COURSE CURRICULUM

M.Sc. Analytical Chemistry

Batch:2024-2025
Academic Year: 2024-25
Updated on: June, 2024

GSFC University
School of Science, Vigyan Bhavan, P. O. Fertilizernagar, Vadodara - 391750, Gujarat, India

VISION

- GSFCU strives to be the best compact boutique institution with a futuristic approach, encouraging student centric culture and sharpened focus on developing industry ready & employable students with all-round development.

MISSION

- Establish an institution, which promotes creativity and innovation.
- Develop unique quality standards for academic excellence and pedagogical innovations.
- Remain agile through learning ecosystem with flexible processes & systems.
- Holistic growth for industry readiness.

No.	Programme Outcomes (POs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PO1	Basic Knowledge: To impart knowledge regarding basic concepts of applied chemical sciences.	Cognitive domain	Apply
PO2	Interdisciplinary approach: To explain the relationships between chemical sciences, biological sciences, physical sciences and mathematical sciences.	Cognitive domain	Apply
PO3	Practical learning: To perform procedures as per laboratory standards in the areas of Chemical Sciences and to think analytically.	Cognitive domain	Create
PO4	Effective Communication and social Interaction: To communicate effectively in terms of reading, writing, speaking and delivering the view to others.	Cognitive domain	Evaluate
PO5	Ethics: To culminate and understand the moral values for any of the subjects with respect to good practices and humanity.	Cognitive domain	Create
PO6	Environment and Sustainability: To explain the importance of ecological balance along with conservation of natural resources for human well being.	Cognitive domain	Create

No.	Programme Specific Outcomes (PSOs)	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
PSO1	To prepare the students to understand the chemistry particularly organic and analytical chemistry related research and Industrial applications	Cognitive domain	Understand Evaluate Create
PSO2	To make students expert in interpreting complex data related to chemistry problems and challenges.	Cognitive domain	Evaluate Analyse
PSO3	To provide knowledge needed to solve current and emerging technologies to students.	Cognitive domain	Apply Create
PSO4	To make students expert in communicating issues related to chemistry to a wide audience	Cognitive domain	Understand Analyse
PSO5	To prepare students in solving complex social and ethical problems confronting the industry and the government.	Cognitive domain	Apply Create
PSO6	To expose students to the different processes used in industries and their applications in chemistry.	Cognitive domain	Apply Create

Mapping of POs & PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	1	1	3	3	3	1
PSO2	2	2	1	3	1	3
PSO3	3	3	3	1	3	3
PSO4	2	2	3	2	3	2
PSO5	2	2	3	2	3	2
PSO6	2	2	3	2	3	2
Avg.	2	2	3	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Definition of Credit:

1 Hour. Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
4 Hours Practical (P) per week	2 credit
2 Hours Practical (P) per week	1 credit
1 Hour Practical (P) per week	0.5 credit
3 Hours Experiential learning	1 credit

Course code Definitions:

Lecture	L
Tutorial	T
Practical	P
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Sciences including Management courses	HSMC
Professional core courses/Major (Core)	PCC
Professional Elective courses/Minor Stream	PEC
Open Elective courses	OEC
Laboratory course	LC
Mandatory courses	MC
Non-credit courses	NC
Project (Experiential learning)	PROJ
Experiential learning ex. Internship, Industrial Visit, Field visit, etc,	EL
Multidisciplinary courses	MDC
Ability Enhancement Course	AEC
Skill Enhancement Course	SCE
Value Added Courses	VAC

Structure of Postgraduate Programme:

Sr. No.	Category	Credit Breakup
1	Professional core courses -**Major (Core)**	120
2	Professional Elective courses relevant to chosen specialization/branch -**Minor Stream**	12
3	Project work, seminar and internship in industry or elsewhere	10
4	Mandatory Courses [Environmental Sciences, Induction Programme, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	**114**

Table: Minimum Credit Requirement

S.No.	Broad Category of Course	Minimum Credit Requirement
		2-year PG
1	Major (Core) (50% of total credit)	120
2	Skill Enhancement Courses (SEC) (from major & Minor)	26
3	Internship and Dissertation	10
	Total	156

Category-wise Courses:

Professional Core Courses

(i) Number of Professional Core Courses:120
(ii) Credits: 92

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1	MSCM111	Analytical Chemistry – I	I	3	4	0	7	3	2	0	5
2	MSCM112	Organic Chemistry - I	I	3	4	0	7	3	2	0	5
3	MSCM113	Physical Chemistry - I	I	3	4	0	7	3	2	0	5
4	MSCM114	Inorganic Chemistry -I	I	3	4	0	7	3	2	0	5
5	MSCM211	Analytical Chemistry – II	II	3	4	0	7	3	2	0	5
6	MSCM212	Organic Chemistry - II	II	3	4	0	7	3	2	0	5
7	MSCM213	Physical Chemistry - II	II	3	4	0	7	3	2	0	5
8	MSCM214	Inorganic Chemistry -II	II	3	4	0	7	3	2	0	5
9	MSCM301	Analytical Chemistry – III	III	4	4	0	8	4	2	0	6
10	MSCM302	Analytical Chemistry – IV	III	4	4	0	8	4	2	0	6
11	MSCM303	Analytical Chemistry – V	III	4	4	0	8	4	2	0	6
12	MSCM401	Analytical Chemistry – VI	IV	4	4	0	8	4	2	0	6
13	MSCM402	Analytical Chemistry - VII	IV	4	4	0	8	4	2	0	6
14	MSCM403	Analytical Chemistry – VIII	IV	4	4	0	8	4	2	0	6
15	MSCM106	Communication Skill - I	I	1	0	1	2	2	0	0	2
16	MSCM206	Communication Skill - II	II	1	0	1	2	2	0	0	2
17	MSCM307	Communication Skill - III	III	1	0	1	2	2	0	0	2
18	MSCM407	Communication Skill - IV	III	1	0	1	2	2	0	0	2
		Total		**60**	**56**	**04**	**120**	**64**	**28**	**0**	**92**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

Project Work, Seminar And Internship In Industry Or Elsewhere

(i) Number of Project Work, Seminar And Internship In Industry Or Elsewhere:10
(ii) Credits:10

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1.	MSCM105	Internship – I	I	0	2	0	2	0	2	0	2
2.	MSCM205	Internship – II	II	0	2	0	2	0	2	0	2
3.	MSCM306	Internship – III	III	0	2	0	2	0	2	0	2
4.	MSCM309	Dissertation	III	0	2	0	2	0	2	0	2
5.	MSCM407	Dissertation	IV	0	2	0	2	0	2	0	2
				0	**10**	**0**	**10**	**0**	**10**	**0**	**10**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

Ability Enhancement Courses

(i) Number of Ability Enhancement Courses:08
(ii) Credits:08

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
1.	MSCM106	Communication Skill - I	I	1	0	1	2	2	0	0	2
2.	MSCM206	Communication Skill - II	II	1	0	1	2	2	0	0	2
3.	MSCM307	Communication Skill - III	III	1	0	1	2	2	0	0	2
4.	MSCM407	Communication Skill - IV	III	1	0	1	2	2	0	0	2
		Total		**04**	**0**	**04**	**08**	**08**	**0**	**0**	**08**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

Skill Enhancement Compulsory/Elective Courses

(i) Number of Skill Enhancement Courses: 26
(ii) Credits: 26

Sr. No.	Course Code	Course Name	Semester	Teaching Scheme (Hours/week)				Teaching Credit			
				L	P	T	Total	L	P	T	Total
Skill Enhancement Compulsory Courses											
1.	MSCM105	Internship – I	I	0	2	0	2	0	2	0	2
2.	MSCM107	Comprehensive Viva-I	I	0	2	0	2	0	2	0	2
3.	MSCM205	Internship – II	II	0	2	0	2	0	2	0	2
4.	MSCM206	Comprehensive Viva-II	II	0	2	0	2	0	2	0	2
5.	MSCM306	Internship – III	III	0	2	0	2	0	2	0	2
6.	MSCM308	Comprehensive Viva-III	III	0	2	0	2	0	2	0	2
7.	MSCM408	Dissertation	III	0	2	0	2	0	2	0	2
8.	MSCM408	Dissertation/Special Practical	III and IV	0	2	0	2	0	2	0	2
9.	MSCM409	Comprehensive Viva-IV	IV	0	2	0	2	0	2	0	2
Skill Enhancement Elective Courses											
9.	MSCM304 /305	Computer application in Chemistry or Research Methodology	III	4	0	0	4	4	0	0	4
10.	MSCM406 /415/404	Analysis and Characterization of Polymers/Organic Chemistry-IX/Enviornmental Analytical Chemistry	IV	4	0	0	4	4	0	0	4
		Total		8	18	0	**26**	8	18	0	**26**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

About the Programme :

Science is the basic foundation of any technological and engineering creation. In view of the changing scenario at the national and international level in the field of Science and Technology, there is a great demand for basic sciences with considerable knowledge of its applications. GSFC University is committed to high academic standards. The M.Sc. Chemistry Program is designed for Four Semesters (Two Years) in such a way that a

good basic foundation of subjects is laid and applications along with recent developments are covered. Students will also get theoretical and practical knowledge by undergoing industrial internship after every semester.

The more focused specialization course of organic and analytical chemistry is designed in the 2 year of M.Sc. Chemistry program to fulfill recent demands of industrial career. The M.Sc. Chemistry Program provides an opportunity to make a career in R&D, Industries and Academic Institutions. Opportunity for the placement may be provided by the Institute.

Teaching Scheme
Semester – I M. Sc. Chemistry Program

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	A. Ability Enhancement Compulsory Course															
1.	MSCM106	Communication Skills – I	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM105	Internship	0	2	0	2	0	2	0	2	0	0	0	0	0	50
3.	MSCM107	Comprehensive Viva- I	0	0	2	2	0	0	2	2	0	0	0	0	0	50
	C. Core Course															
4.	MSCM111	Analytical Chemistry – I *(Basics of analytical chemistry)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
5.	MSCM112	Organic Chemistry – I *(Principles of Organic Chemistry)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
6.	MSCM113	Physical Chemistry – I *(Quantum & Polymer Chemistry)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
7.	MSCM114	Inorganic Chemistry – I (Coordination compounds & Organometallic Chemistry)	3	4	0	7	3	2	0	5	20	40	40	100	50	150
	C. Minor Course															
8.	CHE-2303 ISC	Introduction to Chemical Engineering and Safety in Chemical Industry	4	0	0	4	4	0	0	4	20	40	40	100	00	100
		Total	**17**	**18**	**03**	**38**	**17**	**10**	**03**	**30**						**850**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

COURSE CODE MSCM111	COURSE NAME **Analytical Chemistry-I** *(Basics of Analytical Chemistry)*	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	00	105	3	2	00	5

Course Pre- requisites	Basic B.Sc. Level Analytical Chemistry Concept
Course Category	Professional core course
Course focus	Skill Development
Rationale	This course offers a robust foundation in both classical and modern analytical techniques essential for accurate chemical analysis. It covers fundamental concepts like sampling, data handling, and laboratory practices, progressing to the statistical validation of analytical data. Students will gain practical skills in chromatography and advanced separation methods, preparing them for diverse analytical challenges in research and industry. This comprehensive approach ensures a thorough understanding of analytical chemistry principles and their applications.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Understand** the role and classification of analytical methods **Master** the assessment of analytical data **Learn** the principles, classifications, and applications of various chromatographic techniques. **Gain** expertise in advanced chromatographic methods **Explore** specialized separation techniques

Course Content (Theory)	Weightage	Contact hours
Unit 1: Fundamental of Analytical Chemistry Language of Analytical Chemistry, Analytical techniques, Selection of methods and instruments, Laboratory operations and practices, Handling of Glassware, Selecting and handling of reagents, Sample preparations, Laboratory notebooks, Safety in the analytical laboratory, Standardization and Calibration.	**20%**	**09**
Unit 2: Assessment of Analytical Data and Numerical Chemistry Analytical method validation: accuracy, precision, sensitivity, selectivity, robustness, ruggedness, scale of operation, analysis	**20%**	**09**

time, availability of equipment & cost, Errors, Significant figures, Tests, Numerical of statistical analysis .		
Unit 3: **Distillation:** Principles and Applications. **Solvent extraction:** Types, principle and efficiency of extraction, sequence of extraction process, factors affecting extraction-pH and oxidation state, masking and salting out agents, techniques-batch and continuous extraction, applications. **Electrophoresis:** Two-dimensional gel electrophoresis, staining, zone electrophoresis, capillary electrophoresis, isoelectric focusing. **Centrifugation:** High speeds centrifuges, ultracentrifuge, sedimentation coefficients, density gradient, sedimentation equilibrium, analytical centrifugation	**20%**	**09**
Unit 4: Introduction to Techniques & Instrumentations: Spectroscopy, Chromatography and Thermal Analysis: Principles and Instrumentation and applications.	**20%**	**09**
Unit 5: Chromatography Differential migration rates, partition ratio, retention time, relation between partition ratio and retention time, capacity factor, selectivity factor. Plate theory and rate theory. Band broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column, types of columns, column efficiency, optimization column performance, selectivity factor, column resolution, distribution constant and applications of conventional column, advantages and limitations.	**20%**	**09**

