COURSE CURRICULUM

M.Sc. Analytical Chemistry

Batch:2022-2023
Academic Year: 2023-24
Updated on: July, 2023

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	MSCM101	Analytical Chemistry – I	I	3	4	0	7	3	2	0	5
2	MSCM102	Organic Chemistry - I	I	3	4	0	7	3	2	0	5
3	MSCM103	Physical Chemistry - I	I	3	4	0	7	3	2	0	5
4	MSCM104	Inorganic Chemistry -I	I	3	4	0	7	3	2	0	5
5	MSCM201	Analytical Chemistry – II	II	3	4	0	7	3	2	0	5
6	MSCM202	Organic Chemistry - II	II	3	4	0	7	3	2	0	5
7	MSCM203	Physical Chemistry - II	II	3	4	0	7	3	2	0	5
8	MSCM204	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**

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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**

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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
	B. Core Course															
4.	MSCM111	Analytical Chemistry – I	3	4	0	3	4	2	0	5	20	40	40	100	50	150
5.	MSCM112	Organic Chemistry – I	3	4	0	3	4	2	0	5	20	40	40	100	50	150
6.	MSCM113	Physical Chemistry – I	3	4	0	3	4	2	0	5	20	40	40	100	50	150
7.	MSCM114	Inorganic Chemistry – I	3	4	0	3	4	2	0	5	20	40	40	100	50	150
		Total	**13**	**18**	**03**	**24**	**17**	**10**	**03**	**26**						**750**

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COURSE CODE MSCM 111	COURSE NAME Analytical Chemistry-I	SEMESTER I

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	Professional core course
Course focus	Skill Development
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of analytical chemistry topics which introduce basic knowledge of analytical chemistry to the students. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	10/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the basic analytical methods and have a sound knowledge of chemistry involved in an analysis. 2: **Understand** the concept of analytical techniques 3. Able to **apply** knowledge on perform data handling 4: **Understanding** on spectroscopic technique 5: **Able to perform** analytical characterization of unknown sample

Course Content (Theory)	Weightage	Contact hours
Unit 1: Language of Analytical Chemistry: Analytical perspective, Common analytical problems, terms involved in analytical chemistry (analysis, determination, measurement, techniques, methods, procedure and protocol). Data Handling Spreadsheet in Analytical Chemistry: Accuracy and Precision, determinate error, Independent errors, Significant numbers, expressing accuracy, standard deviations, propagation of errors, confidence limits. Rejection of results and problems. Standardization and Calibration: Analytical samples and methods of sampling, sample handling, gross sample, preparation of laboratory samples, automated sample handling comparison with standards numerical problems.	**20%**	**12**
Unit 2: Calculations based on chemical principles: The following topics are to be covered in the form of numerical problems only: concentration of a solution based on volume and mass units, calculations of ppm, ppb and dilution of the solutions, concepts of mol, stoichiometry of chemical reactions, concepts of kg mol, limiting reactant, theoretical and practical yield, solubility and	**20%**	**12**

solubility equilibria, effect of presence of common ion, calculations of pH of acids, bases acidic and basic buffers, concept of formation constants, stability and instability constants, stepwise formation constants, oxidation number, rules for assigning oxidation number, redox reaction in term of oxidation number, oxidizing, and reducing agents, equivalent weight of oxidizing and reducing agents, stoichiometry of redox titration (Normality of a solution of a oxidizing /reducing agent and its relationship with molarity).		
Unit 3: Spectroscopic Methods: Recapitulation of basic concepts, electromagnetic spectrum, sources, detectors. Sample containers, laser as source of radiation, fiber 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%**	**12**
Unit 4: 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%**	**12**
Unit 5: Thermal methods: 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.	**20%**	**12**

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 sample by Winkler's method.	**12.5%**	4
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: (Max. 100 words) 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: **knowledge** for the processes of data handling CO2: **Knowledge** of spectroscopy techniques. CO3: **Understanding** of data analysis in depth. CO4: **Knowledge** of symmetry of different kinds of errors. CO5:**Perform** Practical analytical characterization	Cognitive	Remember & Understand Remember & Analyse Undestand Analyse 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
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>
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<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	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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of organic chemistry topics like basics of organic chemistry, stereochemistry and reaction mechanism. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: To **understand** The concepts of stereochemistry 2: To **understand** the reaction mechanism and its evaluation. 3: Able to **analyze** stereochemistry of molecules. 4: **Knowledge** of organic synthesis and characterization . 5: **Understand** the concept of aromaticity

