Pt. Ravishankar Shukla University

Raipur (C.G.), India 492010

CURRICULUM & Syllabus

(Based on CBCS & LOCF)

M.Sc. Chemistry

(Semester System)

Semester: I-IV

Session: 2025-27

Approved by
Board of Studies : **Chemistry**
Dates : **15.05.2025**
Name of chairman : Prof. Kamlesh Kumar Shrivas
Name of Members : Prof. Kallol K. Ghosh (Head, SoS in Chemistry & (CBS)
: Prof. M. K. Deb (Head, SoS in Environmental Science)
: Prof. N. K. Karade (External Members, RTM university) JOINED ONLINE
: Prof. Shamsh Pervez
: Prof. M. K. Rai
: Dr. M. L. Satnami
: Dr. Bhanushree Gupta
: Dr. Ajita Dixit
: Shree Hemant Deshmukh
: Shree B. L. Yadav
: Dr. Indrapal Karbhal
: Dr. Shobhana Ramteke

Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry
	Online										

M. Sc. Chemistry

The objective of an MSc in Chemistry is to provide advanced education and training in various branches of chemistry, equipping students with a deep understanding of theoretical principles and practical skills. The program aims to foster critical thinking, research capabilities, and the ability to apply advanced chemical knowledge to address scientific and technological challenges, preparing graduates for diverse career opportunities in academia, industry, or research institutions.

Program Outcomes:

Upon successful completion of the M. Sc. Chemistry program, student will be able to:

PO-1	**Knowledge:** Demonstrate the basic understanding of concepts, theories and principles of chemical sciences
PO-2	**Critical Thinking and Reasoning:** Exhibit advanced critical thinking and reasoning skills, enabling them to critically evaluate and analyze complex chemical arguments, theories, and experimental data.
PO-3	**Problem Solving:** Applying their chemical knowledge and problem-solving skills to tackle intricate scientific and real-world issues.
PO-4	**Advanced Analytical and Computational Skills:** Proficient in employing advanced analytical techniques and computational tools to conduct in-depth chemical analyses and research.
PO-5	**Effective Communication**: Effectively communicate complex scientific concepts and research findings to both technical and non-technical audiences, using written reports, presentations, and teaching.
PO-6	**Social/ Interdisciplinary Interaction**: Integrate chemical concepts and methodologies into interdisciplinary contexts, collaborating effectively with professionals from various fields to address complex scientific and societal challenges.
PO-7	**Self-directed and Life-long Learning**: Recognize the importance of ongoing professional development and lifelong learning in the dynamic field of Chemistry and acquire knowledge and skills in chemistry throughout their professional careers.
PO-8	**Effective Citizenship**: **Leadership and Innovation:** Capable to identify, formulate, investigate and analyze the scientific problems and innovatively to design and create products and solutions to real life problems
PO-9	**Ethics**: Maintain the highest ethical standards in research and professional conduct within the field of chemistry
PO-10	**Further Education or Employment:** Pursue for Ph.D. program and get employment in academia, research institutions, industry, government, and other related sectors.
PO-11	**Global Perspective**: Recognize the global nature of scientific research in Chemistry and its impact, appreciating diverse cultural perspectives in scientific practices and considering international contexts in their work.

Online											
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PROGRAMME SPECIFIC OUTCOMES (PSOs):

At the end of the program, the studentwill be able to:

PSO1	Comprehensive understanding of fundamental theoretical principles and practical aspects of chemistry.
PSO2	Apply the knowledge of chemistry concepts in interdisciplinary fields to address and solve societal issues.
PSO3	Apply the analytical instruments and computation programs ensuring precision, efficiency, and innovation in scientific research, industry, healthcare, and education.
PSO4	Proficiently convey and promote ideas in the field of chemical sciences to disseminate knowledge and enhance the awareness of the chemical community.
PSO5	Qualify national and state-level examinations like GATE, NET, SLET, and SET can lead to career opportunities in academia, research, and related fields.

M. Sc. CHEMISTRY

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	19	85
Elective	IV	5	15
Total		24	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	04
Indian Knowledge system	I	01	02
Internship**	II	01	02
Skill Enhancement (Value Added Courses)	III	01	02

**** Student should need give 60 hrs. duration for Internship during semester II (Experience certificate is needed for requirement of the credit).**

Online

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M.Sc. CHEMISTRY
PROGRAMME STRUCTURE

Semester	Course Nature	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
							CIA	ESE	Total
Semester-I	Core	CHE101	Group Theory and chemistry of metal complex	T	5	5	30	70	100
	Core	CHE102	Concepts in Organic chemistry	T	5	5	30	70	100
	Core	CHE103	Quantum Chemistry, Thermodynamic and Chemical Dynamic-I	T	5	5	30	70	100
	Core	CHE104	Theory and Applications of spectroscopy-I	T	5	5	30	70	100
	Core	CHE105	Lab Course - I	P	10	3	30	70	100
	Core	CHE106	Lab Course - II	P	10	2	30	70	100
Semester-II	Core	CHE201	Transition Metal complexes	T	5	5	30	70	100
	Core	CHE202	Reaction Mechanism	T	5	5	30	70	100
	Core	CHE203	Quantum Chemistry, Thermodynamic and Chemical Dynamic-II	T	5	5	30	70	100
	Core	CHE204	Theory and Applications of Spectroscopy-II	T	5	5	30	70	100
	Core	CHE205	Lab Course - III	P	10	3	30	70	100
	Core	CHE206	Lab Course – IV	P	10	2	30	70	100
Semester-III	Core	CHE-301	Spectroscopy, Photochemistry and Organocatalysis	T	5	5	30	70	100
	Core	CHE302	Chemistry of Biomolecules	T	5	5	30	70	100
	Core	CHE303	Catalysis, Solid state, and surface Chemistry	T	5	5	30	70	100
	Core	CHE304	Analytical Techniques and data analysis	T	5	5	30	70	100
	Elective courses 2 (Select (305 & 306 or 307 only)	CHE305	Lab Course – V	P	10	3	30	70	100
		CHE306	Lab Course – VI	P	10	2	30	70	100
		CHE307	Research Project	P	20	5	60	140	200
	Core	CHE401	Instrumental Methods of Analysis	T	5	5	30	70	100
	Core	CHE402	Natural Product and Medicinal Chemistry	T	5	5	30	70	100
	Core	CHE403	Material and Nuclear Chemistry	T	5	5	30	70	100
	Elective 9 courses	CHE404	Environmental and Applied Chemical Analysis	T	5	5	30	70	100

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Semester-IV	(Select any One)	CHE404a	Medicinal Chemistry	T	5	5	30	70	100
		CHE404b	Chemistry of surfactants	T	5	5	30	70	100
		CHE404c	Chemistry and application of pesticides	T	5	5	30	70	100
		CHE404d	Molecular symmetry, coordination and organometallic chemistry	T	5	5	30	70	100
		CHE404e	Nanochemistry	T	5	5	30	70	100
		CHE404f	Chemistry of Natural products	T	5	5	30	70	100
		CHE404g	Polymers	T	5	5	30	70	100
		CHE404h	Forensic Chemistry	T	5	5	30	70	100
	Elective courses 2 (Select (405 & 406 or 407 only)	CHE405	Lab course VII	P	10	3	30	70	100
		CHE406	Lab course VIII	P	10	2	30	70	100
		CHE407	Research Project	P	20	5	60	140	200

Note:-

1. In place of Elective Courses (9) Student can choose paper (s) from MOOC Courses(Swayam Portal) subject to the following conditions:

(a) The chosen paper will be other than the papers offered in the currentcourse structure.

(b) The paper will be PG level with a minimum of 12 weeks' duration.

(c) The list of courses on SWAYAM keeps changing, the departmentalcommittee will finalize the list of MOOC courses for each semester.

(d) The paper(s) may be chosen from Swayam Portal on the recommendationof Head of the Department.

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Generic Elective Courses:

(Offered to PG students of other Departments/SoS only)

The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Generic Elective Courses (only qualifying innature) offered by other departments/SoS in Semester II and Semester III.

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credit	Marks		
						CIA	ESE	Total
II	CHE501	Analytical Techniques and Data Analysis	T	2	2	30	70	100
	CHE502	Instrumental of Methods analysis	T	2	2	30	70	100
III	CHE503	Resonance spectroscopy and photochemistry	T	2	2	30	70	100
	CHE504	Chemistry of biomolecules	T	2	2	30	70	100
	CHE505	Nanochemistry and Applications	T	2	2	30	70	100

Skill Enhancement/Value Added Courses:
(Offered to the PG students of SoS inChemsitry)

The candidates who have joined the PG Programme in School of Studies (UniversityTeaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester I and Semester III.

Semester	Course Code	Course Title	Course Type(T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	CHE107	Indian Knowledge System	T	2	2	30	70	100
II	CHE207	Internship	P	60 hrs	2	Experience Certificate (To full the credits)		
III	CHE308	Application of software's in chemistry	P	4	2	30	70	100

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Programme Articulation Matrix:

Following matrix depicts the correlation between all the courses of the programme and Programme Outcomes

Course Code	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CHE101	√	√	√	√	√	√	√	×	√	√	√	√	√	√	×	√
CHE102	√	√	√	√	√	√	×	√	×	√	√	√	√	×	√	√
CHE103	√	√	√	√	×	√	√	√	√	√	√	√	√	√	×	√
CHE104	√	√	√	√	√	√	×	×	×	√	√	√	√	√	×	√
CHE105	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CHE106	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CHE201	√	√	√	√	√	√	√	×	√	√	√	√	×	√	√	√
CHE202	√	√	√	√	√	√	√	×	×	√	√	√	√	√	×	√
CHE203	√	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√
CHE204	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
CHE205	√	√	√	√	√	√	√	×	√	√	√	√	√	√	×	×
CHE206	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×
CHE301	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√
CHE302	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√
CHE303	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
CHE304	√	√	√	√	√	√	√	×	×	√	√	√	√	√	√	√
CHE305	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×
CHE306	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×
CHE307	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	×
CHE401	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√
CHE402	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√
CHE403	√	√	√	√	√	√	√	√	×	√	√	√	√	×	√	√
CHE404	√	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√
CH404a	√	√	√	√	√	√	×	√	√	√	√	√	√	√	√	√
CHE404b	×	√	√	√	×	√	√	√	×	√	√	√	√	√	×	×
CHE404c	√	√	√	×	√	√	√	√	×	√	√	√	√	√	√	×
CHE404d	√	√	√	×	√	√	×	√	√	√	√	√	√	√	√	√
CHE404e	√	√	√	√	×	√	√	√	×	×	√	√	√	√	×	×
CHE404f	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√
CHE404g	×	√	×	√	√	√	√	√	×	×	√	√	√	×	√	×
CHE404h	√	√	√	√	×	×	×	×	×	√	√	√	√	√	×	×
CHE405	√	√	√	√	√	√	√	√	√	√	×	√	√	√	√	×
CHE406	√	√	√	√	√	√	√	√	√	√	√	√	×	√	×	×
CHE407	√	√	√	√	√	×	√	√	×	√	√	√	√	√	√	×
	32	**34**	**32**	**32**	**30**	**32**	**29**	**28**	**20**	**31**	**33**	**34**	**32**	**31**	**19**	**21**

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M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	Course Title		Course Type
CHE101	**GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):-

The course aims to equip students with a deep understanding of symmetry and group theory, metal-ligand bonding theories, and the chemistry of main group elements, including metal clusters and unique ring structures.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the symmetry elements, group definitions, subgroups, matrix representations, and character tables empowers students to apply these concepts in spectroscopy with a deep understanding of underlying principles.	U
2	Analyze and predict the properties of transition metal complexes using various bonding theories, including Valence Bond Theory, Crystal Field Theory, and Molecular Orbital Theory, Jahn-Teller distortion and metal complexes.	An
3	Understand of metal-ligand equilibria in solution, factors affecting stability, chelate effect, and determination methods. Additionally, they will explore the chemistry of main group elements, encompassing classification, preparation, properties, and structures of borides, carbon allotropes, carbides, nitrides, silicides, silicate classification and structure, as well as the preparation, properties, and applications of silicones.	U
4	Understand metal clusters, including higher boranes, carboranes, metalloboranes, metallocarboranes, metal carbonyl, halide clusters, and compounds featuring metal-metal multiple bonds, chains, and rings.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	-	2	2	1	-	2	2	3	1	-	3	3
CO2	3	3	3	3	1	1	2	2	-	2	3	3	2	-	2	3
CO3	3	3	3	2	1	1	3	1	-	2	2	3	2	-	3	2
CO4	3	3	3	1	-	2	3	1	-	2	1	3	2	-	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: Group Theory and chemistry of metal complex (CHE101)

Unit No.	Topics	No. of Lectures	CO No.
I	**SYMMETRY AND GROUP THEORY IN CHEMISTRY:** Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schoenflies 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. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy.	12	1
II	**TRANSITION ELEMENTS AND COORDINATION COMPOUNDS:** **Metal ligand bonding:** Nomenclature, Structure and Isomerism, theories & limitations of Bonding (Valence bond theory (VBT), Crystal Field Theory (CFT) and Molecular Orbital Theory (MOT)), Energy level diagram in various crystal field (octahedral, tetrahedral and square planar complexes, Application of CFT. Jahn Teller Distortion. **Metal complexes:** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.	20	2
III	**Metal ligand Equilibria in solution:** 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. **Chemistry of Main Group elements:** Classification, Preparation, properties and structures of borides**,** Carbon allotropes, carbides, nitrides and silicides. Silicates-classification and Structure, Silicones- preparation, properties and application.	20	3
IV	**Metal clusters:** Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbnonyl and halide cluster, compounds with metal-metal multiple bonds. **Chains:** catenation, heterocatenation, intercatenation. **Rings:** Borazines, phosphazines.	18	4

BOOK SUGGESTED:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry: Principles and structure and reactivity, J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medi, Pearson
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
4. Comprehensive Coordination Chemistry Eds. G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
5. Inorganic Chemistry, E. Catherine. Houshecroft, Alan G. Sharpe, Pearson

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6. Principles of Inorganic Chemistry, Brian W. Pfenning, Wiley
7. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Pearson
8. Concise Inorganic Chemistry, J. D. Lee, Oxford University Press.
9. Shriver & Atkins Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Michael Hagerman, Oxford University Press
10. Inorganic Chemistry, Gary Wulfsberg, Viva Books
11. Symmetry and Spectroscopy of Molecules, K. Veera Reddy, New Age International (P) Ltd.
12. Concepts and Models of Inorganic Chemistry, B. Douglas, D. Mcdaniel, J. Alexander, Wiley

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I

Course Code	Course Title	Course Type
CHE102	**CONCEPTS IN ORGANIC CHEMISTRY**	**Core**

Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The aim of this course to provide students a deep understanding of comprehensive understanding of the nature of chemical bonding in organic molecules, including concepts related to localized and delocalized bonds, aromaticity, conformational analysis, stereochemistry, reaction intermediates, elimination reactions, and pericyclic reactions.

Course Outcomes (CO):-

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Demonstrate a deep comprehension of the principles governing the nature of chemical bonding in organic molecules, including localized and delocalized bonds, aromaticity, and the influence of structure on reactivity.	Ap
2	Understand the intricacies of stereochemistry, including the identification and manipulation of chiral centers, methods of resolution, and the principles of stereospecific and stereoselective synthesis.	U
3	Examine diverse reaction intermediates (carbocations, carbanions, radicals, carbenes, nitrenes), predicting their generation, structure, stability, reactivity, and applications in chemical transformations. Understand elimination reactions, including mechanisms and influencing factors.	E
4	Understand the classification and mechanisms of pericyclic reactions, including electrocyclic reactions, cycloadditions, and sigmatropic rearrangements, and their applications in organic synthesis, guided by Woodward-Hoffmann correlation diagrams and frontier molecular orbital (FMO) and pericyclic molecular orbital (PMO) approaches.	U

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	-	3	3	3	-	3	3	3	3	2	3	3
CO2	3	3	3	1	-	2	2	3	-	3	3	3	3	2	3	3
CO3	3	3	3	-	-	1	2	3	-	3	3	3	3	1	2	3
CO4	3	3	3	-	-	2	2	3	-	3	3	3	3	1	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE102 (Concepts in Organic Chemistry)

Unit No.	Topics	No. of Lectures	CO No.
I	**NATURE OF BONDING IN ORGANIC MOLECULES:** Localized and Delocalized chemical bond, conjugation and cross-conjugation, Bonding in Fullerenes, Bonds weaker than covalent, addition compounds, Crown ether complexes and cryptands. Inclusion compounds, Cyclodextrins, Catenanes and Rotaxanes. **AROMATICITY:** Aromaticity in benzonoid and non-benzenoid compounds, Huckel anti-aromaticity, homo-aromaticity. PMO approach for Aromaticity, Annulenes.	20	1
II	**CONFORMATIONAL ANALYSIS**: Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. **STEREOCHEMISTRY:** Elements of symmetry, chirality, molecules with more than one chiral center, methods of resolution, optical purity, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon - Biphenyls, allenes and spiranes, chirality due to helical shape**.**	20	2
III	**REACTION INTERMEDIATES:** Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Sandmeyer reaction, Free radical rearrangement and Hunsdiecker reaction. **ELIMINATION REACTIONS:** The E_2, E_1 and E_1cB mechanisms. Orientation of the double bond. Reactivity, effects of substrate structures, attacking base, the leaving group and the medium.	17	3
IV	**PERICYCLIC REACTIONS:** Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antrafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatrophic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Ene reaction.	18	4

BOOKS SUGGESTED:

1. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
2. Organic Chemistry, J. Clayden, N. Greeves, S. Warren
3. Modern Methods of Organic Synthesis, William Carruthers, Iain Coldham
4. Fundamental of Organic Chemistry, Jahn E. Mc Murry
5. Organic Chemistry, P. Y. Bruice, Eighth Edition
6. Organic Chemistry Principal and Mechanism, Joel Karty
7. Organic Chemistry, F. A. Carey, R. M. Giuliano
8. Reaction, rearrangements and reagents, S. N. Sanyal

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9. Stereochemistry, P. S. Kalsi
10. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
11. Structures and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
12. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
13. Modern Organic Reactions, H. O. House, Benjamin.
14. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackle Academic and Professional.
15. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
16. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillian.
17. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
18. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
19. Rodd's Chemistry of Carbon Compounds, Ed. S. Coff
20. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
21. Stereo selective Synthesis: A Practical Approach, M. Nogradi, and VCH.
22. Organic Chemistry, Paula Yurkanis Bruice, Pearson Education.

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	Course Title		Course Type
CHE103	**QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course aims to equip students with a deep understanding of mathematical concepts, the Schrödinger equation, thermodynamics, electrochemistry, and chemical dynamics, including rate laws, reaction theories, and kinetic control of reactions.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop a strong foundation in mathematical concepts, including vector properties, complex numbers, and basic calculus, and apply these skills to quantum chemistry problems. Understand the Schrödinger equation, its postulates, and its solutions for model systems like the particle in a box, harmonic oscillator, rigid rotator, and hydrogen atom.	U
2	Gain a deep comprehension of thermodynamics, encompassing Maxwell's relations, partial molar properties, and the behavior of chemical potential in different phases.	U

3	Learn the principles of electrochemistry, including the Nernst equation, electrolytic conductance, and Debye-Hückel theory, and apply these concepts to understand electrochemical systems and reactions.	R
4	Understand the methods of determining rate laws, collision theory, reaction rate steric factors, and understand dynamic chain reactions and oscillatory reactions, enabling the analysis of reaction mechanisms and control.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	-	-	-	-	2	2	3	-	2	2	3
CO2	3	3	3	3	2	3	2	3	-	2	2	3	3	2	2	3
CO3	3	3	3	3	2	3	2	3	-	2	2	3	3	2	2	3
CO4	3	3	3	3	2	3	2	3	-	2	2	3	2	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE103 (QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I)

Unit No.	Topics	No. of Lectures	CO No.
I	**MATHEMATICAL CONCEPTS IN QUANTUM CHEMISTRY: A.** Vector quantities and their properties. Complex numbers and Coordinate transformation. Differential and Integral Calculus, Basic rules of differentiation and Integration applications. **B.** The Schrodinger equation and postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz Particle in a box, the harmonic oscillator, the rigid rotator, the hydrogen atom.	17	1
II	**BASICS OF THERMODYNAMICS:** Maxwell's thermodynamic relations, Vant's Hoff hypothesis. Partial molar volume and partial molar heat content. Chemical potential, Gibbs-Duhem equation, variation of chemical potential with temperature and pressure. Chemical potential of ideal gases, pure solids, liquids and mixture of ideal gases. Activity and Fugacity, Determination of Fugacity, Variation of Fugacity with Temperature and Pressure.	19	2
III	**ELECTROCHEMISTRY–I:** Electrochemical Cell, Redox system, Nernst equation, Electrolytic Conductance-Kohlrausch Law and its application, Electrochemistry of solution. Debye-Huckel Onsager treatment and its extension, ion solvent interactions. Debye-Huckel Limiting Law. Debye-Huckel theory for activity coefficient of electrolytic solutions. Determination of activity and activity coefficient, ionic strength, Thermodynamics of electrified interface equations. Derivation of electro-capillarity, Lippmann equation (surface excess), methods of determination.	20	3

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IV	**CHEMICAL DYNAMICS –I:** Methods of determining rate laws, consecutive reactions, collision theory of reaction rates, steric factor, Activated complex theory, kinetic salt effects, steady state kinetics, and thermodynamic and kinetic control of reactions. Dynamic chain (Hydrogen-bromine and Hydrogen-chlorine reactions) and Oscillatory reactions (Belousov-Zhabotinsky reaction etc.)	19	4

BOOKS SUGGESTED:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Coulson's Valence, R. McWeeny, ELBS.
3. Chemical Kinetics, K. J. Laidler, Pearson.
4. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
5. Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
6. Thermodynamics for Chemists, S. Glasstone EWP.
7. An Introduction to Electrochemistry S. Glasstone EWP.
8. Organic Chemist's Book of Orbitals. L. Salem and W.L. Jorgensen, Academic Press
9. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	**Course Title**		**Course Type**
CHE104	**THEORY AND APPLICATIONS OF SPECTROSCOPY- I**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course aims to equip students with a deep understanding and analyze electromagnetic radiation-matter interactions, covering absorption, emission, transmission, and scattering, and apply these principles to understand rotational, vibrational, and electronic energy levels across the electromagnetic spectrum, particularly in microwave, infrared, and Raman spectroscopy, facilitating molecular structure determination and spectral analysis.