List of Practical	**Weightage**	**Contact hours**
1. **Determination** of strength of a weak acid by conductometric titration	**12.5%**	4
2. **Determination** of equivalent conductance, degree of dissociation and dissociation constant of weak acid conductometrically	**12.5%**	4
3. **Determination** of strength of a weak acid by Potentiometric titration.	**12.5%**	4
4. **Determination** of λmax and concentration of given potassium permanganate solution using visible spectrometry	**12.5%**	4
5. **Determination** of Hardness of a given water sample by complexometric method.	**12.5%**	4
6. **Determination** of dissolved oxygen (DO) in a given water	**12.5%**	4

sample by Winkler's method.		
7. **Determination** of Chemical Oxygen Demand (COD) for a given polluted water sample.	**12.5%**	4
8. **Investigation** of adsorption of oxalic acid on charcoal.	**12.5%**	4

Instructional Method and Pedagogy: Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Subdomain**
After successful completion of the above course, students will be able to: CO1: Understand the role, classification, and selection of analytical methods, along with laboratory practices and sample preparation. CO2: Learn to assess analytical data through statistical methods, validate results, and minimize experimental errors. CO3: Explore the concepts of Distillation, solvent extraction, electrophoresis and its applications CO4: Grasp the principles, classifications and applications of various analytical techniques likes spectroscopy, chromatography and thermal analysis. CO5: Gain expertise in various chromatographic conditions and grasp the principles of Gel Permeation Chromatography (GPC), Affinity Chromatography, and advanced methods like LC/MS and electrophoresis	Cognitive	Remember& Understand Remember & Analyse Understand Analyze Apply Apply

Learning Resources	
1.	Reference Books: 1. Douglas A. Skoog, Donald M. West, F. James, Fundamentals of Analytical Chemistry, 2. J W Robinson, Marcel Dekker, Undergraduate Instrumental Analysis, 6th Edition, Ch:1. 3. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 5th Edition, Harcourt Asia Publisher

	4. David Harvey, Modern Analytical Chemistry, McGraw-Hill Higher Education
2.	Journals & Periodicals: Analyst, Journal of Analytical Chemistry.
3.	Other Electronic Resources: Unacademy, NPTEL etc

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Open Book Assignment</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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</td></tr>
<tr><td>Project/Industrial Internship Marks</td><td>
<table>
<tr><td>Quantity of the Project/Industrial in terms of Language, Presentation & format.</td><td>30 marks</td></tr>
<tr><td>Practical understanding of the subject on the Project/Industrial.</td><td>30 marks</td></tr>
<tr><td>Industry/University mentor's feedback on the Project/Industrial.</td><td>30 marks</td></tr>
<tr><td>Attendance</td><td>10 marks</td></tr>
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		Total	**100 Marks**

Mapping of PSOs& COs

	PSO1	PSO2	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	1	0	1	1	2
CO2	3	2	0	1	0	0	3
CO3	2	2	2	2	1	1	2
CO4	1	1	0	0	0	0	1
CO5	1	2	2	1	1	1	1

Mapping of POs& COs

	PO1	PO2	PO2	PO3	PO4	PO5	PO6
CO1	3	0	2	3	0	0	3
CO2	3	0	1	1	0	0	3
CO3	2	1	2	2	0	0	2
CO4	3	0	2	1	0	0	3
CO5	3	1	3	1	0	0	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM112	COURSE NAME **Organic Chemistry I** *(Principles of Organic Chemistry)*	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	00	105	3	2	0	5

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course covers essential concepts and reactions, starting with acidity, basicity, and aromaticity. It explores the nature and behavior of key intermediates like carbocations, carbanions, radicals, carbenes, and nitrenes. The course also explains nucleophilic and electrophilic substitution reactions, focusing on their mechanisms and factors that affect their reactivity. This knowledge helps students understand and predict organic reactions, crucial for advanced chemistry studies and applications.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the structure, reactivity of organic molecules, and concepts of aromaticity. 2: **Learn** about the generation, structure, stability, and reactivity of carbocations and carbanions, and their role in organic reactions. 3: **Study** the structure, generation, and reactions of carbenes, nitrenes, and radicals, including key rearrangement reactions. 4: **Explore** aliphatic and aromatic nucleophilic substitution mechanisms and factors influencing these reactions. 5: **Understand** aliphatic and aromatic electrophilic substitution mechanisms, including important name reactions and factors affecting reactivity.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Basic Organic chemistry & Aromaticity **Structure and reactivity:** Introduction to Acids and Bases, Structural effects on acidity and basicity of organic molecules, hydrogen bonding, resonance, inductive and field effects, hyper	**20%**	**09**

conjugation effects, steric effect, Bredt's rule. **Aromaticity:** Huckel's rule of aromaticity, benzenoid and non-benzenoid aromatic compounds, Tropones, Tropolones, Pyrilium cation, ferrocene. Alternant and nonalternant hydrocarbons, aromaticity of charged rings (3-8 membered), non-aromatic, antiaromatic and homo aromatic systems, Annulenes and hetero annulenes (10-18).		
Unit 2: Organic reactive intermediates & its reactions-I Reaction Intermediates: Generation, structure, stability, reactivity and detection of classical and non-classical carbocations, carbanions, free radicals, carbenes and nitrenes including nitrogen,phosphorous and sulfur ylides **Carbocation:** Generation, structure and stability of carbocations, Classical and non-classical carbocations, Neighboring group participation and rearrangements including Wagner-Meerwein, Pinacol-pinacolone, semi-pinacol rearrangement, C-C bond formation involving carbocations, Oxymercuration, halolactonisation. **Carbanion:** Generation, structure and stability of carbanions	**20%**	**09**
Unit 3: Organic reactive intermediates & its reactions-II **Carbenes and Nitrenes:** Structure of carbenes, generation of carbenes, addition and insertion reactions, rearrangement reactions of carbenes such as Wolff rearrangement, generation and reactions of ylid by carbenoid decomposition, Structure of nitrene, generation and reactions of nitrene and related electron deficient nitrogen intermediates, Curtius, Hoffmann, Schmidt, Beckmann rearrangement reactions. **Radicals:** Generation of radical intermediates and its (a) addition to alkenes, alkynes (inter & intramolecular) for C-C bond formation and Baldwin's rules (b) fragmentation and rearrangements.	**20%**	**09**
Unit 4: Organic reaction mechanisms-I **Aliphatic Nucleophilic Substitution** SN1, SN2, SET and SNi mechanism, NGP by pi and sigma bonds, classical and nonclassical carbocations, phenonium ions, norbornyl system, carbocation rearrangement in NGP, effect of structure, nucleophile, leaving group, factors affecting reactivity in SN reactions (e.g. solvent on rate of SN1 and SN2 reactions, ambident nucleophile and regioselectivity etc.) nucleophilic substitution at an allylic, trigonal and vinylic carbon **Aromatic Nucleophilic Substitution** ArSN1, ArSN2, aromatic nucleophilic substitution via benzynes, factors affecting ArSN reactions Some important name reactions involving nucleophilic substitution reactions: Sommelet hauser rearrangement, smiles rearrangement etc.	**20%**	**09**
Unit 5: Organic reaction mechanisms-II **Aliphatic Electrophilic Substitution:** Unimolecular and biomolecular mechanism, aliphatic diazo coupling	**20%**	**09**

Aromatic Electrophilic Substitution: Arenium ion mechanism, orientation and reactivity, energy profile diagram, steric effects and ortho/para ratios, ipso attack, orientation in other ring systems, naphthalene, anthracene, six and five membered heterocycles, diazonium coupling. Important reactions like Friedel crafts alkylation and acylation, Nitration, halogenation, formylation, chloromethylation, sulphonation. Some important name reactions involving electrophilic substitution reactions: Vilsmeier hack, Reimer tiemann, Fries rearrangement, diazonium coupling, bischker napieralski etc.		

List Of Practical	Weightage	Contact hours
1: To understand The concepts of stereochemistry	11%	4
2: Estimation of amount of glucose present in the unknown sample(D-glucose)	11%	4
3: Estimation of amount of glucose present in the unknown sample (cold drink)	11%	4
4: Preparation of urea-formaldehyde resin and determination of its saponification value	11%	4
5: Preparation of phenol-formaldehyde resin and determination of its saponification value	11%	4
6: Estimation of phenol	11%	4
7: Estimation of aniline	11%	4
8: Nitration of Salicylic acid	11%	4
9: Preparation of benzoquinone from hydroquinone	11%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: CO1: analyze and predict the acidity, basicity, and aromaticity of organic molecules. CO2: To understand the generation, structure, stability, and reactions of carbocations and carbanions. CO3: Students will gain knowledge about the generation and reactions of carbenes, nitrenes, and radicals, including key rearrangement reactions. CO4: Comprehend the mechanisms of aliphatic and aromatic nucleophilic substitutions and the factors influencing these reactions.	Cognitive	Understand Remember Understand Apply Apply

CO5: explain the mechanisms of aliphatic and aromatic electrophilic substitutions and understand important name reactions and reactivity factors.		

Learning Resources	
1.	Reference Books: 1. Advanced Organic Chemistry –by J. March 6th EditionUndergraduate Instrumental Analysis, 6th Edition, J W Robinson, Marcel Dekker, Ch:1. 2. Advance Organic Chemistry (part A) –by A. Carey and R.J. Sundberg
2.	Journals & Periodicals: JACS, JOC etc
3.	Other Electronic Resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory:Mid semester Marks	20 marks
Theory:End Semester Marks	40 marks
Theory:Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**

Project/Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/Universitymentor's feedback on the Project/Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs& COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	0	0	0	0
CO2	3	1	2	2	2	0
CO3	3	1	1	2	1	0
CO4	2	0	0	1	1	0
CO5	3	2	1	1	1	2

Mapping of POs& COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	3	0	2	1	1	0
CO3	3	1	2	1	1	1
CO4	2	0	1	0	0	0
CO5	2	1	0	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM113	COURSE NAME **Physical Chemistry I** *(Quantum & Polymer Chemistry)*	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
45	60	00	105	3	2	0	5

Course Pre-requisites	Basic B.Sc. Level Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course in Quantum Chemistry provides a foundational understanding of the fundamental principles and theories that define the behavior of particles at the quantum level. It delves into the mathematical framework of quantum mechanics, including postulates, commutation relations, and various motion types (translational, rotational, vibrational). Additionally, it explores the application of quantum mechanics in chemical bonding, including molecular orbital theory and valence bond theory, along with the role of group theory in understanding molecular symmetry and properties. By integrating these concepts, the course equips students with the essential tools to analyze and predict the behavior of particles in molecular systems, offering a comprehensive foundation for advanced studies and research in chemistry and related field.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Understand** the foundational postulates of quantum chemistry and the commutation relations of various operators. **Explore** the translational and rotational motions of particles. **Study** the vibrational motion of particles and the quantum mechanics of hydrogen-like atoms, including wave function normalization and polynomial solutions. **Learn** approximate quantum mechanics methods. **Understand** the theories of chemical bonding and the application of group theory in quantum mechanics.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Postulates of quantum mechanics: Introduction to operator algebra. Postulates, Commutation relations: Commutative property; momentum operator; Hamiltonian operator; angular momentum operator; angular momentum operators and their commutation relations; shift operators and their commutation relations; the effect of shift operators on an eigenvalue of the angular momentum; some theorems and problems.	**20%**	**09**
Unit 2: Origin of quantization: Particle in a box Translational motion of a particle: Free particle; particle in a box with infinite potential barrier; quantization and quantum numbers; symmetry of the wave functions; use of the box model; cubical box and degeneracy; quantum mechanical tunneling and problems Rotational motion of a particle: Particle on a sphere; normalization of the wave functions; rotation of a diatomic molecule and problems. Valence bond and molecular orbital theories. Molecular orbitals of homonuclear and heteronuclear diatomic molecules. VSEPR. Molecular orbital and Valence bond approaches to polyatomic molecules. Hybrid orbitals.	**20%**	**09**
Unit 3: Polymer Chemistry-I Introduction: Background, Nomenclature, Classifications, Molecular Weight, Examples of Applications, Principles of Polymerization, Synthesis of Polymers: Step-Growth Polymerization	**20%**	**09**
Unit 4: Polymer Chemistry-II Radical Chain Polymerization, Controlled Radical Polymerization, Emulsion Polymerization, Ionic Chain Polymerization, Coordination Polymerization, Ring-Opening Polymerization, Copolymerization, Characterization of Polymers.	**20%**	**09**
Unit 5: Polymer Chemistry-III Determination of Molecular Weight (cont.), Frictional Properties of Polymers in Solution, Hydrodynamic Size, Chemical Composition, Polymer Processing, Phase Structure and Morphology of Bulk Polymers: Amorphous and Crystalline States, Viscoelasticity, Multicomponent Polymer Systems, Properties of Bulk Polymers.	**20%**	**09**

List Of Practical	Weightage	Contact hours
1: To determine the rate constant and activation energy of methyl acetate at different temperature	14%	4
2: To determine the dissociation constant Pk1 and Pk2 of given dibasic acid by pH metric.	14%	4
3: To determine solubility product (ksp) of given sparingly soluble salts (BaSO4) by conductivity water.	14%	4
4: Titrate copper (II) solution with EDTA spectrochemical	14%	4
5: To Determine concentration of protein in an unknown sample.	14%	4
6: To Determine critical micelle concentration of given surfactant using conductivity method.	14%	4
7: To study the reaction between persulphate and iodide to determine the rate constant	14%	4

Instructional Method and Pedagogy: Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of Physical Chemistry Studies.

