **2. pH metry** (i) NaOH Vs. HCl titration. (ii) NaOH vs Oxalic acid titration. (iii) NaOH vs. CH_3COOH titration. **3. Chemical Kinetics** (i) To study kinetics of hydrolysis of ester in the presence of acid. (ii) To compare the relative strength of acids (HCl and H_2SO_4). **4. Distribution Law** (i) To determine partition coefficient of benzoic acid between benzene and water (ii) To determine partition coefficient of Iodine between Carbon	90

	tetrachloride and water. (iii) Determination of Equilibrium constant for $I_2 + I^- = I_3^-$	

Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practicum**	**25**	➢ **Practicum**	**50**
• Class Participation:	5	Lab record 10, Viva-Voce 10, write-up and execution of the practical 30	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. J.B.Yadav: Advanced Practical Physical Chemistry, K Prakashan Media (P) Ltd (2015).
2. B.D. Khosla, V.C. Garg, A. Khosla: Senior practical physical chemistry, R. Chand& Co., New Delhi (2011).
3. A Thawale and P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).

Further Readings:

1. B. Vishwanathan, P.S. Raghav: Practical Physical Chemistry, Viva Books (2014).
2. P.S. Sindhu: Practical in Physical Chemistry, Macmillan Publishers India (2005)
3. A Thawale and P. Mathur: Experimental Physical Chemistry, New Age International Private Limited; 1st edition (2001).

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Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc (Chemistry)		
Semester	2nd		
Name of the Course	Organic Chemistry Practical- II		
Course Code	M24-CHE-207		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1) Understand the principles and objectives of performing a multi-step synthesis involving sequential reactions. CLO 2) Utilize techniques such as recrystallization, distillation, or column chromatography to purify the final product. CLO 3) Troubleshoot problems in synthesis and optimize experimental processes. CLO 4) Explore and apply advanced synthesis techniques and interdisciplinary applications.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	0	6 hours (or as decided by PGBOS)	

Part B- Contents of the Course	
Practicals	**Contact Hours**
1. Organic Synthesis and checking purity of samples prepared. Two Step preparations: 1. p-Nitroaniline from acetanilide. 2. p-Bromoaniline from acetanilide 3. Anthranilic acid from phthalic anhydride. 4. p-Bromoacetanilide from aniline. 5. p-Nitroacetanilide from aniline. 6. Sym-tribromobenzene from aniline. 7. 2,4-Dinitrophenyl hydrazine from Chlorobenzene. 8. 2,5-Dihydroxyacetophenone from hydroquinone.	90

Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practicum**	**25**	➢ **Practicum**	**50**
• Class Participation:	5	Lab record 10, Viva-Voce 10, write-up	

• Seminar/Demonstration/Viva-voce/Lab records etc.:	10	and execution of the practical 30
• Mid-Term Exam:	10	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. H. Clark: Handbook of Organic Analysis-Qualitative and Quantitative, CBS; 4th Revised edition (2007).
2. A. R. Tatchell, Peter W.G. Smith, A.J. Hannaford, B.S. Furniss: Vogel's Textbook of Practical Organic Chemistry, Pearson Education; 5th edition (2003).
3. D. Pasto, C. Johnson and M. Miller: Experiments and Techniques in Organic Chemistry, Prentice Hall; Instructor's edition (1992).

Further Readings:

1. K.L. Williamson, & K.M. Masters: Macroscale and Microscale Organic Experiments, Cengage Learning; 6th edition (2010).
2. H. Middleton: Systematic Qualitative Organic Analysis, Edward Arnold & Co. (1948).

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