Online											
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Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Acquire an in-depth understanding of spectroscopic principles, including electromagnetic radiation-matter interactions and the interpretation of various spectra. Understand the fundamental quantum concepts to enhance spectral analysis skills, encompassing the uncertainty relation, natural line width, selection rules, and the Born-Oppenheimer approximation.	Ap
2	Understand the microwave spectroscopy, molecule classification by internal rotation, determining rotation energy, analyzing spectral line intensities, and exploring isotopic substitution effects. They'll apply these skills to study non-rigid rotators, linear, symmetric top polyatomic molecules, and employ microwave spectroscopy for bond length determination.	U
3	apply infrared spectroscopy concepts, covering oscillators, diatomic-vibrating rotators, polyatomic vibrations, Fourier Transform instrumentation, and interpretation of diverse compound spectra.	Ap
4.	Understand classical and quantum theories of the Raman effect, various Raman spectra, selection rules, resonance phenomena, and advanced techniques like SERS and CARS. This knowledge enables applications in molecular structure analysis.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	2	2	-	3	3	3	3	2	2	3
CO2	3	3	3	3	2	3	2	2	-	3	3	3	3	2	2	3
CO3	3	3	3	3	2	3	2	2	-	3	3	3	3	2	2	3
CO4	3	3	3	3	2	3	2	2	-	3	3	3	3	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE104 (THEORY AND APPLICATIONS OF SPECTROSCOPY- I)

Unit No.	Topics	No. of Lecture	CO No.
I	**UNIFYING PRINCIPLES:** Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission transmission, reflection, dispersion, polarization and scattering, Uncertainty relation and natural line width and natural line broadening, transition probability, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels. Region of spectrum, representation of spectra, F.T. spectroscopy, computer averaging, lasers.	19	1
II	**MICROWAVE SPECTROSCOPY:** Classification of molecules in term of their internal rotation mechanism, determination of rotation energy of diatomic and polyatomic molecules, intensities of rotational spectral lines, effect of isotopic substitution on diatomic and polyatomic molecules, intensities of rotational spectral lines and parameters of rotational energy of linear and the transition frequencies, non-rigid rotators, spectral lines and parameters of rotational energy of linear and symmetric top polyatomic molecules. Application in determination of bond length.	20	2

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III	**INFRA RED SPECTROSCOPY:** Introduction, simple and anharmonic oscillators in vibrational spectroscopy, diatomic-vibrating rotator, Modes of vibration in polyatomic molecules, vibration-coupling, Fourier Transform IR spectroscopy: instrumentation, interferometric spectrophotometer, sample handling, Factors influencing vibrational frequencies, Application of IR spectroscopy: Interpretation of IR spectra of normal alkanes, aromatic hydrocarbons, alcohols, phenols, aldehydes, ketones, ethers, esters, carboxylic acids, amines and amides.	18	3
IV	**RAMAN SPECTROSCOPY:** Classical and quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle, Application of Raman effect in molecular structures, Raman activity of molecular vibration, structure of CO_2, H_2O, N_2O, SO_2, NO_3^-, ClF_3. Resonance Raman spectroscopy, Surface-Enhanced Raman Spectroscopy (SERS), Coherent anti Stokes Raman spectroscopy (CARS), Instrumentation,	18	4

BOOKS SUGGESTED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell.
3. Spectroscopy, B.K. Sharma, Goel Publication.
4. Organic Spectroscopy: Principles and Applications, Jag Mohan, Narosa Publication.
5. Spectroscopy Methods in Organic Chemistry, D.H. Williams & I. Fleming, Tata Mcgraw-Hill Publication.
6. Spectrophotometric Identification of Organic Compounds, R.M. Silversteion & F. X. Webster, John Wiley Publication.

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	**Course Title**		**Course Type**
CHE105	**LABORATORY COURSE–I**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The learning objective is to perform a qualitative analysis of a mixture containing eight radicals, including two less common metals, chosen from the provided list, utilizing a semi-micro method, and to conduct quantitative analysis involving volumetric and gravimetric methods for the separation and estimation of specific components in various substances, as well as the preparation and study of selected inorganic compounds through various spectroscopic and physical measurements, while also handling air and moisture-sensitive compounds.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding of the properties, reactions, and applications of a diverse range of basic and acid radicals, enabling students to analyze and manipulate chemical systems with proficiency.	An
2	Ability to proficiently conduct quantitative analysis through the separation of specified components in ores, alloys, or mixtures in solution, employing both volumetric and gravimetric methods.	An
3	Expertise in the precise estimation of various chemical substances such as Phosphoric acid, Boric acid, Ammonia, Manganese dioxide, Available chlorine, and Hydrogen peroxide in diverse commercial samples through accurate analytical methods.	An
4	Proficiency in the preparation of specific inorganic compounds, coupled with an in-depth investigation using analytical techniques such as I.R., electronic spectra, Mössbauer, E.S.R., and magnetic susceptibility measurements, alongside developing expertise in handling air and moisture-sensitive compounds exemplified by the synthesis and analysis of various inorganic complexes like VO(acac)2, TiO(C9H8NO)2.2H2O, cis-K[Cr(C2O4)2(H2O), etc.	AP

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	3	1	3	-	3	2	3	3	3	2	1
CO2	3	3	3	1	2	3	1	3	-	3	2	3	3	3	2	1
CO3	3	3	3	1	2	3	1	3	-	3	2	3	3	3	2	1
CO4	3	3	3	1	2	3	1	3	-	3	2	3	3	3	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE105 (Lab course I)

Unit No.	Topics	No. of Lectures	CO No.
I	**QUALITATIVE ANALYSIS OF MIXTURE CONTAINING EIGHT RADICALS INCLUDING TWO LESS COMMON METAL FROM AMONG THE FOLLOWING BY SEMI MICRO METHOD.** Basic Radicals: Ag, Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K, Ce, Th, Zr, W, Te, Ti, Mo, U, V, Be, Li, Au, Pt. Acid Radicals: Carbonate, Sulphite, Sulphide, Nitrite, Nitrate, Acetate, Flouride. Chloride, Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate, Ferrocyanide, Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.	40	1
II	**QUANTITATIVE ANALYSIS:** Involving separation of two of the following in ores, alloys, or mixtures in solution, one by volumetric and the other by gravimetric methods.	34	2

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III	**ESTIMATION**: Phosphoric acid in commercial orthophosphoric acid; Boric acid in borax; Ammonia in ammonium salts; Manganese dioxide in pyrolusite; Available chlorine in bleaching powder; Hydrogen peroxide in commercial samples.	36	3
IV	**PREPARATIONS**: Preparation of selected inorganic compound and their studies by I.R. electronic spectra, Mössbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds VO(acac)2, $TiO(C_9H_8NO)_2.\ 2H_2O$, cis-K $[Cr(C_2O_4)_2\ (H_2O)_2]$, Na $[Cr\ (NH_3)_2\ (SCN)_4]$, Mn $(acac)_3$, $K_2[Fe(C_2O_4)_3]$ Prussian Blue, Turnbull's Blue. $[Co\ (NH_3)_6]$ $[Co\ (NO_2)_6]$, cis-$[Co(trien)\ (NO_2)_2]$ $Cl.H_2O$, Hg $[Co\ (SCN)_4]$, $[Co\ (Py)_2Cl_2]$, $[Ni\ (NH_3)_6]\ Cl_2$, Ni $(dmg)_2$ $[Cu\ (NH_3)_4]\ SO_4.\ H_2O$	40	4

BOOKS SUGGESTED

1. Vogel's Textbook of Quantitative Analysis, revi Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	**Course Title**		**Course Type**
CHE106	**LABORATORY COURSE –II**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The learning objective is to perform a series of experimental investigations, including the verification of adsorption isotherms, construction of phase diagrams for three-component systems, determination of kinetic parameters for chemical reactions, estimation of molecular weights of various substances, conductometric and potentiometric measurements, and enzyme kinetics studies, all aimed at enhancing the understanding of physical chemistry principles and laboratory techniques.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the surface tension-concentration relationships, validating Freundlich and Langmuir Adsorption isotherms, determining Critical Micelle Concentration (CMC) of surfactants, and constructing phase diagrams for three-component systems, such as chloroform-acetic acid-water.	U

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2	Develop proficiency in determining velocity constants in chemical kinetics by investigating temperature, concentration changes, and ionic strength effects on ester/ionic reactions, analyzing velocity constants in micellar media, assessing rate constants for hydrogen peroxide decomposition, exploring primary salt effects on ionic reaction kinetics, and testing the Bronsted relationship through iodide ion oxidation by persulphate ion.	Ap
3	Expertise in determining the molecular weight of non-volatile substances using the Landsberger method, as well as determining the molar masses of Naphthalene and acetanilide, and exploring molecular weights of polymers through viscosity measurements.	Ap
4	Experience in performing the conductometric experiments for saponification and solubility determinations. In Potentiometry/pHmetry, proficiency in assessing acid strengths, dissociation constants, redox potentials, enzyme kinetics, and optical activity measurements.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	-	1	2	-	-	3	3	3	3	2	-	-
CO2	3	3	3	1	-	1	2	-	-	3	3	3	3	2	-	3
CO3	3	3	3	1	-	1	2	-	-	3	3	3	3	2	-	2
CO4	3	3	3	1	-	1	2	-	-	3	3	3	3	2	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE106 (Lab course-II):-

Unit No.	Topics	No. of Lectures	CO No.
I	**ADSORPTION/SURFACE CHEMISTRY:** Surface Tension - Concentration relationship for solutions (Gibbs equation). To verify the Freundlich and Langmuir Adsorption isotherms using acetic acid/Oxalic acid and activated charcoal. Determination of CMC of surfactants. **PHASE EQUILIBRIA:** To Construct the Phase diagram for three component system (e.g., chloroform-acetic acid-water).	34	1
II	**CHEMICAL KINETICS:** Determination of the effect of (a) Change of temperature (b) Change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media. Determination of the rate constant for the decomposition of hydrogen peroxide by Fe^{3+} and Cu^{2+} ions. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).	45	2
III	**SOLUTIONS/MOLECULAR WEIGHTS:** Determination of molecular weight of non-volatile substances by Landsberger method. Determination of Molar masses of Naphthelene/acetanilide. Molecular weight of polymers by viscosity measurements.	36	3

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IV	**CONDUCTOMETRY:** Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically. Determination of solubility and solubility product of sparingly soluble salts (e.g., $PbSO_4$, $BaSO_4$) conductometrically. Determination of pK_a of Acetic acid and verification of Ostwald dilution law. **POTENTIOMETRY/pH METRY:** Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter. Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH. Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method. Determination of Redox potential of Fe^{++}/Fe^{+++} system. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter. Enzyme kinetics –inversion of sucrose. Determine the specific and molecular rotation of optically active substances.	34	4

BOOKS SUGGESTED

1. Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
   Handbook of Organic Analysis –Qualitative and Quantitative, H. Clark, Adward Arnold.
4. Vogel's Textbook of Practical Organic Chemistry,
5. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
6. Findley's Practical Physical Chemistry, B.P. Levi
7. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill

M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE201	**TRANSITION METAL COMPLEXES**		**Core**
Credit			
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The aim of this course to provide students a deep understanding of the reaction mechanisms of transition metal complexes, explore their electronic spectra, and comprehend their bonding and reactivity with a focus on substitution reactions, electronic spectra, magnetic properties, and the nature of bonding in various transition metal complexes with unsaturated organic molecules and hydrogen bonds.

Online											
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Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Examines the reaction mechanisms of transition metal complexes, addressing energy profiles, reactivity, and kinetic applications. It covers topics such as substitution kinetics, anation reactions, and features in square planar complexes, along with exploring redox reactions, electron transfer mechanisms, and the Marcus-Hush theory for inner-sphere reactions, providing students a thorough understanding of transition metal complex reactions.	An
2	Explores the electronic spectra and magnetic properties of transition metal complexes, covering topics such as spectroscopic ground states, correlation diagrams, selection rules, absorption intensity, complex geometries, parameter calculations, spin-forbidden transitions, and magnetic properties based on crystal field models, including spin-free and spin-paired equilibria in octahedral stereochemistry.	U
3	Understand the transition metal complexes with diverse ligands, including unsaturated organic molecules and hydrogen, exploring their preparations, properties, bonding nature, structural features, and their application in nucleophilic and electrophilic reactions for organic synthesis.	AP
4	Comprehensive understanding of transition metal alkyls and aryls, including synthesis, stability, and organocopper applications; explores compounds with transition metal-carbon multiple bonds, focusing on alkylidenes and low valent carbenes; and delves into fluxional organometallic compounds, examining dynamic equilibria in complexes like olefin, -allyl, and dienyl compounds.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	-	3	3	3	3	2	1	3
CO2	3	3	3	2	1	2	3	1	-	3	3	3	3	2	1	3
CO3	3	3	3	2	1	2	3	1	-	3	3	3	3	2	1	3
CO4	3	3	3	2	1	2	3	1	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE201 (Transition Metal Complexes)

Unit No.	Topics	No. of Lectures	CO No.
I	**REACTION MECHANISM OF TRANSITION METAL COMPLEXES:** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.	20	1

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II	**ELECTRONIC SPECTRA AND MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES:** Spectroscopic ground states, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Selection rules, mechanism for breakdown of the selection rules, intensity of absorption, band width, spectra of d-d metal complexes of the type $[M(H_2O)]^{n+}$, spin free and spin paired ML_6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelauxetic series. Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equillibria in octahedral stereochemistry.	18	2
III	**A. TRANSITION METAL COMPLEXES:** Transition metal complexes with unsaturated organic molecules, alkanes, allyl, diene dienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features. Important reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis. **B. TRANSITION METALS COMPOUND WITH BOND TO HYDROGEN:** transition Metals Compounds with Bond to Hydrogen.	17	3
IV	**A. ALKYLS AND ARYLS OF TRANSITION METALS:** Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis. **B. COMPOUNDS OF TRANSITION METAL - CARBON MULTIPLE BONDS:** Alkylidenes, low valent carbenes, nature of bond and Structural characteristics. **C. FLUXIONAL ORGANOMETALLIC COMPOUNDS:** Fluxionality and dynamic equilibria in compounds such as olefin, -allyl and dienyl complexes.	20	4

BOOKS SUGGESTED:

1. Principles and applications of organotransition metal chemistry, J.P.Collman, L.S.Hegsdus, J. R. Norton and R.G. Finke, University Science Books.
2. The Organometallic chemistry of the Transition metals, R. H. Crabtree, John Wiley.
3. Metallo - organic chemistry, A.J. Pearson, Wiley.
4. Organometallic chemistry, R.C. Mehrotra and A. Singh, New age International.
5. Inorganc Chemistry, E. Catherine. Houshecroft, Alan G. Sharpe
6. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr
7. Concise Inorgnic Chemistry, J. D. Lee
8. Basic Organometallic Chemistr, Concept Synthesis and Appliction, B. D. Gupta, A J Elias

M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE202	**REACTION MECHANISMS**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-
Maximum Marks	**CIA**		**ESE**
100	30		70

Online

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Learning Objective (LO):

The course aims to comprehend and apply the mechanisms of aliphatic/aromatic nucleophilic and electrophilic substitution reactions, as well as addition reactions to carbon-carbon and carbon-hetero multiple bonds, including their stereochemical aspects, reactivity factors, and regio- and chemoselectivity, while also gaining knowledge of key heterocyclic chemistry concepts and name reactions in organic chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding of aliphatic and aromatic nucleophilic and electrophilic substitution reactions, including their mechanisms and factors influencing reactivity, enhancing their knowledge of reaction mechanisms in organic chemistry.	U
2	Understand the addition reactions to carbon-carbon multiple bonds, emphasizing mechanistic and stereochemical aspects, regio- and chemoselectivity, and various reactions such as hydrogenation, hydroboration, Michael reaction, and Sharple's asymmetric epoxidation.	U
3	Understand the mechanisms of metal hydride reduction for various carbonyl compounds, addition reactions involving Grignard reagents, organo-zinc, and organo-lithium, as well as condensation reactions like Aldol, Knoevenagel, and Stobbe reactions. Additionally, it covers the hydrolysis of esters and amides, along with ammonolysis of esters.	U
4	Understand and apply the heterocyclic chemistry, including structure, reactivity, and synthesis of various heterocycles, as well as important name reactions like Favorskii, Shapiro, Baeyer-Villiger oxidation, Stork Enamine, Mannich, and Heck reactions, among others.	AP

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	3	2	2	-	3	3	3	3	2	1	3
CO2	3	3	3	2	1	3	2	2	-	3	3	3	3	2	1	3
CO3	3	3	3	2	1	3	2	2	-	3	3	3	3	2	1	3
CO4	3	3	3	2	1	3	2	2	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE202 (Reaction Mechanism)

Unit No.	Topics	No. of Lectures	CO No.
I	**ALIPHATIC/AROMATIC NUCLEOPHILIC SUBSTITUTION:** The S_N^2, S_N^1, mechanisms. The neighboring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile and regioselectivity. The von Richter, Sommelet-Hauser, and Smiles rearrangements. **ALIPHATIC/AROMATIC ELECTROPHILIC SUBSTITUTION:** Mechanisms of- S_E^2 S_E^1, electrophilic substitution accompanied by double bond	20	1

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	shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, ipso attack, orienation in other ring systems. Vilsmeir reaction and Gattermann-Koch reaction.		
II	**ADDITION TO CARBON-CARBON MULTIPLE BONDS:** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings Hydroboration, Micheal reaction. Shrapless asymmetric epoxidation.	18	2
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, Organo-Zinc and Organo-lithium to carbonyls and unsaturated carbonyl compounds, Wittig reaction. Mechanism of condensation reactions involving enolates - Aldol, Knoevenagel and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.	17	3
IV	**Heterocyclic Chemistry:** Introduction to heterocyclics and their importance. Nomenclature of ring systems, structure, reactivity and synthesis of reduced three, four, five and six membered oxygen, nitrogen and sulphur heterocyclics; aromatic heterocyclics, 5-membered, 6- membered and polyhetero ring systems - indole, azoles and diazines. **Name Reactions:** Favorskii reaction, Shapiro reaction, Baeyer-Villiger oxidation, Chichibabin reaction, Stork Enamine reaction, Mannich Reaction, Hoffmann-Loffler-Freytag Reaction, Wurtz reaction, Riemen tiemen reaction, Heck reaction Suzuki coupling, Sonogashira reaction, Birch reduction, Wolff-Kishner reduction, Meerwein-Ponndorf-Verley reduction, Paterno-Buchi reaction.	20	4

BOOKS SUGGESTED :

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March,Johan Wiley.
2. Organic Chemistry, J. Clayden, N. Greeves, S. Warren
3. Modern Methods of Organic Synthesis, William Carruthers, Iain Coldham
4. Fundamental of Organic Chemistry, Jahn E. Mc Murry
5. Organic Chemistry, P. Y. Bruice, Eighth Edition
6. Organic Chemistry Principal and Mechanism, Joel Karty
7. Organic Chemistry, F. A. Carey, R. M. Giuliano
8. Modern Organic Synthesis: An Introduction, G S. Zweifel, M. H. Nantz
9. Reaction, rearrangements and reagents, S. N. Sanyal
10. Modern Organic Reactions, H. O. House, Benjamin.
11. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackle Academic & Professional.
12. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
13. Structures and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
14. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillian