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to: **CO1:** Students will be able to explain the postulates of quantum chemistry and discuss the commutation relations of operators such as momentum, Hamiltonian, and angular momentum. **CO2:** Students will demonstrate an understanding of the translational and rotational motion of particles. **CO3:** Students will be able to describe the vibrational motion of particles. **CO4:** Students will apply perturbation theory and the variation theorem and analyze the treatment of degenerate levels. **CO5:** Students will evaluate molecular orbital and valence bond theories.	Cognitive	Remember Understand Apply Analyse Apply

Learning Resources	
1.	Reference Books: 1.Bockris, J. O'M. and Reddy, A. K. N. (1998) Modern Electrochemistry, Vol. 2 A & B, Second Edition 2. Chakrabarty, D. K. (Reprint 2007), Adsorption and Catalysis by Solids, New Age International 3. Bond, G. C. (1974), Heterogeneous catalysis: Principles and applications Clarendon Press, Oxford 4. Atkins' Physical Chemistry, P. W. Atkins and De Paula, 8th edition (2010).R.C Mehrotra and A.Singh, Organometallic Chemistry- A unified Approach 5. Physical Chemistry, T. Engel and P. Reid, Pearson Education (2006)
2.	Journals: JACS, JPC A etc
3.	Other Electronic Resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks

<table>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Open Book Assignment</td><td>10 marks</td></tr>
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</td></tr>
<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
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<tr><td>Project/ Industrial Internship Marks</td><td>
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<tr><td>Attendance</td><td>10 marks</td></tr>
<tr><td>Total</td><td>100 Marks</td></tr>
</table>
</td></tr>
</table>

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	0	0	1	1	0
CO2	3	1	0	1	0	0
CO3	3	1	1	0	0	0
CO4	2	0	0	0	0	0
CO5	3	2	2	1	1	1

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	1	0	0	0	0
CO3	2	2	1	1	0	0
CO4	1	0	1	1	0	0
CO5	2	2	2	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM114	COURSE NAME Inorganic Chemistry-I *(Coordination compounds & Organometallic Chemistry)*	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	00	105	3	2	0	5

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course offers a comprehensive exploration of various aspects of inorganic chemistry, including group theory, hydrogen and its compounds, the chemistry of non-transition elements, and bioinorganic chemistry. By understanding these topics, students will be able to analyze complex chemical systems and appreciate the fundamental role of inorganic chemistry in biological and environmental contexts.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Understand** the concepts of group theory in chemistry. **Explore** the relations between symmetry elements and symmetry operations. **Study** the classification, properties, and applications of hydrides and non-aqueous solutions. **Analyze** the synthesis, properties, and structures of halides, oxides, boranes, silicates, carbides, and sulfur-nitrogen compounds. **Explore** the role of metal ions in biological systems

Course Content (Theory)	Weightage	Contact hours
Unit 1: Transition Metal Chemistry Structure, bonding and properties of transition metal ligand complexes – ligand, coordination, geometry, coordination number, isomerism and optical isomerism, HSAB concept, thermodynamic stability, successive and overall stability constants, Irving-William series, chelate and macrocyclic effect. Magnetic Properties of Coordination Complexes	**20%**	**09**
Unit 2: Coordination Chemistry: I Theories of bonding: VBT, CFT and their limitations; d-orbital splitting in octahedral, JT-distorted octahedral, square planar, square pyramidal, trigonal bipyramidal, and tetrahedral complexes; CFSE for d1 to d10 systems, pairing energy, low-spin and high-spin complexes and magnetic properties; LFT,	**20%**	**09**

and molecular orbital (MO) theory of selected octahedral and tetrahedral complexes.		
Unit 3: Coordination Chemistry: II Electronic Spectra: UV-Vis, charge transfer, colors, intensities and origin of transitions, interpretation, term symbols and splitting of terms in free atoms, selection rules for electronic transitions, Orgel and Tanabe-Sugano diagram, calculation of Dq, B, C, Nephelauxetic ratio. Reaction mechanisms: substitution reactions in octahedral and square planar complexes, trans effect and its influence, water exchange, anation and base hydrolysis, stereochemistry, inner and outer sphere electron transfer mechanism.	**20%**	**09**
Unit 4: Organometallic Chemistry: I 18-electron rule, concept of hapticity; synthesis, structure and bonding of homo and heteroleptic metal-carbonyls, nitrosyls, alkyls, alkenes, allyl, alkynes, and arenes. Synthesis and reactivity of Fischer and Schrock carbenes, Monsanto process, Turn over number (TON), Turn over frequency (TOF).	**20%**	**09**
Unit 5: Organometallic Chemistry: II Electron counting schemes: polyhedral skeletal electron pair theory/Mingo's rule. Structure and Isolobal analogies. Metallocenes and bent-metallocenes. Fluxionality and dynamics in organometallic chemistry	**20%**	**09**

List Of Practical	Weightage	Contact hours
1: Preparation of Potassium dioxalatodiaqua chromate(II)	11%	**4**
2: Preparation of Tetrammine copper(II) sulphate	11%	**4**
3: Preparation of Sodium trioxalato ferrate(III)	11%	**4**
4: Preparation of Titrate copper (II) solution with EDTA spectrochemically	11%	**4**
5: Preparation of Potassium trioxalato chromate(III)	11%	**4**
6: Preparation of Hexammine nickel(II) chloride	11%	**4**
7: Preparation of Ammonium nickel(II) sulphate hexahydrate	11%	**4**
8: Preparation of Hexathiourea plumbus nitrate	11%	**4**
9: Preparation of Lead chromate	11%	**4**

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		

CO1: Understand the concepts of group theory in chemistry. **CO2: Explore** the relations between symmetry elements and symmetry operations. **CO3: Study** the classification, properties, and applications of hydrides and non-aqueous solutions. **CO4: Analyze** the synthesis, properties, and structures of halides, oxides, boranes, silicates, carbides, and sulfur-nitrogen compounds. **CO5: Explore** the role of metal ions in biological systems	Cognitive	Understand Remember Apply Understand Apply

Learning Resources	
1.	Reference Books: 1.Bockris, J. O'M. and Reddy, A. K. N. (1998) Modern Electrochemistry, Vol. 2 A & B, Second Edition 2. Chakrabarty, D. K. (Reprint 2007), Adsorption and Catalysis by Solids, New Age International 3. Bond, G. C. (1974), Heterogeneous catalysis: Principles and applications Clarendon Press, Oxford 4. Atkins' Physical Chemistry, P. W. Atkins and De Paula, 8th edition (2010).R.C Mehrotra and A.Singh, Organometallic Chemistry- A unified Approach 5. Physical Chemistry, T. Engel and P. Reid, Pearson Education (2006)
2.	Journals: JACS, JPC A etc
3.	Other Electronic Resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Open Book Assignment	10 marks
Total	**40 Marks**

Practical Marks	Attendance	05 marks
	Practical Exam	20 marks
	Viva	10 marks
	Journal	10 marks
	Discipline	05 marks
	Total	**50 Marks**
Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/ University mentor's feedback on the Project/ Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	0	0	0	0	0
CO2	2	1	0	0	0	0
CO3	1	0	0	0	0	0
CO4	1	0	0	0	0	0
CO5	1	1	1	1	1	0

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	1	0	0
CO2	3	0	0	1	0	0
CO3	3	0	1	1	0	0
CO4	3	0	1	1	0	0
CO5	3	0	3	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM106	COURSE NAME Fundamentals of English	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
30	00	00	30	2	0	0	2

Course Pre-requisites	Students should have basic knowledge of English language and grammar
Course Category	Compulsory Course
Course focus	Skill Development
Rationale	It enables humanity to experience the benefits of chemistry when we apply it in the exploitation of materials and energy.
Course Revision/ Approval Date:	14/03/2023
Course Objectives (As per Blooms' Taxonomy)	1 To emphasize the development of listening and reading skills among learners 2 To equip them with writing skills needed for academic as well as workplace context 3 To enable learners of Engineering and Technology develop their basic communication skills in English 4 To strengthen the fundamentals in English Language. 5 To build up the confidence to communicate with the world.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Vocabulary Use of Dictionary Use of Words: Diminutives, Homonyms & Homophones, word formation, prefix-suffix, synonyms, antonyms, and standard abbreviations	25%	8
Unit 2: Writing Skills Types of the sentences, structures of the sentences, use of phrases and clauses, punctuation, comprehension, paragraph writing	25%	7

Unit 3: Spoken Skills Greetings, farewell and introduction, making an apology, accepting an apology, making an appointment, JAM, group discussion	25%	7
Unit 4: Communication Basics Definition of communication, Process of Communication, Principles of Communication, Functions of Communication, Barriers of Communication	25%	8

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to:		
CO1: At the end of the course, the students will be able to understand fundamentals of speaking English.	Understand, Remember, Create	Define, Classify, Describe & Demonstrate
CO2: At the end of the course, the students will be able to develop writing skills needed for academic as well as workplace context.	Create, Analyse, Apply	Classify, Describe & Demonstrate
CO3: At the end of the course, the students will be able to develop strong listening and reading skills.	Understand, Remember, Evaluate	Describe & Demonstrate
CO4: At the end of the course, the students will be more confident about English communication skills.	Evaluate, Apply, Understand	Define, Describe & Demonstrate

Learning Resources	
1.	Reference Books: 1. Ramon & Prakash, Business Communication, Oxford. Sydney Greenbaum Oxford English Grammar, Oxford. 2. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill 3. Anjanee Sethi &Bhavana Adhikari, Business Communication, Tata McGraw Hill
2.	Journals
3.	Periodicals
4.	Other Electronic resources

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks

Theory:End Semester Marks	40 marks
Theory:Continuous Evaluation Component Marks	

Attendance	05 marks
MCQs	10 marks
Open Book Assignment	15 marks
Open Book Assignment	10 marks
Total	**40 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	1	0	3	3	2
CO2	1	1	1	0	3	3	1
CO3	1	1	1	0	3	2	2
CO4	1	1	1	0	3	3	3
CO5	1	1	1	0	3	3	1

Mapping of POs & COs

	PO1	PO2	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	3	0
CO2	3	3	3	3	2	3	0
CO3	3	2	3	3	2	2	0
CO4	3	1	3	3	3	3	0
CO5	3	2	2	3	2	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	A. Ability Enhancement Compulsory Course															
1.	MSCM206	Communication Skills – II	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM205	Internship	0	2	0	2	0	2	0	2	0	0	0	0	0	50
3.	MSCM207	Comprehensive Viva- II	0	0	2	2	0	0	2	2	0	0	0	0	0	50
	B. Core Course															
4.	MSCM211	Analytical Chemistry – II *(Electroanalytical Techniques & Fundamentals of spectroscopy)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
5.	MSCM212	Organic Chemistry – II *(Organic Synthesis-I & Stereochemistry)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
6.	MSCM213	Physical Chemistry – II *(Advanced Chemical Thermodynamics and Kinetics)*	3	4	0	7	3	2	0	5	20	40	40	100	50	150
7.	MSCM214	Inorganic Chemistry – II *(Group theory, p block elements & Bio-inorganic Chemistry)*	3	4	0	7	4	2	0	5	20	40	40	100	50	150
	B. Minor Course															
8.	CHE-2302 ISC	Introduction to Commercially Relevant Chemical Products and Respective Indian Chemical Industries	4	0	0	0	4	0	0	4	20	40	40	100	00	100
		Total	**17**	**18**	**03**	**38**	**17**	**10**	**03**	**30**						**850**

Teaching Scheme
Semester – II M. Sc. Chemistry Program

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES -

End Semester

COURSE CODE MSCM211	COURSE NAME **Analytical Chemistry – II** *(Electroanalytical Techniques and Advanced Instrumental Methods)*	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	0	105	3	2	0	5

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	The course on Electroanalytical Techniques and Advanced Instrumental Methods of Analysis aims to provide students with a comprehensive understanding of various analytical techniques used in the chemical and pharmaceutical industries. By understanding the principles, instrumentation, and applications of these techniques, students will be better equipped to analyze and interpret experimental data, leading to improved problem-solving skills and scientific literacy.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Analyze** various electroanalytical techniques and their applications. **Evaluate** thermal methods and their applications in drug analysis. **Apply** principles of molecular spectroscopy to solve numerical problem **Interpret** IR spectra for qualitative and quantitative analysis. **Create** analysis reports using advanced spectroscopic techniques.