Online											
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M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE203	**Quantum Chemistry, Thermodynamic and Chemical Dynamic-II**		**Core**
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

This course aims to apply matrices in quantum chemistry, understand angular momentum concepts, utilize approximate methods like perturbation theory and the variation method for practical quantum chemistry problems, grasp statistical thermodynamics principles, study electrochemistry, and explore chemical dynamics in fast reactions, transition state spectroscopy, and unimolecular reactions, providing students with the tools to address complex chemical systems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop a strong foundation in the application of matrices in quantum chemistry, enabling them to solve complex problems involving quantum systems, angular momentum concepts and their application in quantum chemistry.	AP
2	Understanding of statistical thermodynamics, including ensembles, partition functions, and statistical basis of entropy, allowing them to analyze the behavior of molecular systems.	U
3	Apply their knowledge of electrochemistry to understand electrified interfaces and double layers, and delve into chemical dynamics, which includes fast reactions, transition state spectroscopy, and theories of unimolecular reactions.	Ap
4	Understand chemical dynamics, exploring fast reactions through flow, relaxation, flash photolysis, and nuclear magnetic resonance methods. They'll delve into transition state spectroscopy, femtochemistry, ultrafast dynamics, molecular reaction dynamics.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	1	2	2	-	3	3	3	3	2	-	3
CO2	3	3	3	3	1	1	2	2	-	3	3	3	3	2	-	3
CO3	3	3	3	3	1	1	2	2	-	3	3	3	3	2	-	3
CO4	3	3	3	3	1	1	2	2	-	3	3	3	3	2	-	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online

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Detailed Syllabus: CHE203 (Quantum Chemistry, Thermodynamic and Chemical Dynamic-II)

Unit No.	Topics	No. of Lectures	CO No.
I	**APPLICATION OF MATRICES IN QUANTUM CHEMISTRY:** Addition and multiplication, inverse and transpose of matrices. Determinants, in quantum Chemistry**.** **ANGULAR MOMENTUM IN QUANTUM CHEMISTRY:** Angular momentum, angular momentum Operators. Eigen functions and Eigen values Angular momentum, ladder operators. **APPROXIMATE METHODS:** The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom.	20	1
II	**STATISTICAL THERMODYNAMICS:** Probability, permutations and combinations concepts of probability, Maxwell Boltzmann distribution. Different ensembles and Partition functions translational, rotational, vibrational and Electronic. Thermodynamic function using appropriate Partition function. Fermi-Dirac and Bose-Einstein Statistics and statistical basis of entropy. Heat capacity of solids, Debye and Einstein Models.	18	2
III	**ELECTROCHEMISTRY–II:** Structure of electrified interfaces. Gouy-Chapman, Stern, Over potentials and exchange current density, Derivation of Butler –Volmer equation, Tafel plot. Semiconductor interfaces, Theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interfaces. Electro catalysis influence of various parameters. Hydrogen electrode.	18	3
IV	**CHEMICAL DYNAMICS –II:** General features of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Transition state spectroscopy, Femto-chemistry and ultrafast dynamics, Molecular reaction dynamics, Dynamics of molecular motions, probing the transition state, dynamics of barrierless chemical reactions in solutions, dynamics of unimolecular reaction. [Lindemann –Hinshelwood, RRK and Rice-Ramsperger-Kassel-Marcus {RRKM}] theories of unimolecular reactions.	19	4

BOOKS SUGGESTED :

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sutclilffe, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D.M, Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt, Wiley.
7. Physical Chemistry, P.W. Atkins, ELBS.
8. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
9. Quantum Chemistry, Ira N. Levine, Prentice Hall.
10. Coulson's Valence, R. McWeeny, ELBS.
11. Chemical Kinetics, K. J. Laidler, Pearson.
12. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
13. Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
14. Thermodynamics for Chemists, S. Glasstone EWP.
15. An Introduction to Electrochemistry S. Glasstone EWP.
16. Physical Chemistry, Ira N. Levine McGraw Hill.
17. Physical Chemistry, Silbey, Alberty, Bawendi, John-Wiley.
18. Molecular Reaction Dynamics and Chemical Reactivity, R. D. Levine and R. B.Bernstein, Oxford University Press, Oxford 1987.

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE204	**THEORY AND APPLICATIONS OF SPECTROSCOPY –II**		**Core**
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The objective of this course is deep understanding of various spectroscopic techniques, including ultraviolet and visible spectroscopy, scattering spectroscopy, mass spectrometry, and nuclear resonance spectrophotometry, and their applications, equipping students with the knowledge and skills necessary to analyze complex molecular structures, identify compounds, and determine stability constants.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand UV and visible spectroscopy, vibrational-electronic spectra intensity, the Frank-Condon principle, and rotational fine structure. They'll analyze molecular orbitals, electronic spectra of organic molecules, and chromophores, applying electronic spectroscopy for spectrophotometric studies, ligand/metal ratio determination, compound identification, and stability constant determination.	An
2	Understand the scattering spectroscopy, covering Auger spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), turbidimetry, nephelometry, fluorometry, fluorescence, phosphorescence, and factors influencing them. They'll gain practical insights into instrumentation and applications in various analytical techniques.	U
3	Develop expertise in mass spectrometry, including the interpretation of mass spectral fragmentation of organic compounds, enabling them to determine molecular weight and formula and apply mass spectrometry in different in several chemical analysis.	AP
4	Gain a strong foundation in nuclear resonance spectrophotometry, including NMR spectroscopy and Carbon-13 NMR spectroscopy, equipping them with the skills to determine the structure of organic compounds and analyze chemical environments through various NMR techniques	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	2	2	-	3	3	3	3	2	1	3
CO2	3	3	3	3	2	3	2	2	-	3	3	3	3	2	1	3
CO3	3	3	3	3	2	3	2	2	-	3	3	3	3	2	1	3

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CO4	3	3	3	3	2	3	2	3	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE204 (THEORY AND APPLICATIONS OF SPECTROSCOPY –II)

Unit No.	Topics	No. of Lectures	CO No.
I	**ULTRAVIOLET AND VISIBLE SPECTROSCOPY**: Introduction, intensity of vibrational-electronic spectra and Frank-Condon principle for dissociation energy, rotational fine structure of electronic-vibrational spectra, Shape of some molecular orbitals viz., H_2, He_2, N_2, O_2. Electronic spectra of organic molecules, chromophores, application of electronic spectroscopy: spectrophotometric studies of complex ions, determination of ligand/metal ratio in a complex (Jobs method, mole ratio and slope ratio method), identification of compounds, determination of stability constants.	20	1
II	**SCATTERING SPECTROSCOPY:** Principle, instrumentations and application of Auger spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) Theory, instrumentation and application of turbidimetry, nephelometry, fluorometry. Fluoroscence and phosphorescence and factors affecting them.	18	1
III	**MASS SPECTROMETRY:** Introduction, basic principles, separation of the ions in the analyzer, resolution, molecular ion peak, mass spectral fragmentation of organic compounds, factors affecting fragmentation, McLafferty rearrangement. Instrumentation, ionization sources (EI, CI, FAB, ESI, MALDI), mass analyzers (sector, quadrupole, QIT, TOF, FTICR), Characteristics of mass spectra of Alkanes, Alkenes, Aromatic hydrocarbons, Alcohols, Amines. Nitrogen rule, ring rule, Molecular weight and formula determination.	19	3
IV	**NUCLEAR RESONANCE SPECTROPHOTOMETRY:** Theory of NMR spectroscopy, interaction of nuclear spin and magnetic moment, chemical shift, processional motion of nuclear particles in magnetic field, spin-spin splitting, coupling constants, factor affecting the chemical shift, shielding effect, effect of chemical exchange, hydrogen bonding, instrumentation of Fourier transform NMR spectrophotometer, structure determination of organic compounds, Carbon-13 NMR spectroscopy, Multiplicity-proton (^{1}H) decoupling-noise decoupling, off resonance decoupling, selective proton decoupling, chemical shift.	18	4

BOOKS SUGGESTED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell.
3. Spectroscopy, B.K. Sharma, Goel Publication.
4. Organic Spectroscopy : Principles and Application, Jag Mohan, Narosa Publication.
5. Spectroscopic Methods in Organic Chemistry, D.H. Williams & I. Fleming, Tata Mc Graw-Hill Publication.
6. Spectrophometric Identification of Organic Compounds, R.M. Silverstein & F.X. Webster, John Wiley Publications.

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M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE205	**LABORATORY COURSE –III**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The objective of this course is to acquire a thorough understanding of general methods for separating and purifying organic compounds, distillation techniques, and analytical skills for identifying organic binary mixtures, while also gaining practical experience in the preparation of organic compounds through various single-stage reactions, enhancing students' proficiency in organic chemistry laboratory techniques

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop proficiency in general methods for the separation and purification of organic compounds, with a special focus on solvent extraction and fractional crystallization.	**AP**
2	Understand the various distillation techniques, including simple distillation, steam distillation, fractional distillation, and distillation under reduced pressure, enabling them to separate and purify organic compounds effectively.	**AP**
3	Acquire strong analytical skills for the separation and identification of organic binary mixtures, with the capability to analyze a variety of binary mixtures containing compounds with different substituents.	**AP**
4	Gain hands-on experience in organic synthesis, single-stage organic compound preparations, students will be able to synthesize, purify, and characterize organic compounds using various reactions, enhancing their practical skills and understanding of organic synthesis.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	-	2	1	-	3	3	3	1	2	-	1
CO2	3	3	3	2	2	-	2	1	-	3	3	3	1	2	-	1
CO3	3	3	3	2	2	1	2	1	-	3	3	3	1	2	-	1
CO4	3	3	3	2	2	1	2	1	-	3	3	3	1	2	-	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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	Online										

Detailed Syllabus: CHE205 (Lab course III)

Unit No.	Topics	No. of Lectures	CO No.
I	**GENERAL METHODS OF SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS WITH SPECIAL REFERENCE TO:** Solvent Extraction, Fractional Crystallization	20	1
II	**DISTILLATION TECHNIQUIES**: Simple distillation, steam distillation, Fractional distillation and distillation under reduced pressure.	20	2
III	**ANALYSIS OF ORGANIC BINARY MIXTURE:** Separation and Identification of organic binary mixtures containing at least one component with two substituents. (A student is expected to analyse at least 10 different binary mixtures.)	17	3
IV	**PREPARATION OF ORGANIC COMPOUNDS: SINGLE STAGE PREPARATIONS.** **Acetylation**: Synthesis of β-Naphthyl acetate from β-Naphthol / Hydroquinone diacetate from Hydroquinone. **Aldol condensation**: Dibenzal acetone from benzaldehyde. **Bromination**: p-Bromoacetanilide from acetanilide. **Cannizzaro Reaction**: Benzoic acid and Benzyl alcohol from benzaldehyde. **Friedel Crafts Reaction**: o-Benzoyl Benzoic acid from phthalic anhydride. **Grignard Reaction**: Synthesis of triphenylmethanol from benzoic acid, **Oxidation**: Adipic acid by chromic acid oxidation of cyclohexanol. **Perkin's Reaction**: Cinnamic acid from benzaldehyde. **Sandmeyer Reaction**: p-Chlorotoluene from p-toluidine/o-Chlorobenzoic acid from anthranilic acid. **Schotten Baumann Reaction:** β-Naphthyl benzoate from:β-Naphthol / Phenyl benzoate from phenol. **Sulphonation Reaction**: Sulphanilic acid from aniline. Benzophenone from benzhydrol, Sucrose from Oxalic acid, Dye preparation, Sulphanilic acid from Methyl orange, Dye preparation: p-nitroaniline from p-red	18	4

BOOK SUGGESTED :

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Salija.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett.
6. Practical Physical chemistry by Alexander Findlay.
7. Experimental Physical chemistry, D. P. Shoemaker, G. W. Garland and J. W. Niber, Mc Graw Hill Interscience.
8. Findlay's Practical Physical chemistry, revised B

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M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	**Course Title**		**Course Type**
CHE206	**LABORATORY COURSE –IV**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The aim of this course is to acquire practical skills in electrophoresis, spectroscopy, and various analytical techniques, including the verification of Beer's Lambert Law, the determination of stoichiometry and stability constants of inorganic and organic complexes, characterization of complexes through electronic and IR/UV spectral data, and the determination of indicator constants (pKa) using experimental methods, ultimately enabling students to perform and analyze complex chemical experiments and data.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Skilled the students with essential computer, covering PC operation, standard program execution (linear regression, X-Y plot, numerical integration, differential equation solutions), and applications like Monte Carlo and Molecular dynamics using data from physical chemistry labs. Additionally, students will gain proficiency in using software packages including Microsoft Excel, Word, PowerPoint, SPSS, Origin, MATLAB, and EasyPlot.	**AP**
2	Proficient in error analysis and statistical data analysis, encompassing skills in linear regression analysis, curve fitting, Student "t" test, and the application of basic statistical parameters for data analysis. The course also includes calibration techniques for volumetric apparatus such as burette, pipette, and weight box.	**AP**
3	Skilled in flame photometric determinations, including the analysis of sodium and potassium in various sample types, such as solid and liquid samples, and the determination of lithium, calcium, barium, strontium, cadmium, and magnesium in tap water. Additionally, the course covers nephelometric determinations for sulfate, phosphate, and silver.	**AP**
4	Capable of performing the electrophoresis for separating inorganic salt cations and capillary electrophoresis for water-soluble vitamins. The course also covers spectroscopic techniques, including verifying Beer's Lambert Law, determining stoichiometry and stability constants of complexes, characterizing complexes through electronic and IR/UV spectral data, and determining the indicator constant (pKa) of methyl red.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;

CO-PO/PSO Mapping for the course

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	2	2	1	-	3	3	3	3	1	2	-

Online											
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CO2	3	3	3	3	1	2	2	1	-	3	3	3	3	1	2	-
CO3	3	3	3	3	1	3	2	3	-	3	3	3	3	1	2	-
CO4	3	3	3	3	1	3	2	3	-	3	3	3	3	1	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE206 (LABORATORY COURSE –IV)

Unit No.	Topics	No. of Lectures	CO No.
I	**ERROR ANALYSIS AND STATISTICAL DATA ANALYSIS:** Linear Regression Analysis, Curve Fitting, Student "t" Test, Data Analysis Using Basic Statistical Parameters, Calibration of volumetric Apparatus, Burette, Pipette Weight Box etc.	20	1
II	**USE OF COMPUTER PROGRAMMES:** The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory. Further, the student will operate one or two or the packages such as MICROSOFT EXCEL, WORLD, POWERPOINT, SPSS, ORIGIN, MATLAB, EASYPLOT.	17	
III	**A. FLAME PHOTOMETRIC DETERMINATIONS:** Sodium and potassium when present together. Sodium/potassium in solid samples. Solid Sodium and Potassium in Liquid Samples. Lithium/calcium/barium/strontium. Cadmium and magnesium in tap water. **B. NEPHELOMETRIC DETERMINATIONS:** Sulphate, Phosphate, Silver	20	2
IV	**ELECTROPHORESIS:** To separate cations of inorganic salts by paper electrophoresis. Capillary Electrophoresis of water –soluble Vitamins **SPECTROSCOPY:** Verification of Beer's Lambert Law. Determination of stoichiometry and stability constant of inorganic (e.g. ferric – salicylic acid) and organic (e.g. amine-iodine) complexes, thiocyanate. Characterization of the complexes by electronic and IR, UV spectral data. Determination of Indicator constant (pKa) of methyl red.	18	3

BOOK SUGGESTED :

1. Computer and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
2. Computational Chemistry, A.C. Norris.
3. Microcomputer Quantum Mechanics, J.P. Killngbeck, Adam Hilger.
4. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishnan, Prentice Hall.
6. Experiments in Chemistry, D.V. Jahagirgar

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M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE301	**SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANOCATALYSIS**		**CORE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The aim of this course is to understand and apply advanced spectroscopic techniques, including Electron Spin Resonance Spectroscopy, Nuclear Quadrupole Resonance Spectroscopy, Photoelectron Spectroscopy, Photoacoustic Spectroscopy, and to gain knowledge of photophysical and photochemical processes, reaction mechanisms, and organocatalysis principles in the context of various chemical systems and reactions.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the Electron Spin Resonance Spectroscopy, exploring hyperfine and spin-orbit couplings, g-tensors, and their applications in transition metal complexes with unpaired electrons. Additionally, they'll understand Nuclear Quadrupole Resonance Spectroscopy.	**U**
2	Understand Photoelectron Spectroscopy principles, including the photoelectric effect, ionization processes, Koopman's theorem, and spectra of simple molecules. They'll also understand the determination of dipole moments and X-ray photoelectron spectroscopy (XPS). In addition, they'll grasp the basic principles of Photoacoustic Spectroscopy (PAS).	**U**
3	Understand photochemical principles, excited state processes, and reaction mechanisms; apply concepts like quantum yield, energy transfer, and photoreduction; and explore key photoreactions including Norrish, Photo-Fries, and Barton reactions, along with photochemistry of vision and environmental applications.	**An**
4	Acquire knowledge of the principles and applications of organocatalysis, including homogeneous and heterogeneous catalytic reactions, enabling the design and optimization of catalytic processes for chemical transformations.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3
CO2	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3
CO3	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3

Online

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CO4	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE301 (SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANOCATALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**ELECTRON SPIN RESONANCE SPECTROSCOPY**: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron). **NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY:** Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting, applications.	18	1
II	**PHOTOELECTRON SPECTROSCOPY:** Basic principle both for atoms and molecules; Photo-electric effect, ionization process, Koopman's theorem, Spectra of simple molecules Determination of Dipole moment, X-ray photo electron spectroscopy (XPS) **PHOTOACOUSTIC SPECTROSCOPY:** Basic principle of Photo acoustic Spectroscopy (PAS), PAS –gases and condensed system Chemical and Surface application	20	2
III	**PHOTOCHEMICAL REACTIONS:** Interaction of electromagnetic radiation with matter, Photophysical processes, Stern Volmer equation, types of excitations, rate of excited molecule, quantum yield, transfer of excitation energy, Actinometry. Types of excitations, quenching, Quantum efficiency, singlet and triplet states, experimental methods in photochemistry of carbonyl compounds, and transition, Norrish type I and Norrish type II reactions, Photoreduction, Photochemistry of enones, Hydrogen abstraction, rearrangement of unsaturated ketones and cyclohexadienones, Photochemistry of p-benzoquinones, photochemistry of aromatic compounds with reference to isomerization, addition and substitution, Photochemical isomerization of cis and trans alkenes, Photochemical cyclization of reaction. **DETERMINATION OF REACTION MECHANISM**: Classification, rate constants and life times of reactive energy states –determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. **MISCELLANEOUS PHOTOCHEMICAL REACTIONS**: Photo-Fries reactions of anilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers, Photochemistry of vision.	20	3
IV	**ORGANOCATALYSIS** General Principles: Energetic, Catalytic cycles, catalytic efficiency and life time, selectivity. Type of organometallic reaction: Ligand substitution, Oxidative addition, reductive elimination and insertion and deinsertion. Homogeneous catalysis: Hydrogenetion of alkenes, Hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, Alkenes metathesis, Palladium-Catalysed C-C bond forming reactions, asymmetric oxidation. Heterogenous catalysis: The nature of heterogenous catalysts, Fischer- Tropsch synthesis, alkene polymerization	17	4

BOOK SUGGESTED:

1. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.

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2. Fundamentals of Photochemsitry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
3. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publications.
4. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
5. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill.
6. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
7. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.
8. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
9. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
10. Shriver & Atkins Inorganic Chemistry: P.Atkins, T.Overtone, J. Rourke, M. Weller, F. Armstrong, Oxford University Press
11. Inorganic Chemistry: C.E. Housecraft, A.G. Sharpe, Pearson Education Limited.
12. Inorganic Chemistry: Principles of Structure and Reactivity: J.E. Huheey, E.A. Keiter, R.L.Keiter, O.K. Medhi, Pearson Education
13. Organometallic Chemistry: A Unified Approach: R.C. Mehrotra, A.Singh, New Age International Publishers.