Course Content (Theory)	Weightage	Contact hours
Unit1: Electroanalytical Techniques Potentiometry, ion selective electrodes and their applications (solid state, precipitate, liquid-liquid enzyme and gas sensing electrodes), ion selective field effect transistors, biocatalytic membrane electrodes and enzymes based biosensors. Polarography- Ilkovic equation, derivation starting with Cottrell equation, effect of complex formation on the polarographic waves. Electrogravimetry: Introduction, principle, instrumentation, factors affecting the nature of the deposit, applications. Coulometry: Introduction, principle, instrumentation, coulometry at controlled potential and controlled current.	**20%**	**09**
Unit 2: Thermal methods	**20%**	**09**

Introduction, recapitulation of types of thermal methods, comparison between TGA and DTA. Differential Scanning Calorimetry – Principle, comparison of DTA and DSC, Instrumentation, block diagram, nature of DSC curve, factors affecting curves (Sample size, sample shape, pressure). Determination of heat of reaction, specific heat, percentage crystallinity, magnetic transition, oxidative stability, Applications- Analysis of drug analysis.		
Unit 3: Titrimetric Analyses General principle and classification, Volumetric and gravimetric, titrimetric methods and calculation, Requirements of reaction in titrimetric, Endpoint detection Acid-base, redox, precipitation, and complexation reactions, Dissociation of acids and bases in aqueous and non-aqueous media **Fundamentals of spectroscopy and Components of optical instruments** Recapitulation of basic concepts, electromagnetic spectrum, sources, detectors. Sample containers, laser as source of radiation, fibre optics, Introduction of Fourier Transform. Molecular Spectroscopy-Ultraviolet and Visible Spectroscopy (Numericals). Derivation of BeerLambert's Law and its limitations, factors affecting molecular spectroscopy-temperature, solvent and effect of substituents on charge transfer bands. Applications of Ultraviolet and Visible spectroscopy: Simultaneous spectroscopy, derivative spectroscopy.	**20%**	**09**
Unit 4: UV-VIS and IR Spectroscopy Infrared Absorption Spectroscopy: Instrumentation sources, sample handling, transducers dispersive, non - dispersive instrument. FTIR and its advantages, applications of IR: Qualitative with emphasis on "Finger Print" region, Quantitative analysis, Advantages and Limitations of IR., Introduction and basic principles of diffuse reflectance spectroscopy and attenuated total reflectance Spectroscopy.	**20%**	**09**
Unit 5: **Atomic Absorption Spectroscopy:** methods, instrumentation of AAS, spectral interference, standard addition and internal standard, method of analysis **Mass spectrometry:** recapitulation, instrumentation, ion source for molecular studies, electron impact, filed ionization, field absorption, chemical ionization and fast atom bombardment sources. Mass analyzer: Quadrupole, time of flight and ion trap. Applications. **Mossbauer Spectroscopy:** Theory, Instrumentation, Applications - isomer shift, nuclear quadruple coupling and hyperfine interaction, Problems related to Mossbauer Spectroscopy.	**20%**	**09**

List Of Practical	Weightage	Contact hours
1: Estimation of quinine by fluorimetry.	10%	4
2: To prepare TLC plates, and identify unknown compounds in the	10%	4

given mixture and also to calculate the R f values of unknown compounds		
3: Column chromatographic separation and estimation	10%	4
4:Determination of concentration of Fe +3 (as 8-hydroxy quinolone) and Ni +2 (as Ni-DMG) mixture by solvent.	10%	4
5:Determine % purity of given sample of boric acid by Conductivity method.	10%	4
6:Estimation of detergents by coulometry.	10%	4
7:Estimation of ferrous ion by potentiometric titration.	10%	4
8: Assay of folic acid.	10%	4
9: Determination of salt concentration by ion exchange method.	10%	4
10: Separation of pigments from Given sample.	10%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of Analytical studies.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: CO 1: **Analyze** electroanalytical techniques and determine their applications in chemical analysis. CO 2: **Evaluate** thermal analysis methods and utilize them in drug analysis. CO 3: **Apply** molecular spectroscopy principles to solve numerical problems effectively. CO 4: **Interpret** IR spectra to conduct qualitative and quantitative analyses. CO 5: **Create** detailed analysis reports using advanced spectroscopic techniques.	Cognitive	Understand Apply Apply Remember Apply

Learning Resources	
1.	Textbook: 1. Modern Analytical Chemistry, D. Harvey , McGraw Hill, 2000 2. Principles of Instrumental Analysis : Douglas Skoog, Pearson 3. Introduction to Instrumental Analysis: Robert Brown.
2.	Reference books : 1. Instrumental Method of Analysis : H. H. Willard, L. L. Merritt & J.A. Dean 2. Instrumental Methods of Chemical Analysis, B.K. Sharma, Goel Pub's House)
3.	Journal: Royal Society of Chemistry, Analyst etc.
4.	Periodicals: Chemistry Today
5.	Other Electronic resources: Unacademy NPTEL etc.

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<tr><td>Practical understanding of the subject on the Project/Industrial.</td><td>30 marks</td></tr>
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<tr><td>Total</td><td>100 Marks</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	2	2	1	1	1
CO2	2	1	1	1	1	0
CO3	2	1	1	1	2	1
CO4	2	1	1	1	0	1
CO5	2	2	1	1	2	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	2	2	1	0
CO2	3	0	2	2	1	0
CO3	3	0	2	2	1	0
CO4	3	1	2	2	2	0
CO5	3	0	3	1	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE **MSCM212**	**COURSE NAME** **Organic Chemistry – II** *(Organic Synthesis-I & Stereochemistry)*	**SEMESTER** **II**

Teaching Scheme (Hours)				**Teaching Credit**			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	0	105	3	0	2	5

Course Pre-requisites	Basic B.Sc. Level Organic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course aims to provide a detailed understanding of advanced organic synthesis techniques, focusing on various reagents and their applications in oxidation, reduction, rearrangements, stereochemistry, and elimination/addition reactions. Through the structured units, students will gain a comprehensive grasp of both theoretical concepts and practical applications, enabling them to solve complex organic synthesis problems. Each unit is designed to build upon the students' existing knowledge, promoting critical thinking and application of advanced organic chemistry concepts.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Analyze** the mechanisms and applications of oxidation reagents in organic synthesis. **Evaluate** reduction reagents and their applications in organic synthesis. **Interpret** mechanisms and applications of molecular rearrangements involving different reactive intermediates. **Apply** stereochemical principles to predict and analyze stereoisomerism and reaction outcomes. **Create** mechanistic pathways for elimination and addition

	reactions in organic synthesis.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Oxidation Reagents in Organic Synthesis Oxidation Reagents: CrO3, MnO2, SeO2, Pb(OAc)4, HIO4, DMSO, HgO, K3Fe(CN)6, DDQ, Dess-Martin periodinane, Peracid;CrO3, PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb (OAc)4, Pd-C, OsO4, mCPBA, O3, NaIO4, HIO4	**20%**	**09**
Unit 2: Reduction Reagents in Organic Synthesis Boranes and hydroboration reactions, R3SiH, Bu3SnH, MPV, H2/Pd-C, Willkinsons, NaCNBH3, NH2NH2, DIBAL, Al(O-tBu)3, Al(O-iPr)3 **Some Miscellaneous Reagents in Organic Synthesis:** Trimethylsilylhalide, LDA, Wilkinson catalyst, alkyl lithium, Grignard reagent, Gilman reagent, PTC, NBS, DCC.	**20%**	**09**
Unit 3: **Reactive Intermediates in Molecular Rearrangements**: Molecular Rearrangement involving Non-Classical Carbocation: Neighbouring group participation by π(pi) and σ(sigma) bonds. **Molecular Rearrangement involving Carbocation:** Wagner-Meerwein, Pinacol-Pinacolone, Demjanov and Beckmann Rearrangement. **Molecular Rearrangement involving Carbanion:** Favorskii, Benzil-Benzilic Acid, Stevens and Sommelet-Hauser Rearrangement. **Molecular Rearrangement involving Free radical:** Riemer-Tiemann, Fries Rearrangement **Molecular Rearrangement involving Nitrene:** Curtius, Schmidt, Lossen and Hoffmann Rearrangement **Molecular Rearrangement involving Carbene:** Wolf Rearrangement [Emphasizing on Various Techniques for Determination of Mechanism]	**20%**	**09**
Unit 4: Stereochemistry Stereochemical principles, enantiomeric relationship, diastereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds, Prochiral relationship, stereospecific and stereoselective reactions, optical activity in biphenyls, spiranes, allenes and helical structures. Conformational analysis of cyclic and acyclic compounds. Concept of Chirality, Chirality and Symmetry, Sawhorse, Newman and Fischer Projections, Interconversion of Projection formula, Elements of Chirality including Chiral centre, Chiral axis, Chiral plane and Helicity, CIP Nomenclature, Molecules with more than one Chiral centre, Total number of Stereoisomer in such molecules, Enantiomeric and Diastereomeric Relationship, Chirogenicity and Stereogenecity, Pseudochirality, Topicity and Prostereoisomerism, Determination of Topic relationship between Homomorphic ligands in Intact Molecules, Concept of stereoselective and stereospecific reactions, Optical Purity.	**20%**	**09**

Unit 5: Elimination and Addition Reactions **Elimination Reactions:** Mechanisms and Orientation, E1, E1cb, E2 spectrum, Effects of Changes in Substrate, Base, Leaving Group and Medium on Reactivity, Hoffman and Saytzef eliminations, Bredt's Rule, Pyrolytic Eliminations- Cope and Chugaev eliminations. **Addition reactions:** Mechanisms, Orientation and Reactivity, Markonikoff and anti-Markonikoff additions, Reactions including Hydro-Halo, Hydro-Hydroxy, Hydro-Alkoxy, Dihydro, Dihydroxy, dihalo, ozonolysis, Woodward-Prevost Hydroxylation.	**20%**	**09**

List Of Practical	Weightage	Contact hours
1:Organic Spotting: Qualitative Analysis of Tertiary Mixture-1	10%	4
2:Organic Spotting: Qualitative Analysis of Tertiary Mixture-2	10%	4
3:Organic Spotting: Qualitative Analysis of Tertiary Mixture**-3**	10%	4
4:Organic Spotting: Qualitative Analysis of Tertiary Mixture-4	10%	4
5:Organic Spotting: Qualitative Analysis of Tertiary Mixture-5	10%	4
6:Organic Spotting: Qualitative Analysis of Tertiary Mixture-6	10%	4
7:Organic Spotting: Qualitative Analysis of Tertiary Mixture-7	10%	4
8:Organic Spotting: Qualitative Analysis of Tertiary Mixture-8	10%	4
9:Organic Spotting: Qualitative Analysis of Tertiary Mixture-9	10%	4
10: Organic Spotting: Qualitative Analysis of Tertiary Mixture-10	10%	4

Instructional Method and Pedagogy:

Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of Organic studies.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO 1: Analyze** the mechanisms and applications of oxidation reagents in organic synthesis. **CO 2: Evaluate** reduction reagents and their applications in organic synthesis. **CO 3: Interpret** mechanisms and applications of molecular rearrangements involving different reactive intermediates. **CO 4: Apply** stereochemical principles to predict and analyze stereoisomerism and reaction outcomes. **CO 5: Create** mechanistic pathways for	Cognitive	Understand Understand Understand Apply Apply

elimination and addition reactions in organic synthesis.		

Learning Resources	
1.	Textbook: Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford) Modern Synthetic reactions- H.O. HouseOrganic Chemistry, Stanley H. Pine Organic Synthesis – M.B. Smith.
2.	Reference books: Advanced Organic Chemistry (part A & B)– A. Care y and R.J. Sundberg Stereochemistry conformations and mechanism by P.S. Kalsi. Introduction to spectroscopy – D.l. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition.
3.	Journal: JACS, JOC, Org Lett etc.
4.	Periodicals: Chemistry Today.
5.	Other Electronic resources: Unacademy NPTEL etc.

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**

Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/ University mentor's feedback on the Project/ Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	0	0	0	0
CO2	3	1	2	2	2	0
CO3	3	1	1	2	1	0
CO4	2	0	0	1	1	0
CO5	3	2	1	1	1	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	0	0	0
CO2	3	0	2	1	1	0
CO3	3	1	2	1	1	1
CO4	3	0	1	0	0	0
CO5	3	1	0	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM213	COURSE NAME **Physical Chemistry – II** (Advanced Chemical Thermodynamics and Kinetics)	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
45	60	0	105	3	0	2	5

Course Pre-requisites	Basic B.Sc. Level Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed to provide a comprehensive understanding of the principles and applications of thermodynamics, statistical thermodynamics, electrochemistry, surface chemistry, and chemical kinetics. Through these units, students will gain both theoretical knowledge and practical skills, enabling them to analyze complex chemical systems and processes. Each unit is structured to build upon students' prior knowledge, enhancing their cognitive abilities and preparing them for advanced studies or professional applications in chemistry.
Course Revision/ Approval Date:	18/06/2024
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Analyze** the principles and applications of classical thermodynamics **Evaluate** the significance thermodynamic properties. **Apply** electrochemical principles to solve problems. **Interpret** the concepts of surface properties and their thermodynamic implications. **Create** mechanistic pathways for chemical reactions.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Classical Thermodynamics Review of Classical Thermodynamics, laws of thermodynamics, Concept of entropy, Properties of Gibbs free energy, Phase equilibrium of one and two component system, Mixtures, Chemical equilibrium, Molecular Interactions: Dipole moment, Electrical polarization, Charge-dipole, Dipole-dipole and Dipole-induced dipole interaction, Dispersion interaction. Transport Phenomena: Diffusion (Ficks laws)	**20%**	**09**
Unit 2: Statistical Thermodynamics-I Introduction to statistical thermodynamics: Concept of ensembles, partition functions and distributions, microcanonical, canonical and	**20%**	**09**

grand canonical ensembles, canonical and grand canonical partition functions, Boltzmann, Fermi-Dirac and Bose-Einstein distributions.		
Unit 3: Statistical Thermodynamics-II Partition function and its significance, Translational, Rotational, Vibrational and Electronic partition functions and their evaluation, Thermodynamic properties in terms of partition functions, Internal energy, Molar heat capacity, Entropy and free energy functions, Translational, rotation and vibrational entropies of ideal mono atomic gases, Sackur Tetrode equation, Numericals.	**20%**	**09**
Unit 4: Chemical kinetics-I Chemical kinetics and its scope, rate of reaction, factors influencing the rate of a reaction, measurements of reaction rates, differential and integral rate laws, rate laws and equilibrium constants for elementary reactions, temperature dependence of rate constants, Arrhenius equation, concept of activation energy, determination of reaction mechanisms; collision and transition state theories of rate constants; Unimolecular reactions, bimolecular reaction dynamics: Potential energy surface, Transition state theory.	**20%**	**09**
Unit 5: Chemical kinetics-II Advanced topics in chemical kinetics: Introduction to photochemistry, Kinetics of multicomponent systems: Combustion and Atmospheric chemistry. Introduction to solution phase reaction dynamics: Cage effect, Diffusion controlled reactions, Polar solvation.	**20%**	**09**