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE302	**CHEMISTRY OF BIOMOLECULES**		**CORE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The objective of this course is to understand the principles of bioenergetics, electron transfer in biological systems, metalloproteins, enzyme structure and function, coenzyme chemistry, biotechnological applications of enzymes, biopolymer interactions, thermodynamics of biopolymer solutions, and cell membrane functions in the context of biochemistry and biophysical chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Acquire a thorough grasp of bioenergetics, calculating standard free energy changes, distinguishing exergonic and endergonic processes, and explaining ATP hydrolysis and synthesis. Gain insights into electron transfer in biology, focusing on metalloproteins like cytochromes and iron-sulfur proteins, and applying synthetic models to understand these systems.	U
2	Understand enzyme nomenclature, classification, and the induced fit hypothesis. They will identify active sites using inhibitors. Additionally, students will understand coenzyme structures and functions and explore enzyme immobilization techniques, their effects, and applications in medicine, industry, and recombinant DNA technology.	U

3	Acquire a deep understanding of metalloenzymes and their various roles in biological processes, including zinc enzymes, iron enzymes, copper enzymes, and molybdenum oxatransferase enzymes, as well as the importance of these enzymes in catalysis.	AP
4	Understand structure and types of carbohydrates, amino acids, proteins, and peptides; explore nucleic acid structures, biosynthesis of DNA/RNA, functions of RNA types, and techniques like PCR and RT-PCR related to genetic replication and expression.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO2	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO3	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO4	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE302 (CHEMISTRY OF BIOMOLECULES)

Unit No.	Topics	No. of Lectures	CO No.
I	**BIOENERGETICS:** Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. **ELECTRON TRANSFER IN BIOLOGY:** Structure and function of metalloproteins in electron transport processes –cytochromes and ion-sulphur proteins, synthetic models. **TRANSPORT AND STORAGE OF DIOXYGEN:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and haemerythrin, model synthetic complexes of iron, cobalt and copper.	18	1
II	**ENZYMES:** Nomenclature and classification of Enzyme. Induced fit hypothesis, concept and identification of active site by the use of inhibitors. **CO-ENZYME CHEMISTRY:** Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B_{12}. **BIOTECHNOLOGICAL APPLICATIONS OF ENZYMES:** Techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilization enzymes in medicine and industry. Enzymes and Recombinant DNA Technology.	19	3
III	**METALLOENZYMES:** Zinc enzymes –carboxypeptidase and carbonic anhydrase. Iron enzymes – catalase, peroxidase and cytochrome P-450. copper enzymes-superoxide dismutase. Molybdenum oxatransferase enzymes –xanthine oxidase. **ENZYME MODELS:** Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, Cyclodextrin-based enzyme models, calixarenes, ionophores, synthetic enzymes or enzymes.	17	2
IV	**Carbohydrates:** Types of naturally occurring sugars, deoxy sugars, amino sugars, branched chain sugars, and acid derivatives of sugars, configurations of aldoses and	21	4

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	applications. **Amino acids, protein and peptides:** Amino acids, structural characteristics, acid base property, stereochemistry of amino acids, optical resolution, Stecker synthesis, **Nucleic Acids:** Primary, secondary and tertiary structure of DNA; DNA replication and heredity; Structure and function of mRNA, tRNA and rRNA. Purines and pyrimidine bases of nucleic acids and their preparation, Biosynthesis of DNA and RNA, Polymerase Chain Reaction (PCR) and RTPCR		

BOOK SUGGESTED:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.L. Lippard and J.S. Valentine, University Science Books.
3. Inorganic Biochemistry vols II and I.Ed G.L. Eichhorn, Elservier.
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
5. Bioinorganic Chemistry, I. Bertinin, H.B. Gary, S.J. Lippard and J.S. Valentine, University Science.
6. Inorganic Biochemistry vols I and II ed. G.L. Eichhorn, Elsevier.
7. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-verlag.
8. Understanding Enzymes, Trevor palmer, Prentice Hall.
9. Enzyme Chemistry : Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
10. Enzyme Mechanisms Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
11. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
12. Immobilizaed Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, and John Wiley.
13. Enzymatic Reaction Mechanisms, C. Walsh, W.H. Freeman.
14. Enzyme Structure and Mechanisms, A Fersht, W.H. Freeman.
15. Biochemistry: The Chemical Reacitons of liging cells, D.E. Metzler, Academic Press.
16. Principles of Biochemistry, A.L. Lehninger, Wroth Publishers.
17. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C.
18. Penny, Springer-Verlag
19. Understanding Enzymes, Trevor Palmer, Prentice Hall
20. Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall
21. Enzyme Structure and Mechanism, A. Fersht, W. H. Freeman
22. Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH
23. Wilson and Gisvold's Text Book of Organic Medical and Pharmaceutical Chemistry, Ed Robert F. Dorge
24. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE303	**CATALYSIS, SOLID STATE AND SURFACE CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	EA
100	30	70

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

Learning Objective (LO):

The objective of the course is to provide students a comprehensive understanding of principles of acids and bases, electrophiles and nucleophiles, catalysis, micelles and adsorption, solid-state chemistry, and macromolecules, including their structures, properties, and various associated concepts and applications in the field of chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop a strong foundation in the fundamental concepts of acids, bases, electrophiles, and nucleophiles, enabling students to assess electronic and structural effects, quantify reactivity, and apply these principles to understand acid-base catalysis and enzyme catalysis.	**U**
2	Gain expertise in the chemistry of micelles and adsorption, including the classification of surface-active agents, micellization, critical micellar concentration, and the thermodynamics of micellization, as well as the application of these concepts to understand surface tension, capillary action, and catalysis at interfaces.	**U**
3	Acquire knowledge of solid-state chemistry, encompassing crystal systems, lattice structures, crystal defects, and non-stoichiometry, leading to a comprehensive understanding of ionic crystal structures, electronic properties, and band theory in metals and semiconductors.	**An**
4	Explore macromolecules, including their types, kinetics of polymerization, and synthesis and application of conducting polymers, providing students with insights into the diverse properties and applications of polymers in various industries.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	3	1	2	-	3	3	3	3	2	1	3
CO2	3	3	3	2	1	3	1	2	-	3	3	3	3	2	1	3
CO3	3	3	3	2	1	3	1	2	-	3	3	3	3	2	1	3
CO4	3	3	3	2	1	3	1	2	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE303 (CATALYSIS, SOLID STATE AND SURFACE CHEMISTRY)

Unit No.	Topics	No. of Lectures	CO No.
I	**ACIDS, BASES, ELECTROPHILES, NUCLEOPHILES AND CATALYSIS:** Acid-base dissociation, Electronic and structural effects, acidity and basicity. Acidity function and their applications. 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, Taft equation. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The alpha effect. Ambivalent Nucleophilies. Acid base catalysis-specific and general catalysis. Bronsted catalysis, Enzyme Catalysis.	18	1

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

II	**MICELLES AND ADSORPTION:** Micelles, Classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of Surfactants. Thermodynamics of micellization - phase separation and mass action models. Reverse micelles, micro-emulsion. Micellar Catalysis, Surface tension capillary action, pressure difference across curved surface (Laplace equation), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm.	17	2
III	**SOLID STATE CHEMISTRY:** Crystal System and Lattice, Miller Plane, Crystal Packing, Braggs Law, ionic crystal structure of AX, AX2, ABX3 type compounds, Crystal defects and Non-stoichiometry - Perfect and imperfect crystals, intrinsic and extrinsic defects - point defect, line and plane defects, vacancies - Schottky defects and Frankel defects. Thermodynamics of Schottky and Frenkel defect, formation of color centers, non-stoichiometry and defects. Spinels, Electronic properties, Band theory, Metal and Semiconductors (P and N-type semiconductor synthesis and structure properties).	20	3
IV	**MACROMOLECULES:** Polymer - Definition types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Synthesis and Application of Conducting Polymers: Polyaniline, polypyrrole, Polythiophene etc. Molecular mass and average molecular mass. Molecular mass determination (Osmometry, Viscometry, diffusion and light scattering methods), Sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.	20	4

BOOK SUGGESTED :

1. G.W. Castellan, "Physical Chemistry", Addison- Lesley Publishing Co.
2. E.A. Moelwyn Hughes, "Physical Chemistry", Pergamon Press.
3. Denbigh, "Chemical Equilibria", D. Van Nostrand.
4. J. Rose, "Dynamic Physical Chemistry" Sir Issac Pitman and Sons.
5. Solid state "Chemistry and its Applications, A.R. West, Plenum.
6. Principle of Solid State H.V. Kar, Wiley Eastern.
7. Solid State Chemists, D.K. Chakrabarty, New Age International (P) Ltd.
8. Micelles, Theoretical and Applied Aspects, V. Moral Plenum.
9. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
10. Mathematics for Chemistry, Doggett and Sutcliffe, Longman.
11. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
12. Chemical Mathematics, D.M. Hirst, Longman.
13. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
14. Basic Mathematics for Chemists, Tebbutt, Wiley.
15. Quantum Chemistry, Ira N. Levine, Prentice Hall.
16. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

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M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE304	**ANALYTICAL TECHNIQUES AND DATA ANALYSIS**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The objective of this course is to provide students with a comprehensive understanding of sample preparation techniques, digestion methods, and statistical analysis; understand principles and applications of various separation techniques, including solvent extraction and chromatography; and acquire knowledge of thermal and methods and electrochemical methods, enabling the accurate and precise analysis of diverse types of materials and compounds.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Expertise in sample collection, preservation, and preparation for analysis, using diverse digestion methods. They'll acquire a deep understanding of statistical analysis, precision, accuracy, error analysis, and graphical data presentation for confident evaluation and interpretation of analytical data.	**An**
2	Gain expertise in separation techniques, including solvent extraction and chromatography, and apply these principles to efficiently separate and identify various compounds in complex mixtures.	**An**
3	Understand the principles, instrumentation, and applications of TGA, DTA, DSC, C/H/S/N/O Analyzer, and organic and elemental carbon analyzers, gaining skills in thermal and elemental analysis techniques.	**Ap**
4	Develop a strong foundation in electrochemical methods, including pH potentiometry, coulometry, and conductometry, as well as various voltammetry techniques, facilitating the quantitative analysis and characterization of electrochemical processes and substances.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO2	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO3	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO4	3	3	3	3	1	2	2	2	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online											
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Detailed Syllabus: CHE304 (ANALYTICAL TECHNIQUES AND DATA ANALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**SAMPLE PREPARATION, DEGESTION AND STATISTICAL ANALYSIS:** Sampling - Collection, Preservation and preparation of sample, Techniques of sampling of solid, liquid and gaseous samples, Operation of drying and preparing a solution of the analyte. Principle, methodology and application of different types of digestions such as acid digestion, base digestion, enzymatic and microwave digestion for liquid and solid materials. Evolution and procession of Analytical Data, Precision and Accuracy, Types of Errors, Propagation of errors, Normal Distribution Curve, Standard deviation, Confidence limit, Graphical presentation of result-method of average, Method of Linear least square, Significant figures, Statistical aid to hypothesis of testing- t-test, F-test, Correlation coefficient, Rejection of data.	20	1
II	SEPARATION TECHNIQUES: Principle of Solvent Extraction, Methods of Extraction, Efficiency of extraction, Selectivity of extraction, applications. Principle, classification of chromatographic techniques, Technique and applications of paper chromatography, Thin-layer chromatography, HPTLC, Column chromatography, liquid chromatography and gas chromatography HPLC and GC.	18	2
III	**THERMAL AND X-RAY METHODS:** Principle, Instrumentation, Applications of TGA, DTA and DSC, C/H/S/N/O Analyzer, organic carbon (OC) and elemental carbon Analyzers (Addition).	17	3
IV	**ELECTROCHEMICAL METHODS:** Basic principle and instrumentation of pH potentiometry, coulometry and counductometry. Basic principle and instrumentation of polarography, diffusion current, polarized electrode, micro electrode, dropping mercury electrode llkovic equation, Polarographic wave, Amperometric titration, Linear sweep voltammetry, anodic and cathodic stripping voltammetry, normal pulse voltammetry, differential pulse voltammetry, square wave voltammetry, cyclic voltammetry.	20	4

BOOK SUGGESTED :

1. Fundamental of Analytical Chemistry- Skoog D.A. and West D.M.
2. Saunders, College Publication.
3. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
4. Principles and Practice of Analytical Chemistry-Fifield F.W and Kealey
5. D. Black well Science
6. Instrumental Analysis R. Braun, McGraw Hill, International Edition.
7. Analytical Chemistry, Christian, G.D., WSE/Wiley.
8. Instrumental Analysis, Willard Meritt Dean, CBS.
9. Chemical Analysis, Brawn, McGraw Hill.
10. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M.
11. Principles of instrumental analysis, Skoog Holler - Niemann.
12. Instrumental analysis, Wizard Dean and Merit.
13. Principle and PRACTICAL analytical chemistry, Fifield and Kealey.

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Elective courses 2 (Select (305 + 306 or 307 only)

(Combination should be- Lab course VII (305)+ Lab course VIII (306) OR only Project work (307)

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	Course Title		Course Type
CHE305	**LABORATORY COURSE –V**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The course aims to encompass the calculation of radioactive source activity, determination of half-lives, measurement of absorption coefficients and half thickness for gamma radiation, exploration of β particle characteristics, verification of the inverse square law for gamma rays, utilization of gamma ray spectrometry, and the study of kinetics, catalysis, and various reaction factors, including temperature, concentration, catalysts, and the effect of different solvents and substrates on reaction rates.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the determination of radioactive activity, determine radionuclide half-life, absorption coefficient, half thickness of lead for gamma radiation, range, energy of β particles, prove the inverse square law for gamma rays, measure gamma ray energy, and determine partition coefficients.	**UP**
2	Study exchange kinetics, determine solubility product, dissociation constant, concentration by isotope dilution, and investigate reaction rates under varying conditions using different techniques.	**AP**
3	Understand the reactions of acetone and iodine, KMnO4 and oxalic acid, K2S2O8 and iodine, and the decomposition of benzene diazonium chloride. They'll determine pKa, evaluate equilibrium constants, and measure rate constants at different temperatures.	**An**
4	Investigate complex chemical reactions, including autocatalytic reactions, photolysis, enzyme-catalyzed reactions, and micellar-catalyzed reactions, enhancing the understanding of reaction mechanisms and the influence of various parameters on reaction rates.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	-	2	2	1	-	3	3	3	3	2	1	-
CO2	3	3	3	1	-	2	2	1	-	3	3	3	3	2	1	-
CO3	3	3	3	1	-	2	2	1	-	3	3	3	3	2	1	-
CO4	3	3	3	1	-	2	2	1	-	3	3	3	3	2	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE305 (LABORATORY COURSE –V)

Unit No.	Topics	No. of Lectures	CO No.
I	1. Soap preparation 2. Preparation perfumes from different flower and plants 3. Isolation of organic compound from plants. 4. Colorimetry determination of Iron from water samples using thiocyanate method. 5. Determination of chloride using volumetric titration 6. Determination of Hardness from water samples using EDTA titration. 7. Synthesis of nanomaterials like Au, Ag, Fe_3O_4, ZnO, CuO etc and their Application	40	1
II	1. Study of kinetics of exchange between ethyl iodide & the iodide ion. 2. Determination of the solubility product of lead iodide. 3. Determination of the dissociation constant of Barium Nitrate. 4. Determination of the concentration of iodine in a given sample (KI), by isotope dilution technique. 5. To study the effect of temperature, concentration of the reactant and catalyst on the rate of a chemical reaction (Hydrolysis/Nucleophilic Substitutuion). 6. Reaction between Sodium Formate and Iodine by Volumetric Method & Conductometric Method, 7. Saponification of ethyl acetate by Volumetric Method & Conductometric Method.	36	2
III	1. Reaction between Acetone and Iodine. 2. To study the autocatalylic reaction between $KMnO_4$ and Oxalic acid. 3. Reaction between $K_2S_2O_8$ and Iodine. 4. Determination of pKa by Kinetic Measurement. 5. Evaluation of Equilibrium constants from kinetic data. 6. Determination of rate constant of the decomposition of benzene diazonium chloride at different temperature. 7. To study the photolysis of uranyl oxalate.	40	3
IV	1. To study the effect of substate catalyst etc (i) HCl, $K_2S_2O_8$ (ii) KOH, NaOH. 2. To study the Activation parameters. 3. To study the solvent effect using some Aprotic & Protic Solvents. 4. To examine the substituent effect (Hammett equation). 5. To study the effect of Electrolyte on the rate hydrolysis (KCl, NaCl,) 6. To study some simple enzyme catalyzed reaction. 7. To study the Micellar Catalyzed Reaction.	34	4

*** Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, Fluorescence Spectrophotometer, Tensiometer etc.) experiments may be given to the students.**

Online											
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BOOK SUGGESTED:

1. Basic Experiment with radioisotopes by John, N. Andrews & David J. Hornsey, Pitam Publishing New York.
2. Practical radiochemistry by M.F.C. Ladd & W.H. Lee, Cleaver Hune press Ltd.
3. Practical Physical Chemistry by Alexander Findlay.
4. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, Mc Graw Hill Interscience.
5. Findlay's Physical Practical Chemistry, revised B. Phys. Levitt, Longman.

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CH306	**LABORATORY COURSE –VI**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The objectives of this course are to develop the skills needed for spectrophotometric determinations of elements and ions, pH metry, polarography, flame photometric analysis, refractometry, and separation techniques for binary and ternary mixtures, enabling quantitative analysis of complex chemical systems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Attain proficiency in performing spectrophotometric analyses of various elements and ions in complex samples, enhancing the ability to quantitatively determine their concentrations.	**An**
2	Students will master pHmetry for determining proton-ligand and metal-ligand stability constants, polarography for analyzing complex composition and stability, and refractometry techniques including specific and molar refraction determination using an Abbe refractometer. The course also covers verifying the law of refraction for mixtures (e.g., glycerol + water).	**An**
3	Master flame photometric techniques for the precise quantification of alkali and alkaline earth metals in diverse samples, contributing to accurate elemental analysis.	**AP**
4	Students will proficiently utilize separation techniques, including paper chromatography for cadmium and zinc, zinc and magnesium, thin-layer chromatography for nickel, manganese, cobalt, and zinc, ion-exchange, solvent extraction, and electrophoretic separation, enabling accurate quantitative estimations of binary and ternary mixtures.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO2	3	1	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO3	3	1	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO4	3	1	1	1	1	3	1	2	-	3	3	3	2	1	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE306 (Lab course VI)

Unit No.	Topics	No. of Lectures	CO No.
I	**SPECTROPHOTOMETRIC DETERMINATIONS:** 1. Manganese / Chromium, Vanadium in steel sample. 2. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method. 3. Fluoride / Nitrate / Phosphate. 4. Zirconium –Alizarin Red –S complex: Mole-ratio method. 5. Copper –Ethylene diamine complex: Slope-ratio method.	40	1
II	**pH METRY:** Stepwise proton-ligand and metal-ligand stability constant of complexes by Leving –Rossoti methods. **POLAROGRAPHY:** Composition and stability constant of complexes. **REFRACTOMETRY:** 1. Determination the specific and molar refraction of a given liquid by abbe Refractometer. 2. Determine the variation of refractive index. 3. To verify law of refraction of mixture (glycerol + water).	38	2
III	**FLAME PHOTOMETRIC DETERMINATIONS:** 1. Sodium and potassium when present together 2. Lithium / calcium / barium / strontium. 3. Calcium and magnesium in tap water.	40	4
IV	**SEPARATION AND QUANTITATIVE ESTIMATION OF BINARY AND TERNARY MIXTURES BY THE USE OF FOLLOWING SEPARATION TECHNIQUES:** 1. Paper chromatography –Cadmium and Zinc, Zinc and Magnesium. 2. Thin –layer chromatography –separation of nickel, manganese, cobalt and zinc. Ion-exchange. 3. Solvent extraction. 4. Electrophoretic separation.	32	5

***Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, Fluorescence Spectrophotometer, Tensiometer etc.) experiments may be given to the students.**

BOOK SUGGESTED :

1. Quantitative Inorganic Analysis, A.I. Vogel.
2. Test book of quantitative chemical analysis, A.I. Vogel.
3. Practical Physical chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P. Levi
5. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

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M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CH307	**Research Project**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	20

Maximum Marks	CIA	ESE
200	60	140

Learning Objective (LO):

To develop practical skills and theoretical understanding in analytical, organic, inorganic, nano, and physical chemistry through synthesis, characterization, separation techniques, pollutant analysis, and nanomaterial applications in environmental, food, and clinical systems using modern and green methodologies..