List of Practical	Weightage	Contact hours
1: To determine the percentage composition of a given acid mixture containing a strong acid (HCl) and a weak acid (CH3COOH) pH metric method.	10%	4
2: -To determine equivalent conductance, degree of dissociation and dissociation constant of weak acid conductometrically.	15%	4
3: To determine the percentage composition of a given acid mixture containing a strong acid (HCI) and a weak acid (CH3COOH) conductometrically.	15%	4
4:To determine the viscosity average molecular weight of given polymer (polystyrene) by viscosity method.	15%	4
5: To study the adsorption of oxalic acid on charcoal.	15%	4
6: To determine the composition of a given liquid mixture by viscometric method.	15%	4
7:To determine the ƛmax and concentration of given unknown potassium permanganate (KMnO4) using visible spectroscopy technique.	15%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of Physical Chemistry Studies.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1: Analyze** the principles and applications of classical thermodynamics **CO2: Evaluate** the significance thermodynamic properties. **CO3: Apply** electrochemical principles to solve problems. **CO4: Interpret** the concepts of surface properties and their thermodynamic implications. **CO5: Create** mechanistic pathways for chemical reactions.	Cognitive	Understand Evaluate Understand Knowledge Understand

Learning Resources	
1.	**Textbooks:** 4. Thermodynamics for Chemists, Samuel Glasstone, Litton Educational Publishing Inc., Affiliated East-West Press Pvt. Ltd. 5. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House, Merrut 6. Physical Chemistry, B. K. Sharma, Goel Publishing House, Merrut. 4. Principles of Physical Chemistry, B.R. Puri, L. R. Sharma and Madan S. Pathania, Visual Publishing Co. 5.Atkins' Physical Chemistry, P. W. Atkins and De Paula, 8 th edition(2010) 6.Physical Chemistry, T. Engel and P. Reid, Pearson Education (2006) 7. M. C. Gupta, (1990) Statistical Thermodynamics, Second edition, New Age International Publications, New Delhi
2.	**Reference books :** 1. Physical Chemistry a Molecular approach, D. Mcquarie and J. Simon (University Science) 2000. 2. Physical Chemistry for Biological Sciences by Raymond Chang(Universal Books), 2000. 3. T. Engel and P. Reid, (2007) Thermodynamics: Statistical Thermodynamics and Kinetics, First Edition, Pearson Education, Noida.
3.	Journal: JPC C, JPC A, Langmuir etc
4.	Periodicals: Chemistry Today
5.	Other Electronic resources: Unacademy NPTEL etc.

Evaluation Scheme	Total Marks
Theory: Mid semester Marks	20 marks

<table>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Open Book Assignment</td><td>10 marks</td></tr>
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<tr><td>Practical Marks</td><td>
<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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<tr><td>Attendance</td><td>10 marks</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	1	1	1	1
CO2	2	1	0	0	0	0
CO3	2	2	1	1	0	0
CO4	1	0	1	1	0	0
CO5	2	2	2	1	1	0

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	0	0	1	1	0
CO2	3	1	0	1	0	0

CO3	3	1	1	0	0	0
CO4	2	0	0	0	0	0
CO5	3	2	2	1	1	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE **MSCM214**	**COURSE NAME** **Inorganic Chemistry – II** *(Group theory, p block elements & Bio-inorganic Chemistry)*	**SEMESTER** **II**

Teaching Scheme (Hours)				**Teaching Credit**			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	0	120	4	0	2	6

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept.
Course Category	Core Professional
Course focus	Employability
Rationale	This course aims to provide a deep understanding of transition metal chemistry, coordination chemistry, and organometallic chemistry, emphasizing the structure, bonding, properties, and reactivity of transition metal complexes and organometallic compounds. Through a combination of theoretical principles and practical applications, students will develop analytical and problem-solving skills essential for research and industrial applications in inorganic chemistry.
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Analyze** the structure, bonding, and properties of transition metal ligand complexes. **Evaluate** theories of bonding in coordination complexes and their applications. **Interpret** electronic spectra and reaction mechanisms of coordination complexes. **Apply** the 18-electron rule and electron counting schemes in organometallic chemistry. **Create** reaction pathways and catalytic mechanisms in organometallic complexes.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Group theory in Chemistry Concepts of symmetry in molecule:- Symmetry elements, symmetry operations, definitions and theorems in group theory, examples of groups, subgroups and classes, Molecular Point groups :-Identification and classification, notation of point groups, Matrix representation of symmetry operations, Types of matrices, matrix notations for symmetry elements : E, C_n, i, s, Sn. Matrix representation of point groups : product and square rule, inverse rule, matrices for C_3v, C_4v etc.,	**20%**	**09**
Unit 2: Symmetry and Group theory: II Construction of character tables :-rules, reducible and irreducible representations, character of a representation, Properties of a irreducible representations, orthogonality theorem, character tables for C_2v, C_3v, C_4v, D_nh, uses of character tables. General relations symmetry elements and symmetry operations, symmetry elements and optical isomerism, symmetry point groups, classes of symmetry operations, classification of molecular point groups.	**20%**	**09**
Unit 3: Hydrogen and its compounds Theory: Hydrides: Classification, electron deficient, electron precise and electron rich hydrides. PH3 SbH3, AsH3. Selenides, Tellurides. Alkali and alkaline earth metals: solutions in non-aqueous Media, Applications of crown ethers in extraction of alkali and alkaline earth metals.	**20%**	**09**
Unit 4: Bioinorganic Chemistry-I Metal ions in Biological Systems: Essential and trace metals. Na^+/K^+ Pump, Role of metals ions in biological processes, Transport and Storage of Dioxygen	**20%**	**09**
Unit 5: Bioinorganic Chemistry-II Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper. Electron Transfer in Biology Structure and function of metalloproteins in electron transport processes cytochromes and ion-sulphur proteins, synthetic models.	**20%**	**09**

List Of Practical	Weightage	Contact

		hours
1: Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-1)	**12%**	**4**
2:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-2)	**12%**	**4**
3:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-3)	**12%**	**4**
4:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-4)	**12%**	**4**
5:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-5)	**12%**	**4**
6:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-6)	**12%**	**4**
7:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-7)	**12%**	**4**
8:Qualitative Analysis: Inorganic Spotting of mixture containing 3 Cations And 3 Anions And interfering radicals.(Mixture-8)	**12%**	**4**
9: Some others preparation based on Syllabus.	**4%**	**4**

Instructional Method and Pedagogy:
Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of Physical Chemistry Studies.

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Subdomain**
After successful completion of the above course, students will be able to: CO1: **Analyze** the structure, bonding, and properties of transition metal ligand complexes. CO2: **Evaluate** theories of bonding in coordination complexes and their applications. CO3: **Interpret** electronic spectra and reaction mechanisms of coordination complexes. CO4: **Apply** the 18-electron rule and electron counting schemes in organometallic chemistry. CO5: **Create** reaction pathways and catalytic mechanisms in organometallic complexes.	Cognitive	**Understand** **Understand** **Evaluate** **Understand** **Apply**

Learning Resources	
1.	**Textbook:** Chemical Applications of Group Theory, Third Edn., Author - F. A. Cotton(Wiley, New York) Group Theory and its Chemical Applications, P.K. Bhattarchrya Inorganic Chemistry : Shriver & Atkins (4th edition 2003, Oxford)
2.	**Reference books :** Concise Inorganic Chemistry, J. D. Lee, Fourth Edn.(Chapman and Hall)

	Inorganic chemistry: principle of structures and reactivity, Huheey, Keiter, Keiter, Medhi, Pearson Education, Fourth Edn.(2007) Organometallic Chemistry-A Unified Approach: R. C. Mehrotra & A. Singh.
3.	Journal: Coordination Chemistry Review, Journal of Coordination Chemistry.
4.	Periodicals: Chemistry Today.
5.	Other Electronic resources: Unacademy NPTEL etc.

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
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<table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
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<tr><td>Practical Marks</td><td>
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<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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<tr><td>Attendance</td><td>10 marks</td></tr>
<tr><td>Total</td><td>100 Marks</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	0	0	0	0	0
CO2	2	1	0	0	0	0
CO3	1	0	0	0	0	0
CO4	1	0	0	0	0	0
CO5	1	1	1	1	1	0

Mapping of POs & COs

	PO1	PO2	PO2	PO3	PO4	PO5
CO1	3	0	0	1	0	0
CO2	3	0	0	1	0	0
CO3	3	0	1	1	0	0
CO4	3	0	1	1	0	0
CO5	3	0	3	1	1	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM206	COURSE NAME Communication Skills II	SEMESTER II

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
30	00	00	30	30	00	00	2

Course Pre-requisites	Basic Knowledge of English Grammar & communication Basic English Grammar & Intermediate communication skills
Course Category	Mandatory Course
Course focus	Communicational Skills and Ability Enhancement
Rationale	It enables humanity to experience the benefits of chemistry when we apply it in the exploitation of materials and energy.
Course Revision/ Approval Date:	14/03/2023
Course Objectives (As per Blooms' Taxonomy)	1 To emphasize the development of listening and reading skills among learners 2 To equip them with writing skills needed for academic as well as workplace context 3 To enable learners of Engineering and Technology develop their basic communication skills in English 4 To strengthen the fundamentals in English Language. 5 To build up the confidence to communicate with the world.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Communicative Skills Verbal & Non-verbal, Communication, Effective Communication Style & Structure, Strategies of Effective Communication	**25%**	7
Unit 2: Listening Skills Definition, Types of Listening, Characteristics of the Listeners, Traits of a Good Listener, Barriers to Effective Listening	**25%**	8
Unit 3: Reading Skills Definitions Types of Reading, Techniques of Effective Reading, Skimming, Scanning, Reading Tasks (Critical & Inferential)	**25%**	7
Unit 4: Speaking Skills Speech Drills Pronunciation and accent Stress and Intonation, Introducing self, Interview Skills, Public Speaking	**25%**	8

Instructional Method and Pedagogy:
Classroom Lecture, Case Studies, Quizzes, Presentations, Role Play, Expert Lecture (Consultant)

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to:		
CO1: To emphasize the development of listening and reading skills among learners	Understand, Analyse, Remember	Define, Classify & Demonstrate
CO2: To equip them with writing skills needed for academic as well as workplace context	Analyse, Apply, Understand	Classify, Describe & Demonstrate
CO3: To enable learners of Engineering and Technology to develop their basic communication skills in English	Understand, remember	Define, Describe & Demonstrate
CO4: To strengthen the fundamentals in English Language.	Remember, Analyse	Define Describe
CO5: To build up the confidence to communicate with the world.	Understand, Apply	Define, Classify, Describe & Demonstrate

Learning Resources	
1.	Textbook
2.	Reference books 1. Ramon & Prakash, Business Communication, Oxford. Sydney Greenbaum Oxford English Grammar, Oxford. 2. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill 3. Anjanee Sethi & Bhavana Adhikari, Business Communication, Tata McGraw Hill
3.	Journal

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 10 marks MCQs: 10 marks Skill enhancement activities / case study: 10 marks Presentation/ miscellaneous activities: 10 marks **Total: 20 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	1	0	3	3	2
CO2	1	1	1	0	3	3	1
CO3	1	1	1	0	3	2	2
CO4	1	1	1	0	3	3	3

CO5	1	1	1	0	3	3	1

Mapping of POs & COs

	PO1	PO2	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	3	0
CO2	3	3	3	3	2	3	0
CO3	3	2	3	3	2	2	0
CO4	3	1	3	3	3	3	0
CO5	3	2	2	3	2	2	0

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Teaching Scheme
Semester – III M. Sc. Analytical Chemistry

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	A. Skill Enhancement Courses															
1.	MSCM308	Comprehensive Viva-III	1	1	0	2	1	1	0	2	0	0	0	0	0	50
2.	MSCM306	Internship-III	0	1	1	2	0	1	1	2	0	0	0	0	0	50
3.	MSM309	Dissertation	0	1	1	2	0	1	1	2	0	0	0	0	0	50
	B. Core Course															
4.	MSCM301	Analytical Chemistry – III *(Advanced Chromatographic techniques)*	4	2	0	6	4	2	0	6	20	40	40	100	50	150
5.	MSCM302	Analytical Chemistry – IV *(Electroanalytical Chemistry)*	4	2	0	6	4	2	0	6	20	40	40	100	50	150
6.	MSCM303	Analytical Chemistry – V *(Analysis of Materials)*	4	2	0	6	4	2	0	6	20	40	40	100	50	150
	C. Minor Course															
7.	CHE-2306 ISC	Advanced Spectroscopy and Training on Analytical Instruments	2	0	0	2	2	0	0	2	20	10	20	50	00	50
8.	CHE-2305 ISC	Intellectual property Rights (IPR), Literature Searches & Topics in R&D, Green Analytical Chemistry, Introduction to Basic Finance for Business	4	0	0	4	4	0	0	4	20	40	40	100	00	100
		Total	**19**	**09**	**02**	**30**	**19**	**9**	**2**	**30**						**750**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