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Gain expertise in developing analytical methods, quantifying chemical substances in environmental, food, and clinical samples, utilizing nanomaterial-based sensors, applying separation and chromatographic techniques, and analyzing pollutants like pesticides and microplastics to design effective pollutant removal strategies.	**AP**
2	Develop skill in synthesizing organic compounds, isolating and characterizing biomolecules and natural products, understanding drug-related chemistry, applying separation techniques, and using modern methods like microwave-assisted synthesis for efficient, green preparation of flavonoids, alkaloids, and essential oils.	**AP**
3	Understand the synthesis and characterize metal complexes and nanoparticles, apply green chemistry approaches, and explore nanomaterials like Fe_2O_3 and carbon quantum dots for energy, catalysis, and chemical sensing applications.	**AP**
4	Understand separation science, catalysis, surfactants, and biocolloids; study adsorption kinetics and ionic liquid extractions; explore nanozyme catalysis and photocatalysis; and evaluate formulation and stability of surfactant-based emulsions for environmental and industrial applications.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

Online											
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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO2	3	3	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO3	3	3	1	1	1	3	1	2	-	3	3	3	2	1	2	-
CO4	3	2	1	1	1	3	1	2	-	3	3	3	2	1	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: Research Project (CHE307)

Unit No.	Topics	No. of Lectures	CO No.
I	Analytical chemistry and environmental chemistry: Development of analytical methods, quantitative determination of chemical substances from environmental (air, water and soil), foods and clinical samples, Nanomaterials base chemical sensors, separation techniques, chromatography, analysis of pesticides and microplastics, development of removal methods for pollutants, etc.	120	1
II	Organic chemistry: Synthesis, Biomolecules, drugs, separation, microwave-assisted synthesis of organic compounds, isolation and characterization of flavonoids or alkaloids from medicinal plants, essential oils, etc.		2
III	Inorganic chemistry and Nano chemistry: Synthesis and characterization of transition metal complexes with biological activities, green synthesis of metal nanoparticles (Ag, Au, Cu, etc) using plant extracts, preparation and characterization of Fe_2O_3 NPs for different applications, carbon quantum dots and their application in energy, chemical sensing, etc.		3
IV	Physical chemistry: separation science, catalyst, surfactants, biocollids, study of adsorption kinetics of dyes/heavy metals using low-cost adsorbents, ionic liquid-mediated extraction, enzyme-mimicking behavior of nanozymes in oxidation reactions, photocatalytic degradation of dyes using metal oxide catalysts, formulation and stability studies of surfactant-based emulsions, etc.		4

Note: The Project work will be based on research facilities available in colleges, institutions or university

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Online

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE401	**INSTRUMENTAL METHODS OF ANALYSIS**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The objective of this course is to provide students with a comprehensive understanding of comprehensive understanding of advanced chromatographic techniques, X-ray and proton-induced spectroscopy methods, atomic emission, and atomic absorption spectroscopy, and to acquire the analytical skills and knowledge needed to effectively apply these techniques for qualitative and quantitative chemical analysis, including the analysis of pesticides and their interactions with nanoparticles using various instrumental methods.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop expertise in advanced chromatography techniques, including ion chromatography, size exclusion chromatography, supercritical fluid chromatography, capillary electrophoresis, and capillary electrochromatography, enabling students to separate and analyze complex mixtures of compounds.	**AP**
2	Gain a comprehensive understanding of X-ray and proton-induced spectroscopy, including X-ray fluorescent and proton-induced X-ray spectroscopy, and their respective principles, instrumentation, and applications in qualitative and quantitative analysis.	**AP**
3	Acquire knowledge and practical skills in atomic emission and atomic absorption spectroscopy, including flame photometry, atomic emission spectroscopy (AES), inductively coupled plasma atomic emission spectroscopy (ICP-AES), atomic absorption spectroscopy (AAS), cold-vapor, and hydride generation AAS, facilitating precise elemental analysis.	**AP**
4	Understand the principles, instrumentation, and applications of hyphenated techniques such as GC-MS, LC-MS, HPLC, IC-MS, and ICP-MS for advanced analytical and diagnostic purposes.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

Online											
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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO2	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO3	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO4	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE401 (INSTRUMENTAL METHODS OF ANALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**ADVANCED CHROMATOGRAPHY:** Ion chromatography: Ion exchange equilibrium, Ion-exchange packing and Inorganic Applications. Size exclusion chromatography: Column packing, Theory of size of exclusion chromatography and applications. Supercritical fluid chromatography: Properties of supercritical fluid SFC-Instrumentation and operating variables, comparison with other types of chromatography, applications. Capillary Electrophoresis and capillary electro chromatography: overviews and applications	18	1
II	**X-RAY AND PROTON INDUCED SPECTROSCOPY:** X-Ray fluorescent method: Principles-Characteristics x-ray emission. Instrumentation x-ray tube, Radioactive sources. Wavelength dispersive instruments. Energy dispersive instruments. Analytical Applications-Qualitative Analysis. Proton Induced X-Ray Spectroscopy : Theory, instrumentation and application.	20	2
III	**ATOMIC EMISSION AND ATOMIC ABSORPTION SPECTROSCOPY:** Theory, instrumentation and application of flame photometer, ICP-AES and AFS. Theory instrumentation and application of flame and graphite furnace AAS, cold-vapor and hydride generation AAS. Selectivity, sensitivity and interferences of atomic spectroscopy.	20	3
IV	**HYPHENATED TECHNIQUES:** Principle, Instrumentation and Application of GC-MS, LC-MS, IC-MS and ICP-MS.	17	4

BOOK SUGGESTED:

1. Instrumental methods of analysis, Willard, Meritt and Dean.
2. Basic concepts of analytical chemistry, S.M. Khopkar, John Wiley & Sons.
3. Metallurgical analysis, S.C. Jain.
4. Material Science and Engineering. An Introduction, W.D. Callister, Wiley.
5. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
6. Fundamentals of Analytical Chemistry, Skoog, Welt, Holler and Crouch Thomson Learning Inc.

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M.Sc. (Chemistry) Semester-IV

Program	Subject	Year		Se
M.Sc.	Chemistry	2		
Course Code	Course Title			Cou
CHE402	**NATURAL PRODUCT AND MEDICINAL CHEMISTRY**			
Credit		Hours Per Week (L-T-P)		
	L	T		
5	5	-		

Maximum Marks	CIA		ES
100	30		7

Learning Objective (LO):

The objective of this course is to provide students with a understand and master the chemistry of natural compounds such as terpenoids, carotenoids, alkaloids, steroids, and plant pigments, including their classification, structure determination, isolation, synthesis, and the role they play in plants, as well as to explore principles of drug design, structure-activity relationships, modern methods in medicinal chemistry, and pharmacokinetics and pharmacodynamics in the context of drug development.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Gain a deep understanding of the chemistry and properties of natural compounds, including terpenoids, carotenoids, alkaloids, steroids, and plant pigments, along with their isolation, synthesis, and physiological roles in plants.	**U**
2	Understand the steroids, covering isolation, structure determination, synthesis, and cholesterol biosynthesis. They'll explore plant pigments, understanding occurrence, nomenclature, and structure determination, while isolating and synthesizing various compounds.	**U**
3	Acquire knowledge of drug metabolism, absorption, disposition, elimination, enzyme interactions, and the role of biotransformation in medicinal chemistry, enabling a deeper understanding of pharmaceutical development and optimization.	**Ap**
4	Develop a comprehensive understanding learn about antineoplastic agents, antibiotics, antimalarials, antivirals, antibacterials, antioxidants, and antifungal drugs, focusing on their synthesis, properties, and classifications to understand their therapeutic applications.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	3	1	2	2	-	3	3	3	3	2	1	3
CO2	3	3	3	-	3	1	2	2	-	3	3	3	3	2	1	3
CO3	3	3	3	-	3	1	2	2	-	3	3	3	3	2	1	-
CO4	3	3	3	-	3	1	2	2	-	3	3	3	3	2	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE402 (NATURAL PRODUCT AND MEDICINAL CHEMISTRY)

Unit No.	Topics	Lectures	CO No.
I	**Terpenoids and Carotenoids:** Classification, nomenclature, occurrence, isolation, general methods of structure determination of Citral, Geraniol, α-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β – Carotene. **Alkaloids:** Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on Nitrogen heterocyclic ring, role of alkaloids in plant. Synthesis and biosynthesis of the following: Ephedrine, (+)- Coline, Nicotine, Atropine, Quinine and Morphine.	19	1
II	**Steroids:** Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterome, Testosterone, Esterone, Progestrone, Aldostrone and Biosythesis of cholesterol. **Plant Pigments:** Occurrence, nomenclature and general method of structure determination. Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin-3-glucoside, Vitexin, Diadzine, Butein, Aureusin, Cyanidin-7-arebinoside, Cyanidin, Hirsutidin.	18	2
III	**DRUG DESIGN:** Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure – activity relationship (SAR). Theories of drug activity: Occupancy theory, rate theory, induced fit theory. Concepts of drug receptors. Lipophilicity and Lipinski Rule of 5. **Modern methods in Medicinal Chemistry:** Combinatorial Chemistry: Principle, methods and application, High throughput Screening (HTS), QSAR and docking studies. **Pharmacokinetics and pharmacodynamics:** Drug metabolism: absorption, disposition, elimination. Elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, biotransformation, significance of drug metabolism in medicinal chemistry.	18	3
IV	**Anteoplastic Agents:** Introduction, Alkylating agents, antimetabolites, carcinolytic antibiotics, mitotic inhibitors. **Antibiotics:** Constitution and synthesis of penicillins, chloramphenicol, tetracycline and streptomycin. **Antimalarials:** Synthesis and properties of the following Antimalarial: 8-amino quinolone derivatives-Pamaquine, Primapune, Pentaquinr, Isopentaquine, 4- amino quinolone derivatives- Santoquine, Acridine derivatives-Mepracrine, and Biguanid derivatives-Paludrine Pyremethamine. Antivirals, Antibacterial and Antioxidants: Introduction and Properties **Antivirals and anti-fungal drugs:** Introduction ,Properties and classification.	19	4

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Book Suggested:

1. Natural Products: Chemistry and Biological Significance, J. Mann, R. S. Davidson, J. B. Hobbs.
2. D. V. Banthrope and J. B. Harbrone, Longman, Essex., Organic Chemistry, Vol. 2, I. L. Finar, ELBS.
3. Chemistry, Biologcal and Pharmacological properties of Medicinal Plants from the Americans, Ed. Kurt Hostettmann, M. P. Gupta and A. Marston, Harwood Academic Publishers.
4. Introduction to Flavonoids, B. A. Bhom, Harwood Academic Publishers.
5. New Trends in Natural Product Chemistry, Att-ur-Rahman and M. I. Choudhary, Harwood, Academic Publishers.
6. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.
7. Introduction to medicinal Chemistry, A Gringuage, Wiley-VCH.
8. Burger's Medicinal Chemistry-1 (Chapter-9 and Ch- 14), Drug Ed. M. E. Discovery, Wolff, John Wiley.

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CH403	**MATERIAL AND NUCLEAR CHEMISTRY**		**Core**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The aim of this course is to empower students with in-depth understanding of non-equilibrium thermodynamics, material chemistry, supramolecular chemistry, nuclear theory, nuclear fission, nuclear energy, and applied radiochemistry, enabling them to comprehend the principles, applications, and advanced concepts in these diverse fields of chemistry.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the non-equilibrium thermodynamics, including entropy production, irreversible processes, and Onsager relations, and apply these principles to heat flow, chemical, and electrochemical reactions in open systems.	**U**
2	Understand material chemistry, covering the preparation and properties of nanoparticles, metal oxides, quantum dots, carbon-based materials, conducting polymers, ceramics, and composites. They'll understand various synthesis methods, optical, electrical, and magnetic properties, and applications of nanomaterials, along with advanced characterization techniques.	**U**
3	Acquire competence in supramolecular chemistry, including intermolecular forces, molecular recognition, and catalysis, enhancing their ability to design and understand molecular assemblies and interactions.	**Ap**

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4	Understanding of nuclear theory, fission, and energy, covering nuclear structure, reactions, and reactor applications. They'll also develop expertise in applied radiochemistry, using radioactive isotopes and tracers for investigations in medical, agricultural, and analytical chemistry.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO	POs											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	1	2	-	2	1	-	1	1	3	1	2	-	2
CO2	3	3	3	2	2	-	2	1	-	1	1	3	1	2	-	2
CO3	3	3	3	2	2	1	2	1	-	2	1	3	1	2	-	2
CO4	3	3	3	2	2	1	2	1	-	2	1	3	1	2	-	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE403 (MATERIAL AND NUCLEAR CHEMISTRY)

Unit No.	Topics	No. of Lectures	CO No.
I	**NON-EQUILIBRIUM THERMODYNAMICS:** Entropy of irreversible processes, Clausius inequality; entropy production (heat flow, chemical reactions, electrochemical reactions) and entropy flow, Entropy production in open systems; rate of entropy production, generalized forces and fluxes; Phenomenological equations, Onsager reciprocity relation; applications of irreversible thermodynamics.	20	1
II	**MATERIAL CHEMISTRY:** Preparation and Properties of Nanoparticles, Metal Oxides, Semiconductor Quantum Dots, Carbon Quantum Dots, Carbon Based materials (Graphene, Carbon Nanotube, Fullerene, porous Carbon and doped material, Physical and chemical Methods for the synthesis of functional materials, Sol-gel methods, Hydrothermal method, Chemical Vapor Deposition. Optical Properties, Mechanical, Electrical and Magnetic Properties, Application of Nanomaterials in environment and energy, Characterization of nanomaterials using TEM, SEM ,BET, XPS, STM, AFM.	20	2
III	**SUPRAMOLECULAR CHEMISTRY:** Properties of covalent bonds, bond length, inter bond angles, Force constant, bond and molecular dipole moment, molecular and bond polarizability. Intermolecular Forces, hydrophobic effects, Electro static, induction, dispersion and resonance energy, Hydrogen bond, Magnetic interactions. Host-Guest and Molecular Recognition, Principles of molecular association ad organization Biological marcomolecules, Molecular receptors and design principal, cryptands, Cyclophanes, calixeranes and cyclodextrins. Supramoleular reactivity and catalysis.	18	3
IV	**NUCLEAER AND RADIOCHEMISTRY** **NUCLEAR THEORY:** Nuclear cross section and nuclear radii, nuclear shells and magic numbers, theory of nuclear shell model, nuclear potentials, square well and simple harmonic oscillator potentials, application, liquid drop model, semi-empirical mass equation, application and limitations. **NUCLEAR FISSION:** Mass, energy and charge distribution of fission products, decay chains, prompt and neutrons, liquid drop model of nuclear fission. **NUCLEAR ENERGY:** Nuclear fission, chain reaction, multiplication factor,	17	4

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	nuclear reactors **APPLIED RADIOCHEMISTRY:** Radioactive isotopes, purity and strength of radioisotopes. Radiochemical principle in the use of tracers, Application of Tracers in Chemical investigations, Physico-chemical methods, Analytical applications, Age determinations, Medical applications, Agricultural application. Technique of Nuclear chemistry: Neutron Activation Analysis, Isotope dilution methods.		

BOOKS SUGGESTED:

1. Nuclear and Radiochemistry by G. Friedlander, J.W. Kennedy & J.M. Miller, John Willey and Sons, New York.
3. Nuclear Physics by I. Kaplan, Addision –Willey Publishing company, London.
4. Essentials of Nuclear chemistry, H.J. Arnikar, Wiley Eatern Ltd, New Delhi.
5. Introduction to Theoretical Organic Chemistry and Molecular Modelling, W.B. Smith, VCH, Weinheim.
6. Physical Organic Chemistry, N.S. Isaacs, ELBS./ Longman.
7. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
8. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
9. Quantum Chemistry, Ira N. Levine, Prentice Hall.
10. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
11. Introduction to Thermodynamics of Irreversible Process, I. Prigogine, 3rd Ed, Interscience, New York (1968)
12. Fundamental of Chemical Thermodynamics by E. N. Yeremin.

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404	**ENVIRONMENTAL & APPLIED CHEMICAL ANALYSIS**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course aims to equip students with the comprehensive knowledge and practical skills in the monitoring, analysis, and control of various environmental pollutants, including air quality assessment, soil and water quality standards, chemical analysis in industries like cement, iron processing, coal, and thermal power plants, and the evaluation of constituents, additives, and adulterants in food, cosmetics, clinical, and drug-related products.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the classification of air pollution monitoring levels, understand air quality standards, and analyze airborne pollutants, using various analytical techniques and control devices, while comprehending atmospheric chemistry impacts.	**U**

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2	Understand the soil and water quality standards, analyze pollutants, and learn pollution control methods. They will also gain skills in chemical analysis of coal, cement, and steel using modern techniques.	**U**
3	Acquire expertise in the analysis of food and cosmetic products, including the evaluation of constituents, additives, and adulterants, enabling them to ensure the quality and safety of these consumer products.	**AP**
4	Possess a comprehensive understanding of cosmetics formulation, materials, and clinical drug analysis methods. They'll adeptly analyze cosmetic products and clinical specimens, demonstrating proficiency in assessing various components and maintaining quality standards.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	2	1	1	3	2	3	-	3	3	3	3	2	1	3
CO2	3	2	2	1	2	3	2	3	-	3	3	3	3	2	1	-
CO3	3	2	2	1	2	3	2	3	-	3	3	3	3	2	1	-
CO4	3	2	2	1	1	3	2	3	-	3	3	3	3	2	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE404 (ENVIRONMENTAL & APPLIED CHEMICAL ANALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**AIR POLLUTION MONITORING AND ANALYSIS:** Classification of air pollution monitoring levels, air quality standards and index, monitoring and analysis of selected air borne pollutants: gaseous pollutants (SO2, NOx, VOCs, O_3, CO, CO2 by FTIR or GCMS/FID), Suspended particulate matter (SPM, PM_{10}, $PM_{2.5}$), particulate bound pollutants [Heavy metals (Pb, Hg, V. Ni. Cr. Mn. Co, As by AAS or ICP-MS), ionic components (F^-, Cl^-, NO_3^-, SO_4^{2-}, NH_4^+ by ion chromatograph) PCBs/pesticides/POP's by GCMS/LCMS/HPLC, thermal fractions of carbonaceous matter by OC/EC analyzer**.** Air pollution control devices Viz ESP, scrubber technique, baghouse filters etc. Atmospheric chemistry of acid rains, photochemical smog, greenhouse effect, global warming, ozone hole.	20	1
II	**SOIL AND WATER POLLUTION:** Soil and water quality standards, monitoring and analysis of selected soil water contaminants: COD, pesticides, heavy metals, POPs, fluoride, cyanide, nitrate, Geobiochemical impact of municipal solid waste, steel plants effluent, domestic sewage. Water pollution control devices. **CHEMICAL ANALYSIS OF COAL, CEMENT & STEEL:** COAL (Ultimate and Proximate analysis): Moisture content, Ash content, Volatile matters, Fixed carbon, Calorific value **CEMENT:** Cement analysis for Loss on Ignition (LOI), CaO, SiO_2, Al_2O_3, MgO, Fe_2O_3, P_2O_5, TiO_2, K_2O, Mn_2O_3, ZnO by chemical testing methods **STEEL:** analysis of iron ore, and iron bearing raw material and alloy by XRF X-Ray fluorescence spectrometer, Analysis of sulphur, phosphorus and other impurities in hot metal by OES and other modern spectroscopic techniques.	18	2

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III	**FOOD ANALYSIS:** Introduction to general Constituents of food, Proximate Constituents and their analysis, Additives-Introduction -Types - Study of preservatives colors and Antioxidants and method of estimation, adulteration - Introduction, Types, Test for adulterants. **Introduction standards composition and analysis of following foods:** Wheat, Bread, Biscuits, Jam, Jelly, Honey, Milk, Ice Cream, Butter, Cheese, Milk Powder, Oils and Fats, Tea, Coffee, Soft drinks, Alcoholic beverages, Cereal and pulses, Confectionery, Fruits, Vegetables, Egg, Fish, Meat.	17	3
IV	**COSMETICS, CLINICAL AND DRUG ANALYSIS:** Introduction of Cosmetics, evaluation of cosmetics materials, raw material and additives, Cosmetics colors, Perfumes in cosmetics, Cosmetics formulating, introduction, standards and methods of analysis, Creams, face powders, Make-up, Shaving preparations, Bath preparations. Concepts and principles of analytic methods commonly used in the clinical species: i.e. ammonia, Blood Urea Nitrogen, Ca, Cl, CO_2, Fe, K, Li, Mg, Na, P, urea, glucose. Method for analysis of proteins (i.e. albumin, bilirubin, creatinine, cholesterol, HDL-cholesterol, triglycerides, creatinine) and Enzymes (i.e. Alanine, Aminotransferase, acid phosphatase, alkaline phosphatase, amylase, aspartate, aminotransferase, cholinesterase, lactate, and lipase).	20	4

BOOK SUGGESTED :

1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Chemistry, Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Environmental Chemistry, C. Baird, W.H. Freeman.
8. Analytical chemistry, G.D. Christian, J. Wiley.
9. Fundamentals of Analytical Chemistry, D.A. Skoog, D.m. West and F.J. Holler, W.B. Saunders.
10. Analytical Chemistry - Principles, J.H. Kennedy, W. Saunders.
11. Analytical Chemistry-Principles, and Techniques, L.G. hargis, Prentice Hall.
12. Principles of Instrumental Analysis, D.A. Skoog, W.B. Saunders.
13. Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
14. Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern.Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern.
15. Environmental Biotechnology, Indushekhar Thakur, I.K. International Pvt. Ltd.
16. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Thompson Learning Inc.
17. APHA, 1977, "Methods of Analysis of air, water and soil" Washington US.
18. Techniques in Clinical Chemistry, A hand Book for Medical Laboratory Technicians, Frederick N. Bullock

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Elective courses 2 (Select (405 + 406 or 407 only)

(Combination should be- Lab course VII (405)+ Lab course VIII (406) OR only Research Project work (407)

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE405	**Lab Course - VII**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The objectives of this course are to provide students with the essential skills and enable students to perform multi-step organic synthesis of various compounds, including rearrangements, enzymatic synthesis, quantitative organic analysis, functional group estimation, and the extraction of organic compounds from natural sources, while also introducing them to advanced-level instrument-based experiments utilizing techniques such as FTIR, NMR, GC-MS, AAS, fluorescence spectroscopy, tensiometry, and more to enhance their practical organic chemistry skills.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to:	CL
1	Develop proficiency in multi-step organic synthesis, including rearrangements and enzymatic reduction, enabling them to synthesize a variety of organic compounds with precision. estimation for sulfur, nitrogen, and various functional groups, enhancing their analytical skills in organic chemistry.	**An**
2	Learn to estimate the content of specific functional groups, such as amino, hydroxyl, carbonyl, and carboxyl groups, using various methods, expanding their knowledge of functional group analysis.	**An**
3	Become proficient in the extraction of organic compounds from natural sources, such as leaves, milk, tobacco, and various foods, allowing them to isolate and identify specific compounds found in these sources.	**An**
4	Introduced to advanced-level experiments utilizing sophisticated instruments like FTIR, NMR, GC-MS, AAS, fluorescence spectroscopy, tensiometers, and more, enhancing their practical and analytical skills in the field of organic chemistry.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Online											
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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	-
CO2	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	-
CO3	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	-
CO4	3	3	3	1	1	3	1	2	-	3	3	3	3	3	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus Lab Course - VII:

Unit No.	Topics	No. of Lectures	CO No.
I	**A. MULTI-STEP SYNTHESIS OF ORGANIC COMPOUNDS:** Beckmann Rearrangement: Benzanilide from benzene (Benzene Benzophenone benzophenone oxime Benzanilide). Benzilic Acid Rearrangement: Benzilic acid from Benzoin (Benzoin Benzil Benzilic acid) Skraup's synthesis (Synthesis of heterocyclic Quinoline from o -Amino phenol p-Bromoaniline from Aniline (Aniline Acetanilide p - Bromoacetanilide p - Bromoaniline), p-Nitroacetanilide from Acetanilide (Aniline Acetanilide p - Nitroactanilide p - Nitroaniline), m Nitroaniline from Benzene (Benzene Nitrobenzene m - dinitrobenzene m- nitroaniline), Acridone from Anthranilic acid (Anthranilic acid o - Chlorobenzoic acid N –Phenylanthranilic acid Acridone) Enzymatic Synthesis Enzymatic reduction : Reduction of ethylace enantiomeric excess of S(+) ethyl - 3 - hydroxybutanone and determine its optical purity. **B. QUANTITATIVE ORGANIC ANALYSIS:** Estimation of Sulphur by Messenger's Method. Estimation of Nitrogen by Kjeldahl Method.	40	1
II	**ESTIMATION OF FUNCTIONAL GROUP:** Estimation of Aniline. Estimation of Amino Group By Acetylation Method. Estimation of Hydroxyl Group By Acetylation Method. Estimation of Carbonyl Group By Hydrazone Formation Method. Estimation of Carboxyl Group By Titration Method. Determination of Equivalent Weight of Carboxylic Acid By Silver Salt Method. Estimation of Glucose By Fehling Solution Method. Estimation of Glycine By Titration Method.	36	3
III	**EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES:** Isolation of caffeine from leaves. Isolation of Casein from milk. Isolation of lactose from milk. Isolation of nicotine dipicrate from tobacco. Isolation of Cinchonine from cinchona bark. Isolation of Piperine from black pepper. Isolation Lycopene from tomatoes. Isolation of β–Carotene from carrots. Isolation of Limonene from citrus rinds. Isolation of protein and carbohydrates from seeds –colour test. Extraction of Fatty oil from seeds and determination of refractive index of the oil. Isolation of protein and carbohydrate (as reducing sugars) from seed-colour test.	40	4
IV	Some advanced level sophisticated instrument based (FTIR, NMR, GC-MS, AAS, FLUORESCENCE SPECTROPHOTOMETER, TENSIOMETER etc) experiments may be given to the students.	34	5

Online											
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Books:-

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Saluja.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett.
6. Experimental Organic chemistry, M. P. Doyle and W. S. Mungall.
7. Small Scale Organic preparation, P. J. Hill.
8. Experimental Biochemistry, by B.S.Roa and V.Deshpande. I.K. International Pvt.Ltd.
9. Comprehensive Practical Organic Chemistry, Preparation and Qualitative Analysis, V.K.Ahluwalia and Renu Aggarwal, University Press.

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE406	**LABORATORY COURSE –VIII**		**Elective**
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
2	-	0	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course objective is to equip students with practical skills in various analytical techniques, including titrimetric/gravimetric determinations, spectrophotometric determinations, chromatographic separation, flow injection analysis, and atomic absorption spectrophotometry, enabling them to analyze a wide range of samples, from environmental and industrial effluents to clinical and plant/soil/sediment samples, and determine the content of metals, anions, cations, and other compounds, as well as speciate toxic metals.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Conduct titrimetric and gravimetric determinations, covering manganese in iron/steel (Bismuthate, Linganane-Karplus, Periodate methods), manganese in pyrolusite ores, nickel in steel (dimethylglyoxine method), and lead (dithizone precipitation). This course ensures precise element analysis across diverse matrices.	An
2	Perform spectrophotometric determinations for elements in steel and environmental samples, extractive spectrophotometric methods for various elements, and flow injection analysis for anions/cations in synthetic/real/environmental samples, ensuring accurate and comprehensive analyses across diverse matrices.	AP
3	Separate and identify sugars (glucose, fructose, and sucrose) using paper chromatography, determining Rf values. Additionally, the course covers thin-layer chromatography for separating nickel, manganese, cobalt, and zinc, with a focus on determining Rf values for accurate analysis.	An

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4	Apply atomic absorption spectrophotometry for metal content determination in real and environmental samples, and gain expertise in miscellaneous analyses, including nutrient/micronutrient analysis in plant/soil/sediment, toxic metal speciation, and clinical sample analysis (blood, urine, hair).	AP

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	3	1	2	-	1	1	3	3	1	1	-
CO2	3	3	3	-	1	3	1	3	-	2	2	3	3	3	1	-
CO3	3	3	3	3	1	3	1	3	-	3	3	3	3	3	1	-
CO4	3	3	3	3	1	3	1	3	-	3	3	3	3	3	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus LABORATORY COURSE –VIII:

Unit No.	Topics	No. of Lectures	CO No.
I	**TITRIMETIC/GRAVIMETRIC DETERMINATIONS:** Manganese in iron / Steel by Bismuthate / Linganane –Karplus/Periodate methods. Maganese in pyrolusite ores. Nickel in steel by dimethylglyoxine method. Lead by dithizone precipitation.	36	1
II	**A. SPECTROPHOTOMETRIC DETERMINATIONS:** Maganese/Chromium / Vanadium / Copper / Lead in Steel and Environmental / Industrial effluent samples. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method. Fluoride / Nitrite / Phosphate in tap / pond / river industrial waste water. Iron in water samples by thiocyanate and phenanthroline methods. **B. FLOW INJECTION ANALYSIS:** Determination of the following anions/cations in synthetic/real/ environmental samples. Ca^{2+}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cr^{6+}, Fe^{3+} (ii) F^- , Cl^- , PO_4^{3-} , NO_2^- , NO_3^- , SO_4^{2-} , BO_3^{3-} .	42	2
III	**CHROMATOGRAPHIC SEPARATION:** Sepraration and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values. Thin layer chromatography – separation of nickel, manganese, cobalt and zinc, Determination of Rf values.	36	3
IV	**ATOMIC ABSORPTION SPECTROPHOTOMETER:** Determination of metal contents (Fe/Pb/As/Zn/Co/Ni etc.) in real and environmental samples. F. MISCELLANEOUS: Nutrient and micronutrient analysis in plant/soil/sediment. Speciation of toxic metals i.e. As, Hg, Se, etc. Analysis of clinical samples i.e. blood, urine, hair, etc.	36	4

SUGGESTED BOOK:

1. Quantitative Inorganic Analysis, A.I. Vogel.
2. Standard Methods of Water Analysis.
3. Colorimetric Determination of Traces of Metals, E.B. Sandell.
4. GBC, Manuals on AAS analysis, Austria.
5.

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M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE407	**Research Project**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	-	0	10

Maximum Marks	CIA	ESE
200	60	140

Learning Objective (LO):

The course objective is to equip students with practical skills in various analytical techniques, including titrimetric/gravimetric determinations, spectrophotometric determinations, chromatographic separation, flow injection analysis, and atomic absorption spectrophotometry, enabling them to analyze a wide range of samples, from environmental and industrial effluents to clinical and plant/soil/sediment samples, and determine the content of metals, anions, cations, and other compounds, as well as speciate toxic metals.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	This delves into energy-saving devices, batteries, fuels, and nanomaterials. Address environmental pollution by studying removal materials. Develop expertise in sustainable technologies, advancing solutions for energy efficiency and pollution control.	**Ap**
2	Explores organic chemistry synthesis and its applications in environmental, medicinal, and sensing contexts. Develop skills to design and create compounds with relevance to sustainable practices, healthcare, and advanced sensing technologies.	**AP**
3	This will intertwine inorganic and nanochemistry with chemical sensors and analytical techniques. Explore the synthesis of nanomaterials, design chemical sensors, and master analytical methods for precise measurements, advancing skills in modern inorganic and nanoanalytical chemistry.	**Ap**
4	It will integrate physical chemistry, surface chemistry, thermodynamics, and chemical kinetics. Develop a profound understanding of molecular interactions, surface phenomena, and reaction dynamics, laying the foundation for advanced applications in diverse scientific and industrial fields.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	1	2	3	3	3	3	3	1	1	-

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry
	Prof. N. K. Karade (External member										

CO2	3	3	3	3	2	3	1	3	3	3	3	3	3	3	1	-
CO3	3	3	3	3	2	3	1	3	3	3	3	3	3	3	1	-
CO4	3	3	3	3	3	3	1	3	3	3	3	3	3	3	1	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus Research Project (407):

Unit No.	Topics	No. of Lectures	CO No.
I	Energy saving devices, battery, fuel, nanomaterials, environmental pollution, removal materials, etc.	120	1
II	Organic chemistry, synthesis and its application for environmental, medicine and sensing, etc.		2
III	Inorganic chemistry, Nano chemistry, chemical sensors & Analytical chemistry, etc.		3
IV	Physical chemistry, Surface Chemistry, thermodynamics, chemical kinetics, etc.		4

Note: The Project work will be based on research facilities available in colleges, institutions or university

ELECTIVE PAPERS

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404a	**MEDICINAL CHEMISTRY**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide students with a comprehensive understanding of drug design, pharmacokinetics, pharmacodynamics, and the chemistry of various drug classes, including antineoplastic agents, cardiovascular drugs, local anti-infective drugs, antibiotics, and psychoactive drugs, with a focus on their synthesis, mode of action, and medicinal chemistry aspects, in order to prepare them for a thorough exploration of drug development and its applications in the field of pharmacology.

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding of drug design principles, encompassing lead compound development, prodrugs, and SAR. Additionally, they'll master pharmacokinetics and pharmacodynamics, employing key parameters for defining drug disposition and therapeutic efficacy.	**U**
2	Demonstrate a comprehensive understanding of antineoplastic agents, focusing on alkylating agents, antimetabolites, and cardiovascular drugs. They'll proficiently analyze and apply knowledge in the treatment of cancer and cardiovascular diseases, including drug synthesis and mechanisms of action.	**U**
3	Possess in-depth knowledge of local anti-infective drugs and antibiotics, including synthesis and modes of action. They'll demonstrate expertise in analyzing and applying these agents for therapeutic purposes.	**Ap**
4	Apply their knowledge to critically evaluate and discuss the chemistry, mechanisms of action, and therapeutic applications of a wide range of pharmaceutical compounds, facilitating their understanding of drug development and its role in pharmacology.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	3	1	2	-	2	2	3	3	1	-	-
CO2	3	3	3	-	1	3	1	2	-	2	2	3	3	1	-	-
CO3	3	3	3	-	1	3	1	2	-	2	2	3	3	1	-	-
CO4	3	3	3	-	1	3	1	2	-	2	2	3	3	1	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404a MEDICINAL CHEMISTRY

Unit No.	Topics	No. of Lectures	CO No.
I	**DRUG DESIGN**: Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure – activity relationship (SAR). Theories of drug activity: Occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Lipophilicity and Lipinski Rule of 5. **PHARMACOKINETICS**: Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetics parameters in defining drug disposition and in therapeutics. **PHARMACODYNAMICS**: Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, drug metabolism, biotransformation significance of drug metabolism in medicinal chemistry.	20	1
II	**ANTINEOPLASTIC AGENTS**: Introduction, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and Mitotic inhibitors. Mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine. **CARDIOVASCULAR DRUGS**: Introduction, cardiovascular diseases, drug	20	2

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	Online										

	inhibitors of peripheral sympathetic function. Direct acting arteriolar dilators. Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolo, oxyprenolo.		
III	**LOCAL ANTIINFECTIVE DRUGS**: Introduction and general mode of action. Synthesis of sulphonamides, furazolidine, nalidixic acid, ciprofloxacin, norfloxacin, dapsone, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, econozole, griseofulvin, chloroquin and primaquin. **ANTIBIOTICS**: Cell wall biosynthesis, inhibitors, β-lactam rings, antibiotic inhibiting protein synthesis. Synthesis of penicillin G, penicillin V, ampicillin, amoxicillin, chloramphenicol, cephalosporin, tetracycline and streptomycin.	18	3
IV	**PSYCHOACTIVE DRUGS- THE CHEMOTHERAPY OF MIND**: Introduction, neurotransmitters, CNS depressants, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipines, busipirone. Antipsychotic drugs – the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs. Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximode, trimethadione, barbiturates, thiopental sodium, glutethimide.	17	4

Books Suggested

1. Introduction to Medicinal Chemistry, A Gringuage, Wiley-VCH
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge
3. An Introduction to Drug Design, S. S. Pandeya and J.R.Dimmock, New Age International.
4. Burgers's Medicinal Chemistry and Drug Discovery, Vol-1(Chapter-9 and Chapter-14), Ed. M.E. Wolff, John Wiley.
5. Goodmann and Gilman's Pharmacological Basis of Therapeutics, Mc-Graw Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D.Lednicer, John Willey

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404b	**CHEMISTRY OF SURFACTANTS**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide students with a comprehensive understanding of surfactants, including their classification, physicochemical properties, and self-assembly principles, with a focus on micellization, aggregation behavior, and the behavior of surfactant mixtures, and to explore the wide-ranging applications of surfactants in areas such as catalysis, solubilization, drug interactions, and industrial processes.

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Classify surfactants and explain their physicochemical properties, including critical micelle concentration and aggregate shapes.	**Ap**
2	Understand the principles of self-assembly and the various models describing surfactant micellization and aggregation behavior.	**An**
3	Analyze the behavior of surfactant mixtures, distinguishing between ideal and non-ideal mixed micelles and polymer-surfactant interactions.	**Ap**
4	Apply their knowledge of surfactants to various real-world applications, including micellar catalysis, solubilization, drug interactions, and industrial processes.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	1	1	1	3	1	2	-	3	2	3	3	-	-	-
CO2	3	2	1	1	1	3	1	2	-	3	2	3	3	-	-	-
CO3	3	2	1	1	1	3	1	2	-	3	2	3	3	-	-	-
CO4	3	2	1	1	1	3	1	2	-	3	2	3	3	-	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404b CHEMISTRY OF SURFACTANTS

Unit No.	Topics	No. of Lectures	CO No.
I	**OVERVIEW OF SURFACTANTS:** Classification of Surfactants, Physicochemical Properties of Surfactants, Critical Micelle Concentration, Determination, Effect of Additives, Aggregate Shapes, Structure and Morphology, Novel and New Generation Surfactants, Aggregation Behavior.	20	1
II	**PRINCIPLES OF SELF-ASSEMBLY:** Closed and Continuous Association, Surfactant Micellization Pseudo-Phase Model, Mass Action Model, Estimation of Micelle Size, Size Dispersion of Micelles, Concentration Dependence of Micelle Size, Phase Behavior, Aggregation Behavior.	20	2
III	**SURFACTANT MIXTURES:** Ideal and Non-Ideal Mixed Micelles, Regular Solution Model Size and Composition Distribution of Aggregates, Nonionic – ionic Surfactant Mixtures, Ionic -Ionic Surfactant Mixtures, Origin of Ideal and Non-Ideal Mixing Behavior, Polymer Surfactant Interaction.	16	3
IV	**APPLICATIONS OF SURFACTANTS:** Micellar Catalysis, Quantitative Models, Micellar Enzymology, Phenomenon of Solubilization, Solubilization in Mixed Micelles, Drug Surfactant Interaction, Protein Surfactant Interactions, Microemulsions and its applications, Industrial Application of Surfactants.	14	4

Online											
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Books:

1. Surfactants Edited by Th. F. Tadros, Academic Press
2. Micelles : Theoretical and Applied Aspects by Y. Moroi
3. Chemistry and Technology of Surfactants by R. J. Farn Wiley

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404c	**CHEMISTRY AND APPLICATION OF PESTICIDES**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course aims to educate students on pesticides, covering their classification, toxicity, effects on food and human health, as well as their chemical toxicology, instrumental detection techniques, and residue analysis methods.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Classify pesticides, understand their utility, and assess their potential impact on food safety and human health and LD50 values	**U**
2	Understand the biochemical effects of pesticides, their persistence, bioaccumulation, and biomagnification, with a focus on specific pesticide groups.	**U**
3	Apply instrumental techniques, including spectrometry, chromatography, and residue analysis, to detect and quantify pesticides in various commodities.	**Ap**
4	Analysis of pesticides residue covering steps such as cleanup, concentration (evaporation), and analysis. The course emphasizes assessing the extent of pesticide residues in various commodities.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	2	1	1	3	1	2	-	2	1	3	3	2	2	-
CO2	3	2	2	1	1	3	1	2	-	2	1	3	3	2	2	-
CO3	3	2	2	1	1	3	1	2	-	2	1	3	3	2	2	-
CO4	3	2	2	1	1	3	1	2	-	2	1	3	3	2	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404c CHEMISTRY AND APPLICATION OF PESTICIDES

Unit No.	Topics	No. of Lectures	CO No.
I	**INTRODUCTION:** What is pesticides, classification of pesticides, utility of pesticides, categories of toxicity, Threshold limit value, LD 50 value, Effect of pesticides in food, House hold and Human health.	20	1
II	**CHEMICAL TOXICOLOGY**: Biochemical effects of pesticides, pesticides persistence, bioaccumulation and biomagnifications of pesticides, Toxicology of pesticides, Toxicology of organophosphates, carbamates, organochlorine and Dermal Toxicology of pesticides.	16	2
III	**INSTUMENTAL TECHNIQUES IN PESTICIDES DETECTION**: Spectrophotometry, paper chromatography, Thin layer chromatography (TLC), GC-MS, indicator tube, High performance (pressure) Liquid chromatography (HPLC).	14	3
IV	**PESTICIDES AND ITS RESIDUE ANALYSIS**: Steps in pesticides residue analysis, clean-up, concentration (evaporation), Analysis, Extent of residue of pesticides in different commodities.	20	4

BOOKS SUGGESTED:

1. Environmental chemistry. A.K De. New Age International Pvt. Ltd. 6th edition.
2. Soil Testing and Analysis,plant, water and pesticide residues- Patiram,Bajendra N.S. Azad, Thakur and T.Ramesh.Agricultural,Horticultural,Food and Veterinary Science Book.2nd edition.
3. Toxicology of pesticides: Experimental,clinical and regulatory perspectives. Edited by: Lucio G. Costa,Corrado L. GalliSheldon D. Murphy.Springer,1st edition.
4. Persistent Pesticide in the Environment- C.A Edward, CRC Press Inc.,Florida 2nd edition.
5. Agricultural chemicals and chemical mutagens- C.L.Canoria.
6. Progress in pesticide Biochemistry and Toxicology- D.H Hutson and T.R Roberts. Willey,7th edition.
7. Air pollution from Pesticides and Agricultural process. Lee,R.F., Jr.CRC Press Inc., Florida, 1976,174.