COURSE CODE MSCM301	COURSE NAME **Analytical Chemistry –III** *(Advanced Chromatographic techniques)*	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	0	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept
Course Category	Core Professional
Course focus	Employability/ Entrepreneurship/ Skill development
Rationale	The student will be able to: This course aims to provide a comprehensive understanding of various separation techniques and the application of computers in chemistry. By studying traditional and modern chromatographic methods, students will gain insights into the principles, instrumentation, and applications of these techniques in both analytical and industrial settings. Additionally, the integration of computer programming skills will enhance students' ability to perform complex calculations and data analysis relevant to chemical research.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Understand** the principles and applications of basic separation techniques **Analyze** the mechanisms, instrumentation, and applications of classical chromatography techniques. **Evaluate** the principles, instrumentation, and applications of modern chromatographic techniques. **Compare** the instrumentation and applications of advanced chromatographic techniques **Apply** computer programming skills in BASIC to perform chemical calculations

Course Content (Theory)	Weightage	Contact hours
Unit 1: Classical forms of chromatography Techniques-I **Ion chromatography:** Ion chromatography; principle, instrumentation with special reference to separation and suppressor columns, applications **Ion exchange chromatography:** Definitions, principle, requirements for ion exchange resin and its synthesis, types	**20%**	**12**

of ion-exchange resins, basic features of ion exchange reactions, resin properties-ion-exchange capacity, resin selectivity and factors affecting the selectivity, applications of IEC in preparative, purification and recovery processes, applications for separation of inorganic and organic compounds **Column chromatography:** Construction and operation of column, choice of adsorbents, eluents and applications. **Paper chromatography:** Definitions, theory and principle, techniques; one, two dimensional and circular PC, mechanism of separation, types of paper, methodology- preparation of sample, choice of solvents, location of spots and measurement of Rf value, factors affecting Rf values, advantages, qualitative & quantitative applications.		
Unit 2: Classical forms of chromatography Techniques-II **Thin layer Chromatography:** Definition, mechanism, efficiency of TLC plates, methodology–selection of adsorbent, stationary and mobile phases, preparation of micro and macro plates, development, spray reagents, identification and detection, reproducibility of Rf values, qualitative and quantitative analysis **Exclusion chromatography:** Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers.	**20%**	**12**
Unit 3: Modern chromatographic techniques-I **High performance liquid chromatography (HPLC):** Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector, Applications of HPLC. Chiral and ion chromatography. and applications. **Gas chromatography:** Types and nature of stationary and mobile phase, solid supports and their choice, columns-packed, open and capillary, sampling methods, instrumentation, detectors and applications	**20%**	**12**
Unit 4: Modern chromatographic techniques-II **Gel permeation chromatography-** Size exclusion chromatography (Gel filtration) with special reference to separation of protein, carbohydrates and nucleic acids. Preparation of medium, column, determination of void volume, sample application, detectors. **Size exclusion chromatography –** Theory, gel filtration and gel permeation Supercritical fluid chromatography. **Liquid chromatography-** High pressure liquid chromatography- Theory and equipment, types of pumps and their choice, types of columns, large scale separation, applications in analytical and in industry. Principle, instrumentation and applications of new	**20%**	**12**

development in chromatography- Plasma chromatography, super critical fluid chromatography, and Optimum pressure liquid chromatography (OPLC). **Affinity chromatography:** Chromatographic matrix, ligand selection, linkage of ligands, absorbent derivatives. LC/MS, LC/MS-MS, GC/MS, GC/MS-MS for organic compound analysis.		
Unit 5: Computers in Chemistry Basic structure of a computer, input/ output devices, memory and storage systems, central processing unit, peripherals, computer codes and arithmetic, binary number systems, floating point representations, floating point arithmetic and computational errors. Programming in BASIC only for calculation of equilibrium constants, pH of a buffer, Potentiometric titrations and standard deviation.	**20%**	**12**

List of Practical	Weightage	Contact hours
1: Determination of Al/Mg 8-Hydroxyquinoline as complexing agents by spectrophotometric method	10%	4
2: Determination of sulfate by Turbidimetry	10%	4
3: Analysis of vitamin A in food products.	10%	4
4: Analysis of vitamin C in juices and squashes.	10%	4
5: Determination of soap value and iodine value of oil.	10%	4
6: Estimation of the purity of a given azo dye by colorimetry.	10%	4
7: Determination of moisture in pharmaceuticals.	10%	4
8: Estimation of nitrite in meat colorimetrically.	10%	4
9: Estimation of mercury in skin ointment.	10%	4
10: Chemical analysis of chill/turmeric powder.	10%	4
11: Estimation of Na, K and Li individually by Flame Photometry	10%	4

Instructional Method and Pedagogy:

Utilizing models, PowerPoint Presentations, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of analytical chemistry studies.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to/ have: **CO1: Understand** the principles and applications of basic separation techniques **CO2: Analyze** the mechanisms, instrumentation,	Remember and understand Remember	Define, Describe Define,

and applications of classical chromatography techniques. **CO3: Evaluate** the principles, instrumentation, and applications of modern chromatographic techniques. **CO4: Compare** the instrumentation and applications of advanced chromatographic techniques **CO5: Apply** computer programming skills in BASIC to perform chemical calculations	and understand Remember and understand Analysis & Apply	Describe,Apply Define, Describe,Apply Define Define , Describe

Learning Resources	
1.	Reference books : 1. J.M. Hollas, Modern Spectroscopy, 3rd Edition (1996), John Wiley, NewYork. 2. H.A. Strobel, Chemical Instrumentation - A Systematic Approach, 2ndEdition (1973), Addison
2.	Textbook: 1. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, 5th Edition (1998), 2. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis,
3.	Journals: Journal of Analytical Chemistry, Analyst, etc Periodicals: Chemistry Today

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks

		Total	**50 Marks**	
Project/ Industrial Internship Marks		Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks	
		Practical understanding of the subject on the Project/Industrial.	30 marks	
		Industry/ University mentor's feedback on the Project/ Industrial.	30 marks	
		Attendance	10 marks	
		Total	**100 Marks**	

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	0	1	1	0
CO2	1	1	0	1	0	0
CO3	2	2	1	0	2	0
CO4	1	1	2	1	1	1
CO5	2	2	2	1	2	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	1	0	0
CO2	1	1	2	1	0	0
CO3	2	2	1	1	0	0
CO4	1	1	2	1	0	1
CO5	2	3	2	3	2	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM302	COURSE NAME **Analytical Chemistry –IV** *(Electroanalytical Chemistry)*	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	0	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept
Course Category	Core Professional
Course focus	Employability/ Entrepreneurship/ Skill development
Rationale	The student will be able to: This course offers an in-depth exploration of various analytical techniques crucial for quantitative and qualitative chemical analysis. It covers classical methods such as titrations and modern electrochemical methods in electroanalytical chemistry. Furthermore, it delves into advanced methods such as coulometric analysis, fluorimetry, and electrophoresis, as well as magnetic methods of analysis. This comprehensive approach ensures students develop a strong theoretical understanding and practical skills necessary for analytical chemistry applications in both research and industry.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Analyze** the principles, theoretical titration curves, and applications of various titration methods **Evaluate** the polarography and voltammetry techniques for qualitative and quantitative analysis. **Understand** the principles, methods, and applications of coulometric and electrogravimetric analysis. **Apply** the theory and instrumentation of fluorimetry, phosphorimetry, nephelometry, and turbidimetry to practical analytical scenarios. **Interpret** the principles, instrumentation, and applications of electrophoresis and magnetic methods

Course Content (Theory)	Weightage	Contact hours
Unit 1: **Acid-Base and oxidation-reduction titrations:** Dissociation of acids and bases in water, Theoretical titration curves, Feasibility for titration of mono or dibasic acids with strong alkali solution, Applications Redox titration: Redox system and potentials, Formal potential, Nearnst equation, Calculation of redox reaction equilibrium constant, theoretical	**20%**	**12**

titration Curves, Feasibility and redox indicators, Applications **Precipitation titrations:** Introduction, Factors affecting the titimetry, theoretical titration curves, Endpoint detection and indications used, Volhard Fajan and Mohr's methods **Complexometric titration:** Introduction, Ways of detecting end point, Effectives stability constant and derivation of titration curves that involved EDTA titrant, Metallochromic indicators, titration error and feasibility, Strategy to titrate mixture of metal ions in solute, Applications.		
Unit 2: D. C. Polarography and Voltametry Polarography- Theory, instrumentation, DME, diffusion and kinetic and catalytic currents, current- voltage curves for reversible and irreversible systems, qualitative and quantitative applications of polarography to organic and inorganic systems. Derivative polarography, Test polarography, Pulse polarography- Normal and derivative, square wave polarography and AC polarography. Linear sweep and cyclic voltametry, acidic and cathodic stripping voltametry. **Amperometric titrations:** Theory, instrumentation, types of titration curves, successive titrations and two indicator electrodes- applications. Technique of amperometric titrations with the dropping mercury electrode - Titration with the rotating platinum micro electrode. Examples of amperometric titrations using a single polarized electrode, biamperometry- Theory and applications.	**20%**	**12**
Unit 3: Coulometric and Electrogravimetric Analysis Coulometric Analysis - Theory, Faraday's laws, Coulometers - types of macro and micro techniques, Coulometric titrations, external and insitu generation, coulogravimetry and applications, Elementary aspects of chrono coulometry. Electrogravimetry- Theory, order of deposition, over potential, polarization curves, constant potential and consecutive deposition, selective deposition, constant current deposition, assembly of electrode and deposition of complex ions. Micro electrode deposition including radioactive metal ions and its applications.	**20%**	**12**
Unit 4: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry Fluorimetry and Phosphorimetry-Theory of Fluorescence and Phosphorescence, Instrumentation and applications of Fluorimetry and Phosphorimetry. Nephelometry and Turbidimetry-Tyndall, Rayleigh and Raman scattering. Theory, instrumentation and applications.	**20%**	**12**
Unit 5: Electrophoresis and Magnetic method of Analysis Electrophoresis- Introduction, Paper Electrophoresis-Principle, instrumentation and applications. Capillary Electrophoresis-Principle, instrumentation and applications. Magnetic method of Analysis- Magnetic susceptibility and its measurements,	**20%**	**12**

Guoy's, Quink's, Currie's and Ranking's balances. Applications to simple compounds and transition metal complexes.		

List Of Practical	Weightage	Contact Hrs
1: Kjeldahl's method of protein estimation in foods and feeds	**9 %**	**4 hr**
2: Determination of strength of acetic acid in commercial vinegar by conductometric method	**9 %**	**4 hr**
3: Simultaneous estimation of Cl and I by potentiometric method.	**9 %**	**4 hr**
4: Determination of concentration of Fe ion in ferric salicylate complex Spectrophotometrically Estimation of calcium from chalk	**9 %**	**4 hr**
5: Colorimetric and spectrophotometric determination of manganese in steel.	**9 %**	**4 hr**
6: Determination of total salts by cation exchange.	**9 %**	**4 hr**
7: Anion exchange separation of Iron, cobalt and nickel.	**9 %**	**4 hr**
8: Calculation of standard deviation from the results obtained by redox titration of Fe(III) against standard solution of K2Cr2O7	**9 %**	**4 hr**
9: Estimation of Ibuproven/Paracetamol in a pharmaceutical sample	**9 %**	**4 hr**
10: Analysis of milk.	**9 %**	**4 hr**
11: Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).	**9 %**	**4 hr**

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to/ have : **CO1:** Analyze the principles, theoretical titration curves, and applications of various titration methods **CO2:** Evaluate the polarography and voltammetry techniques for qualitative and quantitative analysis. **CO3:** Understand the principles, methods, and applications of coulometric and electrogravimetric analysis.	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe,Apply Define Define , Describe

CO4: Apply the theory and instrumentation of fluorimetry, phosphorimetry, nephelometry, and turbidimetry to practical analytical scenarios. **CO5:** Interpret the principles, instrumentation, and applications of electrophoresis and magnetic methods.		