Online											
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M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404d	**MOLECULAR SYMMETRY, COORDINATION AND ORGANOMETALLIC CHEMISTRY**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide students with a comprehensive understanding of symmetry and group theory in chemistry, metal-ligand bonding, electronic spectra, and magnetic properties of transition metal complexes, reaction mechanisms of transition metal complexes, metal-ligand equilibria in solution, and metal π-complexes, focusing on concepts such as symmetry elements, molecular orbital theory, spectroscopic properties, reaction kinetics, metal-ligand stability, and the nature of bonding in a wide range of transition metal complexes, and their applications in chemical analysis and synthesis.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand and apply symmetry and group theory principles in chemistry to analyze the symmetry elements and operations in molecules and study their spectroscopic and structural properties.	Ap
2	Describe and analyze the various theories of metal-ligand bonding, including crystal field theory, molecular orbital theory, and their limitations in explaining the properties of transition metal complexes.	An
3	Analyze the electronic spectra and magnetic properties of transition metal complexes, including their ground states, correlation diagrams, and selection rules for spectroscopic transitions.	Ap
4	Evaluate metal-ligand equilibria in solution, considering factors affecting the stability of metal complexes, chelate effects, and their thermodynamic origins, and apply this knowledge to determine formation constants and analyze metal π-complexes, including metal carbonyls and complexes with unsaturated organic molecules, in terms of their structure, bonding, and important reactions.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry
	Prof. N. K. Karade (External member										

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	-	1	1	2	-	3	3	3	3	2	1	2
CO2	3	3	3	2	-	1	1	2	-	3	3	3	3	2	1	2
CO3	3	3	3	2	-	1	1	2	-	3	3	3	3	2	1	2
CO4	3	3	3	2	-	1	1	2	-	3	3	3	3	3	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404 d MOLECULAR SYMMETRY, COORDINATION AND ORGANOMETALLIC CHEMISTRY

Unit No.	Topics	No. of Lectures	CO No.
I	**SYMMETRY AND GROUP THEORY IN CHEMISTRY:** Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup.Conjugacy relation and classes.Point symmetry group.Schonflies 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.The great orthogonality theorem (without proof) and its importance.Character tables and their use; spectroscopy.	20	1
II	**METAL-LIGAND BONDING:** Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, bonding and molecular orbital theory. **ELECTRONIC SPECTRA AND MAGNETIC PROPERTIES OF TRANSITION METAL** **COMPLEXES:** Spectroscopic ground states, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Selection rules, mechanism for break down of the selection rules, intensity of absorption, band width, spectra of d-d metal complexes of the type $[M(H_2O)]^{n+}$, spin free and spin paired ML6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelouxetic series.	18	2
III	**REACTION MECHANISM OF TRANSITION METAL COMPLEXES:** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions. **METAL–LIGAND EQUILIBRA IN SOLUTION:** Stepwise and overall formation onstants 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.	20	3
IV	**METAL π-COMPLEXES:** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand. B. Transition metal complexes with unsaturated organic molecules,alkanes, allyl, dienedienyl, arene and trienyl complex, preparations, properties, nature of	17	4

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	bonding and structure features. Important reaction relating to nucleophilic, electrophilic attack on ligands and organic synthesis. Alkylidenes, low valent carbenes nature of bond and Structural characteristics.		

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	Course Title		Course Type
CHE404e	**NANOCHEMISTRY**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide a comprehensive understanding of generic methodologies, material chemistry, characterization methods, and practical applications in nanotechnology, with a focus on the classification of nanostructures, the preparation and properties of nanoparticles, various characterization techniques, and their application in fields such as nanobiology, nanosensors, and nanomedicine, emphasizing the fundamental principles and practical utilization of nanoscale materials and technologies.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Identify and classify different types of nanostructures and understand their impact on electronic and material properties.	**Ap**
2	Gain expertise in material chemistry, specifically nanoparticle preparation, properties of metals and ceramics, employing physical and chemical methods. They'll demonstrate proficiency in size-controlled synthesis, sol-gel techniques, and understand optical, electrical, and magnetic properties, with applications of nanoparticles.	**An**
3	Understand the diverse characterization methods, including X-ray diffraction, synchrotron radiation, Raman spectroscopy, and electron microscopes. Proficiency in thermal analysis techniques, UV-Visible spectrophotometry, FTIR, and photoluminescence spectroscopy will enable their applications in diagnostic and therapeutic scenarios.	**Ap**
4	Analyze and evaluate the potential future directions and advancements in nanotechnology, including its impact on various scientific and medical applications	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO2	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO3	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO4	3	3	3	2	1	3	3	2	-	3	3	3	3	3	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404 e NANOCHEMISTRY

Unit No.	Topics	No. of Lectures	CO No.
I	**GENERIC METHODOLOGIES FOR NANOCHEMISTRY AND NANOTECHNOLOGY:** Introduction and classification, What is nanotechnology?, Classification of nanostructures, Nanoscale architecture, Summary of the electronic properties of atoms and solids, The isolated atom, Bonding between atoms, Giant molecular solids, The free electron model and energy bands, Crystalline solids, Periodicity of crystal lattices, Electronic conduction, Effects of the nanometre length scale, Changes to the system total energy, Changes to the system structure, How nanoscale dimensions affect properties	20	1
II	**MATERIAL CHEMISTRY:** Preparation and Properties of Nanoparticles, Materials-Metals, Ceramics (Oxide, carbides, sulphides, nitrides).physical and chemical Methods, Size and Shape controlled Synthesis, Sol-gel methods, Optical Properteis, Electrical and Magnetic Properties, Application of Nanoparticles.	20	2
III	**CHARACTERIZATION METHODS:** X-ray diffraction, Debye-Scherer formula, dislocation density, micro strain, Synchrotron Radiation, Principle and Applications, Raman Spectroscopy and its Applications, Dynamic Light Scattering (DLS). Electron microscopes: scanning electron microscope (SEM), transmission electron microscope (TEM), atomic force microscope (AFM), scanning tunneling microscope (STM), XPS, Working Principle, Instrumentation and Applications. Differential scanning calorimeter (DSC), Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA), UV – Visible Spectrophotometer, FTIR, Principle and Applications, Photoluminescence (PL) Spectroscopy. Administration Diagnostic and Therapeutic Applications	18	3
IV	**APPLICATIONS ON NANOCHEMISTRY:** Nanobiology, Introduction, Bio-inspired nanomaterials, Interaction Between Biomolecules and Nanoparticle Surfaces, Different Types of Inorganic Materials Used for the Synthesis of Hybrid Nano-bio Assemblies, Applications of Nano in Biology, Nanoprobes for Analytical Applications, Current Status of Nanobiotechnology, Future Perspectives of Nanobiology; Nanosensors, Electrochemical, Nanobiosensors, Smart Dust; Nanomedicines, Nanodrug	17	4

SUGGESTED BOOKS:

1. Nanoparticles: From Theory to Application Edited by Gu¨nter Schmid, @ 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
2. Nanoparticles and Catalysis Edited by Didier Astruc @ 2008 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

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3. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Mike HagermanShriver and Atkin's Inorganic Chemistry, Fifth Edition, Oxford, 2010.
4. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
5. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
6. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404f	**CHEMISTRY OF NATURAL PRODUCTS**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The learning objective for this course is to provide a comprehensive understanding of various natural product classes, including terpenoids, carotenoids, alkaloids, steroids, plant pigments, porphyrins, prostaglandins, pyrethroids, and rotenones, with a focus on their classification, nomenclature, occurrence, isolation, structure determination, synthesis, stereochemistry, biosynthesis, and physiological effects, and their role in the chemistry of plant and animal systems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Classify and nomenclate various natural product classes, including terpenoids, carotenoids, alkaloids, steroids, plant pigments, porphyrins, prostaglandins, pyrethroids, and rotenones.	**An**
2	Understand physiological action, occurrence, and structure elucidation methods. The course explores alkaloid degradation, classification, and their role in plants, along with the structure, stereochemistry, biosynthesis, and synthesis of specific alkaloids.	**U**
3	Understand the structure and synthesis of Cholesterol, Bile acids, Testosterone; and plant pigments like Quercetin, Myricetin, Daidzein, Cyanidin, with biosynthesis exploration.	**U**
4	Understand the porphyrins, Haemoglobin and Chlorophyll synthesis; explore Prostaglandins, including occurrence, nomenclature, classification, biogenesis, physiological effects, and PGE2 and PGF2α synthesis. Study Pyrethroids and Rotenones synthesis and reactions.	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	1	1	3	1	2	-	3	3	3	3	2	1	1
CO2	3	3	2	1	1	3	1	2	-	3	3	3	3	2	1	1
CO3	3	3	2	1	1	3	1	2	-	3	3	3	3	2	1	1
CO4	3	3	2	1	1	3	1	2	-	3	3	3	3	2	1	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404f CHEMISTRY OF NATURAL PRODUCTS

Unit No.	Topics	No. of Lectures	CO No.
I	**Terpenoids and Carotenoids**: Classification; nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules; Citral, Geraniol, α-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-Carotene.	20	1
II	**Alkaloids**: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, biosynthesis and synthesis of the following: Ephedrine, (+)-Coniine, Nicotine, Atropine, Quinine and Morphine.	20	2
III	**Steroids:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progestrone, Aldosterone **Plant Pigments:** Occurrence, nomenclature, general methods of structure determination, isolation and synthesis of Apigenin, Luteolin, Quercetin, myrcetin, Quercetin-3-glucoside, Vitexin, Diadzein, Butein, Aureusin, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway	18	3
IV	**Porphyrins:** Structure and synthesis of Haemoglobin and Chlorophyll. **Prostaglandins:** Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE_2 and $PGF_{2\alpha}$. **Pyrethroids and Rotenones** Synthesis and Reaction of Pyrethroids and Rotenones	17	4

Books Suggested:

1. Natural Products : Chemistry and Biological Significance, J. Mann, R.S. Davidson,
2. J B Hobbs, D.V. Banthrope and J B Harborne, Longman Organic Chemistry, Vol 2 , IL Finar ELBS
3. New Trends in Natural Products Chemistry , A R Rahman and M I Choudhury, Harwood Academic Publishers
4. Roods Chemistry of Carbon Compounds, Ed S. Coffey, Elsevier

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M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404g	**POLYMERS**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide a comprehensive understanding of polymers, including their importance, classification, polymerization techniques, molecular weight concepts, characterization methods, structural aspects, physical properties, processing techniques, and properties of commercial and functional polymers, with an emphasis on practical applications in various fields such as materials science, engineering, and biomedicine.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain the fundamental concepts of polymers, including their importance, monomers, and classification.	Ap
2	Understand various polymerization techniques, including condensation, addition, and co-polymerization, and the conditions under which these reactions occur. Analyze and characterize polymers using molecular weight concepts, spectroscopic methods, thermal analysis, and physical testing.	An
3	Describe the structure and properties of polymers, including crystalline and amorphous regions, and their impact on material behavior.	Ap
4	Apply knowledge of polymer processing techniques and understand the properties and applications of various commercial and functional polymers in fields such as materials science and biomedicine.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	2
CO2	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	2
CO3	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	2
CO4	3	3	3	1	1	3	1	2	-	3	3	3	3	2	1	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

Detailed Syllabus: 404g polymers

Unit No.	Topics	No. of Lectures	CO No.
I	**Basics: Importance of polymers. Basic concepts:** Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers.Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous system.	17	1
II	**Polymer Characterization:** Polydispersion-average molecular weight concept. Number, weight and viscocity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscocity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tear resistance. Hardness and abrasion resistance.	18	2
III	**Structure and Properties:** Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structure of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point Tm- melting point of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.	20	3
IV	**Polymer Processing:** Plastics, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning. **Properties of Commercial Polymer:** Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resions and silicone polymers. Functional polymers- Fire retarding polymers and electrically conducting polymers. Biomedical polymers- contact lens, dental polymers, artificial heart, kidney, skin and blood cells.	20	4

Books Suggested :

1. Textbook of Polymer Science, F W . Billmeyer Jr. Wiley
2. Polymer Science, V R Gowarikar, N V Viswanathan and J Sreedhar, Wiley Eastern
3. Contemporary Polymer Chemistry, H R Alcock and F W Lambe, Prentice Hall
4. Physics and Chemistry of Polymers, J M G Cowie, Blackie Academic and Professional

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M.Sc. (Chemistry) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	IV
Course Code	**Course Title**		**Course Type**
CHE404h	**FORENSIC CHEMISTRY**		**Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course is to provide a comprehensive understanding of forensic science, chemistry, and toxicology, focusing on methodologies, analyses, and practical applications for careers in criminal investigation and related fields, including roles in various agencies and addressing issues like crime, food safety, environmental pollution, and chemical safety.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Demonstrate a thorough understanding of forensic science methodologies and applications, including the analysis of physical evidence, serology, DNA, ballistics, arson investigation, fingerprint analysis, and drug analysis.	Ap
2	Explain the chemical aspects of forensic science as they apply to criminal investigations, with knowledge of instrumental techniques such as chromatography, mass spectrometry, and liquid chromatography.	An
3	Apply the principles and methods of forensic toxicology, including the identification of poisons, their actions, toxicities, and postmortem characteristics. Analyze and interpret the chemical, toxicological, and pathological characteristics of commonly abused drugs, such as ethanol, barbiturates, narcotics, stimulants, and hallucinogens.	Ap
4	Understand and apply the practical applications of forensic chemistry in the investigation of crimes against society, food adulteration, environmental pollution, and the use and distribution of unsafe chemicals, while also being prepared for careers in criminal investigation and roles within relevant agencies and fields like environmental sciences and industrial hygiene.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	3	1	2	-	3	3	3	3	2	2	-

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CO2	3	3	3	1	2	3	1	2	-	3	3	3	3	2	2	-
CO3	3	3	3	1	2	3	1	2	-	3	3	3	3	2	2	-
CO4	3	3	3	1	2	3	1	2	-	3	3	3	3	3	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: 404h Forensic Chemistry

Unit No.	Topics	No. of Lectures	CO No.
I	**Introduction to Forensic Science:** Forensic science : methodologies and applications used in the forensic context. Organic and inorganic chemical analyses of physical evidence, principles of serology and DNA analysis, ballistics, arson, fingerprint analysis, drug analysis,	20	1
II	**Forensic Chemistry:** Chemical aspects of forensic science as it applies to criminal investigation and laboratory preparation. Instrumentation and chemistry associated with crimes. properties of the chemical evidence. Details of the methods employed for analysis, such as color test, Chromatography (GC, GLC, HPLC), mass spectrometry (MS), GC-MS. Laboratory course. Instrumental Aspects of Liquid Chromatography Solvent delivery systems, sample inlets, temperature control, coupled column systems, detectors, and indirect detection other Separation Techniques	20	2
III	**Toxicology:** General principles and fundamentals of forensic toxicology, poisons, action, toxicity, postmortem characteristics, samples required for toxicological analysis and methods of collection, methods of preservation and analysis. Chemical, toxicological and pathological characteristics of commonly abused drugs, including the following: ethanol, barbiturates, narcotics, stimulants, and hallucinogens	18	3
IV	**Applications of Forensic Chemistry:** Investigation of crime against society, food adulteration, environmental pollution, use and distribution of unsafe chemicals, career in criminal investigation, in the laboratory analysis of forensic evidence. Drug Enforcement Administration, Food and Drug Administration, Environmental Protection Agency, and Occupational Safety and Health Administration. environmental sciences, industrial hygiene.	17	4

Online											
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Generic Elective Courses:

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credit	Marks		
						CIA	ESE	Total
II	CHE501	Analytical Techniques and Data Analysis	T	2	2	30	70	100
	CHE502	Instrumental of Methods analysis	T	2	2	30	70	100
III	CHE503	Resonance spectroscopy and photochemistry	T	2	2	30	70	100
	CHE504	Chemistry of biomolecules	T	2	2	30	70	100
	CHE505	Nanochemistry and Applications	T	2	2	30	70	100

M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	Course Title		Course Type
CHE501	**Analytical Techniques and Data Analysis**		**Generic Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The objective of this course is to provide students with a comprehensive understanding of sample preparation techniques, digestion methods, and statistical analysis; understand principles and applications of various separation techniques, including solvent extraction and chromatography; and acquire knowledge of thermal and X-ray diffraction methods and electrochemical methods, enabling the accurate and precise analysis of diverse types of materials and compounds.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Expertise in sample collection, preservation, and preparation for analysis, using diverse digestion methods. They'll acquire a deep understanding of statistical analysis, precision, accuracy, error analysis, and graphical data presentation for confident evaluation and interpretation of analytical data.	**An**

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2	Gain expertise in separation techniques, including solvent extraction and chromatography, and apply these principles to efficiently separate and identify various compounds in complex mixtures.	**An**
3	Master thermal and X-ray diffraction methods, including TGA, DTA, DSC, and X-ray diffraction, allowing students to analyze the thermal and structural properties of materials and compounds.	**Ap**
4	Develop a strong foundation in electrochemical methods, including pH potentiometry, coulometry, and conductometry, as well as various voltammetry techniques, facilitating the quantitative analysis and characterization of electrochemical processes and substances.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO2	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO3	3	3	3	3	1	2	2	1	-	3	3	3	3	2	1	3
CO4	3	3	3	3	1	2	2	2	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE501 (ANALYTICAL TECHNIQUES AND DATA ANALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**SAMPLE PREPARATION, DEGESTION AND STATISTICAL ANALYSIS:** Sampling - Collection, Preservation and preparation of sample, Techniques of sampling of solid, liquid and gaseous samples, Operation of drying and preparing a solution of the analyte. Principle, methodology and application of different types of digestions such as acid digestion, base digestion, enzymatic and microwave digestion for liquid and solid materials. Evolution and procession of Analytical Data, Precision and Accuracy, Types of Errors, Propagation of errors, Normal Distribution Curve, Standard deviation, Confidence limit, Graphical presentation of result-method of average, Method of Linear least square, Significant figures, Statistical aid to hypothesis of testing- t-test, F-test, Correlation coefficient, Rejection of data.	20	1
II	**SEPARATION TECHNIQUES:** Principle of Solvent Extraction, Methods of Extraction, Efficiency of extraction, Selectivity of extraction, applications. Principle, classification of chromatographic techniques, Technique and applications of paper chromatography, Thin-layer chromatography, HPTLC, Column chromatography. Liquid and Gas chromatography.	18	2
III	**THERMAL AND X-RAY DIFFRACTION METHODS:** Principle, Instrumentation, Applications of TGA, DTA and DSC methods, C/H/S/N/O Analyzer. Principle, instrumentation and application of x-ray diffraction.	17	3

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IV	**ELECTROCHEMICAL METHODS:** Principles and instrumentation of pH potentiometry, coulometry and counductometry. Basic principle of polarography, Diffusion current, polarized electrode, Micro electrode, Dropping Mercury Electrode llkovic equation, Polarographic wave, Amperometric titration, Linear sweep voltammetry, anodic and cathodic stripping voltammetry, normal pulse voltammetry, differential pulse voltammetry, cyclic voltammetry	20	4

BOOK SUGGESTED :

1. Fundamental of Analytical Chemistry- Skoog D.A. and West D.M.
2. Saunders, College Publication.
3. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
4. Principles and Practice of Analytical Chemistry-Fifield F.W and Kealey
5. D. Black well Science
6. Instrumental Analysis R. Braun, McGraw Hill, International Edition.
7. Analytical Chemistry, Christian, G.D., WSE/Wiley.
8. Instrumental Analysis, Willard Meritt Dean, CBS.
9. Chemical Analysis, Brawn, McGraw Hill.
10. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M.
11. Principles of instrumental analysis, Skoog Holler - Niemann.
12. Instrumental analysis, Wizard Dean and Merit.
13. Principle and PRACTICAL analytical chemistry, Fifield and Kealey.

M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	II
Course Code	Course Title		Course Type
CHE502	**Instrumental of Methods analysis**		**Generic Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The objective of this course is to provide students with a comprehensive understanding of comprehensive understanding of advanced chromatographic techniques, X-ray and proton-induced spectroscopy methods, atomic emission, and atomic absorption spectroscopy, and to acquire the analytical skills and knowledge needed to effectively apply these techniques for qualitative and quantitative chemical analysis, including the analysis of pesticides and their interactions with nanoparticles using various instrumental methods.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Develop expertise in advanced chromatography techniques, including ion chromatography, size exclusion chromatography, supercritical fluid chromatography,	**AP**

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	capillary electrophoresis, and capillary electrochromatography, enabling students to separate and analyze complex mixtures of compounds.	
2	Gain a comprehensive understanding of X-ray and proton-induced spectroscopy, including X-ray fluorescent and proton-induced X-ray spectroscopy, and their respective principles, instrumentation, and applications in qualitative and quantitative analysis.	**AP**
3	Acquire knowledge and practical skills in atomic emission and atomic absorption spectroscopy, including flame photometry, atomic emission spectroscopy (AES), inductively coupled plasma atomic emission spectroscopy (ICP-AES), atomic absorption spectroscopy (AAS), cold-vapor, and hydride generation AAS, facilitating precise elemental analysis.	**AP**
4	Develop proficiency in utilizing various analytical methods, including gas chromatography (GC), high-performance liquid chromatography (HPLC), ion chromatography-mass spectrometry (IC-MS), and inductively coupled plasma-mass spectrometry (ICP-MS) for the qualitative and quantitative analysis of pesticides and related compounds, allowing for a deeper understanding of pesticide detection and measurement.	**AP**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO2	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO3	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3
CO4	3	3	3	3	1	3	2	3	-	3	3	3	3	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE502 (INSTRUMENTAL METHODS OF ANALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**ADVANCED CHROMATOGRAPHY:** Ion chromatography: Ion exchange equilibrium, Ion-exchange packing and Inorganic Applications. Size exclusion chromatography: Column packing, Theory of size of exclusion chromatography and applications. Supercritical fluid chromatography: Properties of supercritical fluid SFC-Instrumentation and operating variables, comparison with other types of chromatography, applications. Capillary Electrophoresis and capillary electro chromatography: overviews and applications	18	1
II	**X-RAY AND PROTON INDUCED SPECTROSCOPY:** X-Ray fluorescent method: Principles-Characteristics x-ray emission. Instrumentation x-ray tube, Radioactive sources. Wavelength dispersive instruments. Energy dispersive instruments. Analytical Applications-Qualitative Analysis. Proton Induced X-Ray Spectroscopy : Theory, instrumentation and application.	20	2

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III	**ATOMIC EMISSION AND ATOMIC ABSORPTION SPECTROSCOPY** Selectivity, sensitivity and interferences of atomic spectroscopy. Theory, instrumentation and application of flame photometer, AES, ICP-AES and AFS. Theory instrumentation and application of flame and graphite furnace AAS, cold-vapor and hydride generation AAS.	20	3
IV	**PESTICIDE ANALYSIS AND ANALYSIS METHODS INVOLVED,** PESTICIDE: Organophosphorus, Organochlorin, Carbamates, detection and interaction with nanoparticles, GC, HPLC, IC-MS and ICP-MS methods.	17	4

BOOK SUGGESTED:

1. Instrumental methods of analysis, Willard, Meritt and Dean
2. Basic concepts of analytical chemistry, S.M. Khopkar, John Wiley & Sons.
3. Metallurgical analysis, S.C. Jain.
4. Material Science and Engineering. An Introduction, W.D. Callister, Wiley.
5. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
6. Fundamentals of Analytical Chemistry, Skoog, Welt, Holler and Crouch Thomson Learning Inc.

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE503	**RESONANCE SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANOCATALYSIS**		**Generic Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The aim of this course is to understand and apply advanced spectroscopic techniques, including Electron Spin Resonance Spectroscopy, Nuclear Quadrupole Resonance Spectroscopy, Photoelectron Spectroscopy, Photoacoustic Spectroscopy, and to gain knowledge of photophysical and photochemical processes, reaction mechanisms, and organocatalysis principles in the context of various chemical systems and reactions.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the Electron Spin Resonance Spectroscopy, exploring hyperfine and spin-orbit couplings, g-tensors, and their applications in transition metal complexes with unpaired electrons. Additionally, they'll understand Nuclear Quadrupole Resonance Spectroscopy.	**U**
2	Understand Photoelectron Spectroscopy principles, including the photoelectric effect, ionization processes, Koopman's theorem, and spectra of simple molecules. They'll also understand the determination of dipole moments and X-ray photoelectron spectroscopy (XPS). In addition, they'll grasp the basic principles of Photoacoustic Spectroscopy (PAS).	**U**

Online											
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3	Explore various miscellaneous photochemical reactions, including the Photo-Fries reactions of anilides, Barton reaction, and photodegradation of polymers, fostering a comprehensive understanding of the broader field of photochemistry.	**An**
4	Acquire knowledge of the principles and applications of organocatalysis, including homogeneous and heterogeneous catalytic reactions, enabling the design and optimization of catalytic processes for chemical transformations.	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3
CO2	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3
CO3	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3
CO4	3	3	3	3	2	3	1	2	-	3	3	3	3	1	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE503 (RESONANCE SPECTROSCOPY, PHOTOCHEMISTRY AND ORGANOCATALYSIS)

Unit No.	Topics	No. of Lectures	CO No.
I	**ELECTRON SPIN RESONANCE SPECTROSCOPY**: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron). **NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY:** Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting, applications.	18	1
II	**PHOTOELECTRON SPECTROSCOPY:** Basic principle both for atoms and molecules; Photo-electric effect, ionization process, Koopman's theorem, Spectra of simple molecules Determination of Dipole moment, X-ray photo electron spectroscopy (XPS) **PHOTOACOUSTIC SPECTROSCOPY:** Basic principle of Photo acoustic Spectroscopy (PAS), PAS –gases and condensed system Chemical and Surface application	20	2
III	**PHOTOCHEMICAL REACTIONS:** Interaction of electromagnetic radiation with matter, Photophysical processes, Stern Volmer equation, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, Actinometry. **DETERMINATION OF REACTION MECHANISM**: Classification, rate constants and life times of reactive energy states –determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. **MISCELLANEOUS PHOTOCHEMICAL REACTIONS**: Photo-Fries reactions of anilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers, Photochemistry of vision.	20	3
IV	**ORGANOCATALYSIS** General Principles: Energetic, Catalytic cycles, catalytic efficiency and life time, selectivity. Type of	17	4

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	organometallic reaction: Ligand substitution, Oxidative addition, reductive elimination and insertion and deinsertion. Homogeneous catalysis: Hydrogenetion of alkenes, Hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, Alkenes metathesis, Palladium-Catalysed C-C bond forming reactions, asymmetric oxidation. Heterogenous catalysis: The nature of heterogenous catalysts, Fischer-Tropsch synthesis, alkene polymerization		

BOOK SUGGESTED:

14. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
15. Fundamentals of Photochemsitry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
16. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publications.
17. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
18. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill.
19. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
20. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.
21. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
22. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
23. Shriver & Atkins Inorganic Chemistry: P.Atkins, T.Overtone, J. Rourke, M. Weller, F. Armstrong, Oxford University Press
24. Inorganic Chemistry: C.E. Housecraft, A.G. Sharpe, Pearson Education Limited.
25. Inorganic Chemistry: Principles of Structure and Reactivity: J.E. Huheey, E.A. Keiter, R.L.Keiter, O.K. Medhi, Pearson Education
26. Organometallic Chemistry: A Unified Approach: R.C. Mehrotra, A.Singh, New Age International Publishers.

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE504	**Chemistry of biomolecules**		**Generic Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The objective of this course is to understand the principles of bioenergetics, electron transfer in biological systems, metalloproteins, enzyme structure and function, coenzyme chemistry, biotechnological applications of enzymes, biopolymer interactions, thermodynamics of biopolymer solutions, and cell membrane functions in the context of biochemistry and biophysical chemistry.

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Acquire a thorough grasp of bioenergetics, calculating standard free energy changes, distinguishing exergonic and endergonic processes, and explaining ATP hydrolysis and synthesis. Gain insights into electron transfer in biology, focusing on metalloproteins like cytochromes and iron-sulfur proteins, and applying synthetic models to understand these systems.	U
2	Acquire a deep understanding of metalloenzymes and their various roles in biological processes, including zinc enzymes, iron enzymes, copper enzymes, and molybdenum oxatransferase enzymes, as well as the importance of these enzymes in catalysis.	U
3	Understand enzyme nomenclature, classification, and the induced fit hypothesis. They will identify active sites using inhibitors. Additionally, students will understand coenzyme structures and functions and explore enzyme immobilization techniques, their effects, and applications in medicine, industry, and recombinant DNA technology.	AP
4	Understand forces in biopolymer interactions, thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction, energy generation, cell membrane structure, ion transport, and nerve conduction.	U

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate;**C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO2	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO3	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3
CO4	3	3	3	2	1	2	1	2	-	3	3	3	2	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Detailed Syllabus: CHE504 (CHEMISTRY OF BIOMOLECULES)

Unit No.	Topics	No. of Lectures	CO No.
I	**BIOENERGETICS:** Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. **ELECTRON TRANSFER IN BIOLOGY:** Structure and function of metalloproteins in electron transport processes –cytochromes and ion-sulphur proteins, synthetic models. **TRANSPORT AND STORAGE OF DIOXYGEN:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and haemerythrin, model synthetic complexes of iron, cobalt and copper.	18	1
III	**ENZYMES:** Nomenclature and classification of Enzyme. Induced fit hypothesis, concept and identification of active site by the use of inhibitors. **CO-ENZYME CHEMISTRY:** Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B12.	19	3

	BIOTECHNOLOGICAL APPLICATIONS OF ENZYMES: Techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilization enzymes in medicine and industry. Enzymes and Recombinant DNA Technology.		
II	**METALLOENZYMES:** Zinc enzymes –carboxypeptibase and carbonic anhydrase. Iron enzymes – catalase, peroxidase and cytochrome P-450. copper enzymes-superoxide dismutase. Molybdenum oxatransferase enzymes –xanthine oxidase. **ENZYME MODELS:** Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, Cyclodextrin-based enzyme models, calixarenes, ionophores, synthetic enzymes or enzymes.	17	2
IV	**BIOPOLYMER INTERACTIONS:** forces involved in biopolymer interaction. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves. **THERMODYNAMICS OF BIOPOLYMER SOLUTIONS:** Thermodynamics of biopolymer solution, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechnochemical system. **CELL MEMBRANE AND TRANSPORT OF IONS**: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport and Nerve conduction.	21	4

BOOK SUGGESTED:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.L. Lippard and J.S. Valentine, University Science Books.
3. Inorganic Biochemistry vols II and I.Ed G.L. Eichhorn, Elservier.
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
5. Bioinorganic Chemistry, I. Bertinin, H.B. Gary, S.J. Lippard and J.S. Valentine, University Science.
6. Inorganic Biochemistry vols I and II ed. G.L. Eichhorn, Elsevier.
7. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-verlag.
8. Understanding Enzymes, Trevor palmer, Prentice Hall.
9. Enzyme Chemistry : Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
10. Enzyme Mechanisms Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
11. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
12. Immobilizaed Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, and John Wiley.
13. Enzymatic Reaction Mechanisms, C. Walsh, W.H. Freeman.
14. Enzyme Structure and Mechanisms, A Fersht, W.H. Freeman.
15. Biochemistry: The Chemical Reacitons of liging cells, D.E. Metzler, Academic Press.
16. Principles of Biochemistry, A.L. Lehninger, Wroth Publishers.
17. Biochemistry, L. Stryer, W.H. Freeman.
18. Biochemistry, J. David Rawn, Neil Patterson.

Online											
Prof. Kamlesh. K. Shrivas, Chairman	Prof. N. K. Karade (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. M. L. Satnami	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. M. K. Rai SOS in chemistry

M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	2	III
Course Code	**Course Title**		**Course Type**
CHE505	**Nanochemistry and Applications**		**Generic Elective**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	EA
100	30	70

Learning Objective (LO):

The course is to provide a comprehensive understanding of generic methodologies, material chemistry, characterization methods, and practical applications in nanotechnology, with a focus on the classification of nanostructures, the preparation and properties of nanoparticles, various characterization techniques, and their application.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Identify and classify different types of nanostructures and understand their impact on electronic and material properties.	**Ap**
2	Gain expertise in material chemistry, specifically nanoparticle preparation, properties of metals and ceramics, employing physical and chemical methods.	**An**
3	Understand the diverse characterization methods, including X-ray diffraction, synchrotron radiation, Raman spectroscopy, and electron microscopes. Proficiency in thermal analysis techniques, UV-Visible spectrophotometry, FTIR, and photoluminescence spectroscopy will enable their applications in diagnostic and therapeutic scenarios.	**Ap**
4	Analyze and evaluate the potential future directions and advancements in nanotechnology, including its impact on various scientific and medical applications	**Ap**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO2	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO3	3	3	3	2	1	3	3	2	-	3	3	3	3	2	2	2
CO4	3	3	3	2	1	3	3	2	-	3	3	3	3	3	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online

Prof. Kamlesh. K. Shrivas, Chairman
Prof. N. K. Karade (External member
Prof. Kallol K. Ghosh (member)
Prof. M. K. Deb (Member)
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Dr. Indrapal Karbhal (Member)
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Detailed Syllabus: 505 NANOCHEMISTRY

Unit No.	Topics	No. of Lectures	CO No.
I	**GENERIC METHODOLOGIES FOR NANOCHEMISTRY AND NANOTECHNOLOGY:** Introduction and classification, What is nanotechnology?, Classification of nanostructures, Nanoscale architecture, Summary of the electronic properties of atoms and solids, The isolated atom, Bonding between atoms, Giant molecular solids, The free electron model and energy bands, Crystalline solids, Periodicity of crystal lattices, Electronic conduction, Effects of the nanometre length scale, Changes to the system total energy, Changes to the system structure, How nanoscale dimensions affect properties	20	1
II	**MATERIAL CHEMISTRY:** Preparation and Properties of Nanoparticles, Materials-Metals, Ceramics (Oxide, carbides, sulphides, nitrides).physical and chemical Methods, Size and Shape controlled Synthesis, Sol-gel methods, Optical Properteis, Electrical and Magnetic Properties, Application of Nanoparticles.	20	2
III	**CHARACTERIZATION METHODS:** X-ray diffraction, Debye-Scherer formula, dislocation density, micro strain, Synchrotron Radiation, Principle and Applications, Raman Spectroscopy and its Applications, Dynamic Light Scattering (DLS). Electron microscopes: scanning electron microscope (SEM), transmission electron microscope (TEM), atomic force microscope (AFM), scanning tunneling microscope (STM), XPS, Working Principle, Instrumentation and Applications. Differential scanning calorimeter (DSC), Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA), UV – Visible Spectrophotometer, FTIR, Principle and Applications, Photoluminescence (PL) Spectroscopy. Administration Diagnostic and Therapeutic Applications	18	3
IV	**APPLICATIONS ON NANOCHEMISTRY:** Nanobiology, Introduction, Bio-inspired nanomaterials, Interaction Between Biomolecules and Nanoparticle Surfaces, Different Types of Inorganic Materials Used for the Synthesis of Hybrid Nano-bio Assemblies, Applications of Nano in Biology, Nanoprobes for Analytical Applications, Current Status of Nanobiotechnology, Future Perspectives of Nanobiology; Nanosensors, Electrochemical, Nanobiosensors, Smart Dust; Nanomedicines, Nanodrug	17	4

Books

1. Nanoparticles: From Theory to Application Edited by Gu¨nter Schmid, @ 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
2. Nanoparticles and Catalysis Edited by Didier Astruc @ 2008 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
3. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Mike HagermanShriver and Atkin's Inorganic Chemistry, Fifth Edition, Oxford, 2010.
4. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
5. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
6. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

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Value Added Courses:
(Offered to the PG students of SoS in Chemsitry)

M.Sc. (Chemistry) Semester-I

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	**Course Title**		**Course Type**
CHE107	**Indian Knowledge System (Chemistry)**		**Value added course**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

This course will provide ancient Indian scientific theories, including Sāṅkhya-Pātañjala, Vedāntic Pañcīkaraṇa, and atomic theories from Buddhist, Jain, and Nyāya-Vaiseśika traditions. They will explore the chemistry and evolution of dyes, pigments, and metallurgical practices described in classical texts, alongside the development of acids and bases derived from organic and mineral sources in historical contexts.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the theoretical foundations of ancient Indian science, including the Sāṅkhya-Pātañjala system, Vedāntic Pañcīkaraṇa, and atomic theories from Buddhists and Jains. They will also understand the chemistry of ancient dyes, pigments, and coloring materials used in art and textiles, tracing their historical evolution and applications.	**U**
2	Understand the ancient India's metallurgical heritage, exploring the Arthaśāstra's descriptions of metals and examining historical processing techniques for gold, silver, copper, iron, tin, mercury, and lead. They will also learn about zinc distillation in classical texts and investigate the evolution of acid-base concepts from organic and mineral sources.	**U**

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	2	2	1	3	1	2	-	-	-	3	3	2	2	-
CO2	3	2	2	2	1	3	1	2	-	-	-	3	3	2	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Detailed Syllabus CHE601: Indian Knowledge System (Chemistry)

Unit No.	Topics	No. of Lectures	CO No.
I	A. Theoretical framework for the practice of science in ancient India: Sāṅkhya-Pātañjala system, Evolution of different forms of matter (Pañcīkaraṇa) from the Vedāntic view, The atomic theory of the Buddhists and Jains, NyāyaVaiseśika chemical theory B. Chemistry of dyes, pigments, and other coloring materials used in paintings, fabrics, beads, and other day-to-day utilities since ancient times and their constant evolution through different periods of time.	30	1
II	A. Metallurgical heritage: (i) Arthaśāstra as the earliest text describing gold, silver, and other metals; (ii) Processing of gold, silver, copper, iron, tin, mercury, and lead as mentioned in the Indian texts in the ancient and Medieval Period; and (iii) Zinc distillation as mentioned in Rasārṇava and Rasaratnasamukāyā B. Concepts of acid and bases in Indian chemistry from organic fruit, vegetable-based. Acids, plant-ash-based bases to mineral acids of the medieval period	30	2

BOOK SUGGESTED:

1. The Positive Sciences of the Ancient Hindus; BrijendraNath Seal; 4th Edition; 2016
2. Fine Arts & Technical Sciences in Ancient India with special reference to Someśvara's Mānasollāsa; Dr. Shiv Shekhar Mishra, Krishnadas Academy, Varanasi 1982
3. Mints and Minting in India; Upendra Thakur; Chowkhanba Publication; 1972
4. A Concise History of Science in India, ed. D M Bose, S N Sen and B V Subbarayappa; INSA; 2009
5. Science and Technology in Medieval India - A Bibliography of Source Materials in Sanskrit, Arabic and Persian by A Rahman, M A Alvi, S A Khan Ghori and K V Samba Murthy; 1982.
6. Science and Technological Exchanges between India and Soviet Central Asia (Medieval Period), ed B V Subbarayappa;1985
7. Scientific and Technical Education in India, 1781-1900 by S N Sen; 1991
8. History of Technology in India, Vol. I, ed. A K Bag (1997); Vol III, ed. K V Mital (2001); Vol-II by Harbans Mukhia (2012).

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M.Sc. (Chemistry) Semester-II

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	I
Course Code	**Course Title**		**Course Type**
CHE207	**Internship**		**Value added course**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2		-	60 Hrs
Maximum Marks	CIA		ESE
Experience certificate			

Internship:-

A chemistry internship provides 60 hours of practical training in a university, research institute, or industry setting, etc. Interns engage in hands-on laboratory work, including sample analysis, synthesis, instrumentation (e.g., UV-Vis, HPLC, TEM, SEM, GC, etc), and data interpretation under expert supervision. The experience enhances technical skills, understanding of safety protocols, and exposure to real-world applications in pharmaceuticals, environmental analysis, or material science. Upon successful completion, interns receive an experience certificate, which can be used to earn 2 academic credits. This internship bridges academic knowledge with professional practice, preparing students for careers in research, quality control, or higher studies in chemistry.

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M.Sc. (Chemistry) Semester-III

Program	Subject	Year	Semester
M.Sc.	Chemistry	1	III
Course Code	**Course Title**		**Course Type**
CHE308	**Application of software's in chemistry**		Value added
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

This course covers essential chemical research software, introducing ChemDraw, ChemOffice, and ACD/Spectrus. Participants learn molecular modeling using Gaussian, and Schrödinger Suite, emphasizing structure visualization and energy minimization. Computational chemistry with Gaussian for predicting properties, and practical applications of Origin and Excel for various analytical techniques like electrochemical and spectroscopic data analysis are also covered.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Master key chemical research software (ChemDraw, ChemOffice,), recognizing their importance in modern research. They will gain skills in molecular modeling using Gaussian, and Schrödinger Suite, focusing on visualizing structures and energy minimization.	Ap
2	Acquire expertise in Quantum chemistry using Gaussian for predicting molecular properties. They will also learn to use Origin for plotting diagrams related to various analytical results and Excel for statistical data calculations.	AP

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	2	3	1	2	-	3	3	3	3	2	2	-
CO2	3	3	3	1	2	3	1	2	-	3	3	3	3	2	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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Detailed Syllabus: Application of software's in chemistry

Unit No.	Topics	No. of Lectures	CO No.
I	**Overview of Software Applications:** Introduction to widely used software tools: ChemDraw, ChemOffice, Importance of software in modern chemical research **Molecular Modeling Software:** Principles and applications of software: Gaussian, and Schrödinger Suite, Visualization of molecular structures and energy minimization, etc.	15	1
II	**Computational Chemistry Software:** Origin software for plotting diagrams of electrochemical, XRD, XPS, TGA and FTIR results, etc. Xcel for calculation of statistical data	15	2

BOOK SUGGESTED:

1. Peter C. Jurs, Computer Software Applications in Chemistry, Wiley-Interscience; 2nd edition
2. Muthukumarasamy Karthikeyan , Renu Vyas, Practical Chemoinformatics, Spriger

	Online										
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