Learning Resources	
1.	Reference books : 1. E. Berlin, Principles and Practice of X-Ray Spectrometric Analysis, Plenum, NewYork. 2. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, 5th Edition (1998),Harcourt Brace & Company, Florida. 3. Thermal analysis by W.W. Wendlandt, John Wiley, (1986)
2.	Textbook: 1. H. Kaur, Instrumental Methods of Chemical Analysis, PragatiPrakashan , Meerut. 2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis. 3. S. M.Khopkar, Basic Concepts in Analytical Chemistry.
3.	Journals: Journal of Analytical Chemistry, Analyst, etc Periodicals: Chemistry Today
4.	Other Electronic Resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**

Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**
Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.: 30 marks Practical understanding of the subject on the Project/Industrial.: 30 marks Industry/ University mentor's feedback on the Project/ Industrial.: 30 marks Attendance: 10 marks **Total: 100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	0	1	0	0	1
CO2	1	1	0	1	0	0
CO3	1	1	2	1	1	1
CO4	1	1	1	2	1	1
CO5	2	3	2	2	1	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	0	0	1
CO2	1	1	2	1	0	0
CO3	1	2	1	0	0	0
CO4	1	1	2	1	1	2
CO5	2	3	3	2	2	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM303	COURSE NAME Analytical Chemistry –V *(Analysis of Materials)*	SEMESTER III

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
60	60	0	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept
Course Category	Core Professional
Course focus	Employability/ Entrepreneurship/ Skill development
Rationale	The student will be able to: This course is designed to provide students with comprehensive knowledge and practical skills in various analytical techniques crucial for the analysis of water, agricultural products, food, pharmaceuticals, and clinical samples. Understanding these analytical methods is essential for ensuring safety, compliance with regulations, and quality control in different sectors. The course integrates classical and modern analytical techniques, emphasizing both theoretical foundations and practical applications.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Evaluate** the methods for analyzing various water parameters and the treatment processes for drinking and sewage water. **Analyze** the procedures for determining the chemical composition and contaminants in soil, fertilizers, and pesticides. **Assess** the techniques used for detecting food and food additives. **Apply** instrumental and classical analytical techniques for the quality control of pharmaceuticals. **Interpret** the significance of various biochemical tests in clinical analysis.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Analysis of water Dissolved solids, Acidity, Alkalinity, Estimation of dissolved chloride, fluoride, calcium, magnesium, manganese, zinc, dissolved oxygen, BOD, COD and Bacterial examination of water. Drinking water treatment - Estimation of temporary and permanent hardness, Characteristics of water, WHO and Indian standards, Removal of coarse, dispersed and colloidal impurities from water, Coagulation of water, Sterilization and disinfection of	**20%**	**12**

water- Chemical and Physical methods of sterilization. Sewage Water Treatment- Properties of sewage water, Decomposition of sewage- Types of Aerobic biological Oxidation plants and Anaerobic biological Oxidation, plants.		
Unit 2: Agricultural Analysis Soil Analysis- Determination of soil moisture, pH, conductivity, total organic matter, nitrogen, phosphorus, potassium, sulfur, manganese and other metals in soil Analysis of Fertilizers-Determination of moisture by Karl Fischer titration methods. Determination of Ammoniacal nitrogen and Ammoniacal nitrate nitrogen. Analysis of Pesticides-Analysis of organophosphorus pesticides. Determination of Malathion, Methyl malathion and DD residues in vegetable and food grains.	**20%**	**12**
Unit 3: Analysis of Food and Food additives Food adulteration, common adulterants in food, Contamination of food stuffs. Microscopic examination for food adulterants. Chemical and Instrumental Analysis of food additives- Preservatives, Food colorants, Antioxidants, Sweeteners, stabilizers, Thickeners, Clarifying and Bleaching agents. **Analysis of paints and pigments**	**20%**	**12**
Unit 4: Pharmaceutical Analysis Introduction and overview of pharmaceutical analysis, Sulfa drugs, Antipyretic and Analgesics, and antibiotics, Instrumental and classical techniques use in pharmaceutical analysis; Hyphenated techniques use for pharmaceutical analysis.	**20%**	**12**
Unit 5: Clinical Analysis Analysis of Carbohydrates and their significances- Fasting, random and post prandial glucose tests, Estimation of glucose in serum, Analysis of lipids and their significances-Test for cholesterol. Analysis of protein and their significances- Estimation of total protein in serum. Analysis of major metabolites and their significances- Determination of blood urea and creatinine in urine. Analysis of ions and their significances- Estimation of Na, K, Ca, bicarbonates and phosphate in serum. Analysis of Hormones and their significances-ELISA and RIA.	**20%**	**12**

List of Practical	Weightage	Contact hours
1: To obtain the protolysis curves involving cases of weak acid, mixture of acids and polybasic acid employing a pH meter and determine the amount of the respective acid (in ppm) in the given solution.	12.5%	4 hr
2: Determination of Na2CO3 content (in %) of washing soda using a pH meter.	12.5%	4 hr
3: Determination of trace metal impurities present in a polluted water sample by anodic stripping voltammetric procedure	12.5%	4 hr
4: Separation of proteins by polyacrylamide gel electrophoresis.	12.5%	4 hr
5: Determination of the capacity of an ion exchange (cationic and anionic) resin (column method)	12.5%	4 hr

6: Separation of nickel, manganese, cobalt and zinc and determination of Rf values by thin layer or paper strip techniques	12.5%	4 hr
7: To identify the mixture of inorganic cations. (Co 2+ , Fe 2+ and Ni2+) by circular paper chromatography	12.5%	4 hr
8: To determine trace amounts of water in a sample.The titration is done with an automated Karl Fischer titrator	12.5%	4 hr

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to/ have: **CO1: Evaluate** the methods for analyzing various water parameters and the treatment processes for drinking and sewage water. **CO2: Analyze** the procedures for determining the chemical composition and contaminants in soil, fertilizers, and pesticides. **CO3: Assess** the techniques used for detecting food and food additives. **CO4: Apply** instrumental and classical analytical techniques for the quality control of pharmaceuticals. **CO5: Interpret** the significance of various biochemical tests in clinical analysis.	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe,Apply Define Define , Describe

Learning Resources	
1.	Reference books : 1. Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle Sixthedition CBS (1986) 2. Cyclic Voltammetry and frontiers of electrochemistry by N.Noel and K.I. Vasu IBH, New Delhi(1990)
2.	Textbook: 1. Instrumental methods of chemical analysis by Chatwal and Anand. 2. Fundamentals of Analytical Chemistry, 6th edition, D.A. Skoog, D.M. West and F.J. Holler,Saunders college publishing. 3. Introduction to instrumental analysis by R.D.Broun, Mc Graw Hill (1987)
3.	Journals: Journal of Analytical Chemistry, Analyst, etc Periodicals: Chemistry Today
4.	Other Electronic Resources: Unacademy NPTEL etc.

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
<tr><td>Theory: Mid semester Marks</td><td>20 marks</td></tr>
<tr><td>Theory: End Semester Marks</td><td>40 marks</td></tr>
<tr><td>Theory: Continuous Evaluation Component Marks</td><td><table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
<tr><td>Open Book Assignment</td><td>15 marks</td></tr>
<tr><td>Open Book Assignment</td><td>10 marks</td></tr>
<tr><td>Total</td><td>40 Marks</td></tr>
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<tr><td>Practical Marks</td><td><table>
<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
<tr><td>Journal</td><td>10 marks</td></tr>
<tr><td>Discipline</td><td>05 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
</table></td></tr>
<tr><td>Project/ Industrial Internship Marks</td><td><table>
<tr><td>Quantity of the Project/Industrial in terms of Language, Presentation & format.</td><td>30 marks</td></tr>
<tr><td>Practical understanding of the subject on the Project/Industrial.</td><td>30 marks</td></tr>
<tr><td>Industry/ University mentor's feedback on the Project/ Industrial.</td><td>30 marks</td></tr>
<tr><td>Attendance</td><td>10 marks</td></tr>
<tr><td>Total</td><td>100 Marks</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	2	1	1	1
CO2	2	2	1	0	2	0
CO3	1	1	1	2	1	1
CO4	1	2	2	1	0	1

CO5	2	3	2	2	1	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	0	0	0
CO2	2	2	1	1	0	0
CO3	1	1	2	1	1	2
CO4	1	1	0	2	0	1
CO5	2	3	3	2	1	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

Teaching Scheme
Semester – IV M. Sc. Analytical Chemistry

Sr. No.	Course Code	Course Name	Teaching Scheme (Hours/week)				Teaching Credit				Evaluation Scheme					
			L	P	T	Total	L	P	T	Total	Theory: MS Marks	Theory: CEC Marks	Theory: ES Marks	Theory Marks	Practical Marks	Total Marks
	A. Skill Enhancement Courses															
1.	MSCM409	Comprehensive Viva-IV	1	1	0	2	1	1	0	2	0	0	0	0	0	50
2.	MSCM408	Dissertation	0	4	0	4	0	4	0	4	0	0	0	0	0	100
	B. Core Course															
3.	MSCM401	Analytical Chemistry – VI *(Advanced Instrumental Techniques)*	4	0	0	4	4	0	0	4	20	40	40	100	00	100
4.	MSCM402	Analytical Chemistry – VII *(Analytical Spectroscopic Techniques)*	4	0	0	4	4	0	0	4	20	40	40	100	00	100
5.	MSCM403	Analytical Chemistry – VIII *(Analysis of complex materials)*	4	0	0	4	4	0	0	4	20	40	40	100	00	100
	B. Minor Course															
6.	CHE-2301 ISC	Sustainable and Green Chemistry, Industrial Important processes and Synthetic Methodologies for Advanced Materials and Modern Topics in Chemistry	4	0	0	4	4	0	0	4	20	40	40	100	00	100
7.	CHE-2304 ISC	Quality Management and Regulatory Dimensions in Chemical Industry, Environmental & Effluent Treatment Topics, CRM & Product Stewardship	4	0	0	4	4	0	0	4	20	40	40	100	00	100
		Total	**21**	**05**	**00**	**26**	**21**	**01**	**01**	**26**						**650**

Note: L = Lecture, P = Practice, T= Tutorial, MS - Mid Semester, CEC - Continuous Evaluation Component, ES - End Semester

COURSE CODE MSCM401	COURSE NAME **Analytical Chemistry –VI** *(Advanced Instrumental Techniques)*	SEMESTER IV

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
4	4	0	8	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept.
Course Category	Core Professional.
Course focus	Employability
Rationale	The course on advanced spectral methods provides an in-depth understanding of the principles, instrumentation, and applications of various analytical techniques used in modern scientific research and industry. Emphasizing both theoretical knowledge and practical skills, this course equips students with the ability to analyze complex samples, interpret spectra, and apply advanced methods in real-world scenarios.
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Evaluate** the principles, instrumentation, and applications of surface analytical techniques **Analyze** the principles, instrumentation, and applications of ESR, Mössbauer spectroscopy, and atomic emission spectroscopy. **Apply** the theory and instrumentation of NMR spectroscopy, C13, P31, and F19 spectroscopy. **Interpret** mass spectra to correlate with molecular structures **Assess** the principles, instrumentation, and applications of activation analysis, thermal analysis, and various hyphenated techniques

Course Content (Theory)	Weightage	Contact hours
Unit 1: Spectral Methods-I Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis, Principle, instrumentation and applications of the following: Secondary Ion mass spectroscopy, Particle-Induced X-Ray Emission, Low-Energy Ion Scattering and Rutherford Backscattering	**20%**	**12**
Unit 2: Spectral Methods – II Principle, Instrumentation, and Applications of Electron Spin	**20%**	**12**

Resonance Spectroscopy (ESR), Mossbauer's Spectroscopy, Atomic Emission Spectroscopy- based on plasma and electrical discharge sources		
Unit 3: Spectral Methods III **NMR Spectroscopy:** Theory and Instrumentation- recapitulation, FTNMR, 2D NMR- FID signal, generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR), Radio waves in imaging- principle instrumentation and applications of MRI, Application of NMR to other nuclei C13, P31 and F19 spectroscopy	**20%**	**12**
Unit 4: Spectral Methods IV **Mass spectroscopy:** recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from mass spectra- molecular identification, metastable peaks, Fragmentation Reactions **Raman spectroscopy:** Principle Theory Instrumentation, techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy	**20%**	**12**
Unit 5: Radiochemical And Thermal Methods Activation analysis- NAA, radiometric titrations and radio-release methods, Thermal analysis- Principle, Interfacing, instrumentation and Applications of Simultaneous Thermal Analysis- TG-DTA and TG-DSC, Evolved gas analysis- TG-MS and TG-FTIR **Hyphenated Techniques:** concept of hyphenation, need for hyphenation, possible hyphenations, Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS.	**20%**	**12**

List Of Practical	Weightage	Contact hours
1. Nitration of Benzophenone	11%	4
2. Synthesis of 1,2,3,4-Tetrahydrocarbazole	11%	4
3. Synthesis of Dibenzalacetone from Benzaldehyde	11%	4
4. Synthesis of Benzoic acid from Toluene	11%	4
5. Synthesis of Phthalimide from Phthalic acid	11%	4
6. To separate a mixture of amino acids by Thin Layer Chromatography (TLC) and identify the test amino acids by measuring their Rf values.	11%	4
7. Synthesis of phthalein dye	11%	4
8. Synthesis of benzophenone Oxime	11%	4

9. Preparation of Schiff Base	11%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Subdomain**
After successful completion of the above course, students will be able to: **CO1: Evaluate** the principles, instrumentation, and applications of surface analytical techniques **CO2: Analyze** the principles, instrumentation, and applications of ESR, Mössbauer spectroscopy, and atomic emission spectroscopy. **CO3: Apply** the theory and instrumentation of NMR spectroscopy, C13, P31, and F19 spectroscopy. **CO4: Interpret** mass spectra to correlate with molecular structures **CO5: Assess** the principles, instrumentation, and applications of activation analysis, thermal analysis, and various hyphenated techniques	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe Define Define , Describe

Learning Resources	
1.	**Textbook:** 1. Practical Pharmaceutical chemistry third edition volume 1 by A.H.Beckett &J.B.Stenlake 2.Forensic pharmacy by B.S Kuchekar, A.M Khadatare (Nirali Prakashan).
2.	**Reference books :** 1.Practical pharmaceutical analysis by Ashitosh Kaur 2.Analytical problems of drug substances and Exp by Florey.
3.	Journal: Analyst, Journal of analytical chemistry etc.
4.	Periodicals: Chemistry Today.
5.	Other Electronic resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks

Theory: Continuous Evaluation Component Marks	Attendance	05 marks
	MCQs	10 marks
	Open Book Assignment	15 marks
	Open Book Assignment	10 marks
	Total	**40 Marks**
Practical Marks	Attendance	05 marks
	Practical Exam	20 marks
	Viva	10 marks
	Journal	10 marks
	Discipline	05 marks
	Total	**50 Marks**
Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/ University mentor's feedback on the Project/ Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs & COs

	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	1	1	1
CO2	2	1	0	2	0
CO3	1	0	1	1	0
CO4	1	0	1	0	0
CO5	2	2	1	2	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	1	0	1
CO2	2	2	1	1	0	0

CO3	1	0	1	1	0	0
CO4	1	1	2	1	0	0
CO5	2	3	2	3	2	1

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE MSCM402	COURSE NAME **Analytical Chemistry –VII** *(Analytical Spectroscopic Techniques)*	SEMESTER IV

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
4	4	0	8	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept.
Course Category	Core Professional.
Course focus	Employability
Rationale	The course on Atomic Absorption and Emission Spectroscopy is designed to equip students with advanced knowledge and practical skills in various spectroscopic techniques. This course emphasizes the theoretical principles, instrumentation, and applications of atomic and molecular spectroscopy, microscopy, X-ray methods, mass spectrometry, and electron spectroscopy. Students will gain the ability to analyze and interpret complex data, enhancing their proficiency in qualitative and quantitative analysis, structural elucidation, and problem-solving in scientific research and industrial applications.
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: **Evaluate** the principles, instrumentation, and applications of atomic absorption and emission spectroscopy **Analyze** the factors affecting fluorescence and phosphorescence and the application of luminescence and flame photometry in chemical analysis. **Apply** the principles and instrumentation of SEM, STM, and AFM to analyze surface structures and materials at the nanoscale. **Interpret** the principles, instrumentation, and applications of X-ray methods and mass spectrometry for chemical analysis and structural elucidation. **Assess** the principles, instrumentation, and applications of electron spectroscopy and utilize spectroscopic methods for structural elucidation.

Course Content (Theory)	Weightage	Contact hours

Unit 1: Atomic Absorption and Emission Spectroscopy Absorption of radiation by atoms; equipment: radiation sources (Hollow cathode lamps and electrode less discharge lamps); atomizers (Flame and carbon); wavelength selector and detectors; interferences in atomic absorption spectroscopy; applications and problems: qualitative and quantitative analysis. Introduction to plasma, arc and spark emission spectroscopy; equipment: inductively coupled plasma spectrometer and flame photometer; applications and problems.	**20%**	**12**
Unit 2: **Molecular Luminescence Spectroscopy:** Introduction to molecular luminescence and chemiluminescence); factors affecting on fluorescence and phosphorenscence, theory of luminescence; instruments for measuring fluorescence (fluorometer and spectrofluorometer); application and problems. **Flame Photometry:** Theory, Instrumentation and a few important applications. **Emission Techniques:** Theory, techniques of excitation, electrodes and their shapes, flame and plasma emission spectrometry – instrumentation and application. **Atomic Absorption Spectrometry:** Theory, instrumentation (flame and flameless atomization) and applications.	**20%**	**12**
Unit 3: Microscopy Techniques Limitation of the human eye, Introduction to scanning electron microscopy (SEM), Scanning tunneling microscopy (STM) and atomic force microscopy (AFM); basic principles and theory; instrumentation and operating parameters and applications.	**20%**	**12**
Unit 4: **X-ray methods of analysis:** Principle, theory X-ray spectral lines, X-ray tube, X-ray emission, absorptive apparatus, sources, collimation, sample handling, wavelength dispersive devices, energy dispersive devices, detectors, readout device, chemical analysis using X-ray absorption, X-ray fluorescence instrumentation and chemical analysis, X-ray diffraction, chemical analysis with X-ray diffraction, numerical problems. **Mass spectra:** Basic principle, molecular ion peak, base peak, meta stable ion peak, isotopic peaks, Nitrogen rule, ring rule, Mc-Lafferty rearrangement, rules for fragmentation pattern, Examples of mass spectral fragmentation of organic compounds (alkanes, aromatic hydrocarbons, alkyl halides, aldehydes, ketones, alcohols, acids and esters).	**20%**	**12**
Unit 5: Electron spectroscopy Introduction to electron spectroscopy (ESCA, Auger and UPS); principle and theory of ESCA; instrumentation; chemical shifts, satellite peaks and spectral splitting; application and problems. Principle and electron transition of Auger electron spectroscopy; equipment; applications and problems. **Spectroscopic applications:** Structural elucidation of simple	**20%**	**12**

organic molecules using UV-VIS, IR, Proton NMR spectroscopy and Mass spectrometry		

List Of Practical	Weightage	Contact hours
10. Nitration of Benzophenone	11%	4
11. Synthesis of 1,2,3,4-Tetrahydrocarbazole	11%	4
12. Synthesis of Dibenzalacetone from Benzaldehyde	11%	4
13. Synthesis of Benzoic acid from Toluene	11%	4
14. Synthesis of Phthalimide from Phthalic acid	11%	4
15. To separate a mixture of amino acids by Thin Layer Chromatography (TLC) and identify the test amino acids by measuring their Rf values.	11%	4
16. Synthesis of phthalein dye	11%	4
17. Synthesis of benzophenone Oxime	11%	4
18. Preparation of Schiff Base	11%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to: **CO1: Evaluate** the principles, instrumentation, and applications of atomic absorption and emission spectroscopy **CO2: Analyze** the factors affecting fluorescence and phosphorescence and the application of luminescence and flame photometry in chemical analysis. **CO3: Apply** the principles and instrumentation of SEM, STM, and AFM to analyze surface structures and materials at the nanoscale. **CO4: Interpret** the principles, instrumentation, and applications of X-ray methods and mass spectrometry for chemical analysis and structural	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe Define Define , describe

elucidation. **CO5: Assess** the principles, instrumentation, and applications of electron spectroscopy and utilize spectroscopic methods for structural elucidation.		

Learning Resources	
1.	**Textbook:** 1.Introduction to instrumental analysis by R. D. Braun, MC. Graw Hill-International edition. 2. Analytical Spectroscopy by Kamlesh Bansal- First edition. .
2.	**Reference books :** 1.Instrumental methods of chemical analysis by Willard, Dean and Merittee-Sixth edition. 2.Electron microscopy in the study of material, P. J Grundy and G. A Jones, Edward Arnold
3.	Journal: Analyst, Journal of analytical chemistry etc.
4.	Periodicals: Chemistry Today.
5.	Other Electronic resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**

Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/ University mentor's feedback on the Project/ Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	2	1	2
CO2	1	2	1	1	1	1
CO3	1	1	2	1	1	1
CO4	2	2	2	2	1	2
CO5	2	3	2	2	1	2

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	0	2
CO2	1	2	2	2	1	1
CO3	1	2	1	1	1	1
CO4	1	1	2	2	2	2
CO5	2	3	3	2	2	2

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None

COURSE CODE	COURSE NAME	SEMESTER
MSCM403	**Analytical Chemistry –VIII** *(Analysis of complex materials)*	**IV**

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	00	120	4	2	00	6

Course Pre-requisites	Basic B.Sc. Level Analytical Chemistry Concept.
Course Category	Core Professional.
Course focus	Employability
Rationale	The course on advanced analytical techniques is designed to provide students with comprehensive knowledge and practical skills in the analysis of ores, alloys, organic compounds, fuels, and the application of radioanalytical techniques. By understanding and applying these methods, students will be able to perform accurate and efficient analyses in various industrial and research settings, contributing to advancements in material science, chemistry, and environmental studies.
Course Revision/ Approval Date:	14/3/2020
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: **Execute** the complete analysis of ores and alloys **Determine** the elemental composition of organic compounds **Evaluate** functional groups in organic compounds and assess unsaturation in oils and fats. **Perform** the analysis of solid, liquid, and gaseous fuels **Analyze** samples using radioanalytical techniques

Course Content (Theory)	Weightage	Contact hours
Unit 1: Ore and Alloy Analysis	**20%**	**12**

Sample preparation – Decomposition and dissolution of the sample, Fusion process, use of fluxes – acid and alkaline fluxes. General procedure of complete analysis of Ores and Alloys – Oxide Ore- Haematite, Carbonate Ore – Dolomite, Alloys – Solder and Brass.		
Unit 2: Analysis of Organic Compounds-I Elemental analysis – Decomposition of organic compounds – Dry and wet ashing. Fusion -alkali metal fusion. Analysis of carbon, nitrogen and hydrogen in organic compounds. Determination of traces of water in liquids and solids. Direct and indirect methods – use of Karl-Fischer's reagent, Dean and Stark method.	**20%**	**12**
Unit 3: Analysis of Organic Compounds-II Functional group analysis: Amine, phenolic – OH, alcoholic – OH, vicinal hydroxyl, aldehyde and ketonic group analysis. Unsaturation in oils and fats – Bromination and iodine number. Rancidity.	**20%**	**12**
Unit 4: Fuel Analysis Fuel Analysis - Solids, liquids and gaseous fuels – Sampling procedure, ultimate and proximate analysis, specific volatile index, ash content, Calorific value by bomb calorimeter and Junker's gas calorimeter. Liquid fuels – Flash point, viscosity, carbon residue, aniline point, pour point – Determination and significance.	**20%**	**12**
Unit 5: Radioanalytical Techniques Characteristics of radiation, Nuclear instrumentation, measurements of radioactivity – Gas ionisation, semiconductor, Nuclear emulsion and autoradiography. Sample preparation for analysis, Isotopic dilution analysis, Radio immunoassasy. Direct, reverse and special radiometric titrations. Applications of Radio chromatography and Radioelectrophoresis. Activation analysis.	**20%**	**12**

List Of Practical	Weightage	Contact hours
19. Nitration of Benzophenone	11%	4
20. Synthesis of 1,2,3,4-Tetrahydrocarbazole	11%	4
21. Synthesis of Dibenzalacetone from Benzaldehyde	11%	4
22. Synthesis of Benzoic acid from Toluene	11%	4

23. Synthesis of Phthalimide from Phthalic acid	11%	4
24. To separate a mixture of amino acids by Thin Layer Chromatography (TLC) and identify the test amino acids by measuring their Rf values.	11%	4
25. Synthesis of phthalein dye	11%	4
26. Synthesis of benzophenone Oxime	11%	4
27. Preparation of Schiff Base	11%	4

Instructional Method and Pedagogy:
Utilizing models, PowerPoint, Presentations, chalk and board, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the principles of the subject.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: **CO1: Execute** the complete analysis of ores and alloys **CO2: Determine** the elemental composition of organic compounds **CO3: Evaluate** functional groups in organic compounds and assess unsaturation in oils and fats. **CO4: Perform** the analysis of solid, liquid, and gaseous fuels **CO5: Analyze** samples using radioanalytical techniques	Remember and understand Analysis & Apply Remember and understand Remember and understand	Define, Describe Define, Describe,Apply Define, Describe,Apply Define Define , Describe

Learning Resources	
1.	**Textbook:** 1.Standard methods of chemical analysis, volume 3, part-B, F.J. Welcher. 2. Insight into speciality inorganic chemicals by D. Thomson, the royal society of chemistry (1995) 3. Standard methods of water and waste water analysis by A.K.De.
2.	**Reference books :** 1. Industrial water pollution control by W.W. Ecken and elder, Tata McGraw- Hill (2000) 2. Applied chemistry, a text book for Engineers and technologists by H.D. Gesser. 3. Handbook of Industrial chemistry, by Davis Berner.
3.	Journal: Analyst, Journal of analytical chemistry etc.
4.	Periodicals: Chemistry Today.
5.	Other Electronic resources: Unacademy NPTEL etc.

Evaluation Scheme	**Total Marks**
Theory: Mid semester Marks	20 marks
Theory: End Semester Marks	40 marks
Theory: Continuous Evaluation Component Marks	Attendance: 05 marks MCQs: 10 marks Open Book Assignment: 15 marks Open Book Assignment: 10 marks **Total: 40 Marks**
Practical Marks	Attendance: 05 marks Practical Exam: 20 marks Viva: 10 marks Journal: 10 marks Discipline: 05 marks **Total: 50 Marks**

Project/ Industrial Internship Marks	Quantity of the Project/Industrial in terms of Language, Presentation & format.	30 marks
	Practical understanding of the subject on the Project/Industrial.	30 marks
	Industry/ University mentor's feedback on the Project/ Industrial.	30 marks
	Attendance	10 marks
	Total	**100 Marks**

Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	3	1	1	2
CO2	2	1	3	2	2	2
CO3	2	2	2	2	2	3
CO4	2	2	2	2	2	2
CO5	3	3	2	3	2	3

Mapping of POs & COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	1	2
CO2	2	2	1	1	1	2
CO3	2	3	1	2	3	2
CO4	1	3	1	2	3	1
CO5	2	3	2	1	2	3

1: Slight (low); 2: Moderate (Medium); 3: Substantial (High); 0 None