Course Content (Theory)	Weightage	Contact hours
Unit 1: Structure and reactivity: Chemical bonding and basis of reactivity- Chemical bond, delocalization, conjugation, resonance, hyperconjugation, tautomerism, inductive effects, MOT and VBT approach. Bonding other than covalent bonding: Ionic, hydrogen bond, inclusion compounds, rotaxanes, catenanes, cyclodextrins, cryptands, fullerenes, crown ethers. Acidity and basicity: various structural effects, hard and soft acid and base concept.	**20%**	**12**
Unit 2: Aromaticity: Benzenoid and nonbenzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, and Current concepts of aromaticity. Structure and stability of reactive intermediates, carbenes, nitrenes, carbocations, carbanions and free radicals.	**20%**	**12**
Unit 3: Stereochemistry: Stereochemical principles, enantiomeric relationship, diastereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds,	**20%**	**12**

Prochiral relationship, stereospecific and stereoselective reactions, optical activity in biphenyls, spiranes, allenes and helical structures. Conformational analysis of cyclic and acyclic compounds.		
Unit 4: Organic reactions-Substitution reaction, Aliphatic nucleophilic substitution. SN1, SN2, SET and SNV mechanism, NGP by pi and sigma bonds, classical and nonclassical carbocations, phenonium ions, norbornyl system, carbocation rearrangement in NGP, SNi mechanism, nucleophilic substitution in allylic,Trigonal and vinylic carbon, effect of structure, nucleophile, leaving group, solvent on rate of SN1 and SN2 reactions, ambident nucleophile and regioselectivity. Aromatic Electrophilic substitution. Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, 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.	**20%**	**12**
Unit 5: Aromatic nucleophilic substitution- SNAr, SN1, Benzyne and SNR1 reactions, reactivity: effect of substrate structure, leaving group and attacking nucleophile. Addition reactions - Addition to C-C multiple bonds - mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radicals, Regio and chemo selectivity, orientation and reactivity, conjugate addition. Elimination reactions - E1, E2, E1cb mechanisms, orientation and stereochemistry in elimination reaction, reactivity effect of structure, attacking and leaving group, competition between elimination and substitution, syn eliminations.	**20%**	**12**

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: (Max. 100 words)
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: To **understand** The concepts of stereochemistry CO2: To **understand** reaction mechanism and its evaluation. CO3: **Knowledge** on symmetry of molecules. CO4: **Knowledge** of organic synthesis and characterization CO5: **Understand** the concept of aromaticity.	Cognitive	Understand Remember Understand Apply Apply

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.

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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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of Physical chemistry topics which introduce basic knowledge of physical chemistry to the students. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1. **Understand** the importance of various fundamental concepts of physical chemistry 2. **Knowledge of various** industrial applications of phenomena like catalysis and electrochemistry.. 3. Develop **understanding** of limitations of classical thermodynamics. 4. Able to **understand** gas theory and equations 5. Will have **knowledge** of Maxwell distribution.

Course Content (Theory)	Weightage	Contact hours
Unit 1: The Gaseous state & The Kinetic Molecular Theory The gaseous state, General characteristics of gases, The gas laws: Boyle's law, Charles' law, Gay Lussac's law, Avogadro's law, The Idealgas equation, Dalton's Topics –Law of Partial Pressures, Graham's law of Diffusion, Assumptions of the Kinetic Molecular Theory of Gases, Statement of Kinetic Gas Equation and the significance of the terms involved in it, Kinetic Gas Equation in terms of Kinetic Energy, Deduction of Gas Laws (Boyle's law, Charles' law, Avogadro's law & Graham's law of diffusion) as well as Ideal gas equation and Dalton's law of Partial Pressures from the Kinetic Gas Equation	**20%**	**12**
Unit 2: Statement of the Maxwell Distribution Law of Molecular Velocities and its explanation, Different types of molecule velocities and their expressions, Collision Properties (Parameters), Transport phenomena viz. viscosity, thermal	**20%**	**12**

conductivity and diffusion in gases, Derivation of the different relationships between the mean free path and the coefficients of viscosity, thermal conductivity and the diffusion, Influence of temperature and pressure on coefficients of viscosity, thermal conductivity and diffusion, Degrees of Freedom (rotational and vibrational) and their calculations, Principle of Equipartition of Energy, Numericals.		
Unit 3: Electromotive Force (EMF) of Galvanic Cells Introduction, Galvanic Cells, Reversible cells, Reversible electrodes, Single electrode potential, Electrical energy in a galvanic cell, Electrical energy and Free energy change of cell reaction, Relation between Electrical energy and Enthalpy of a cell reaction, Determination of ΔHo , ΔGo and ΔSo of a cell reaction, EMF and Equilibrium constant of a cell reaction, Standard EMF and Equilibrium constant, The Nernst equation, ElectrodeConcentration Cells, ElectrolyteConcentration Cells, Concentration cells with and without transference, Liquid Junction Potential, Hydrogen electrode, Calomel electrode, Silver- Silver electrode, Glass electrode, Quinhydrone electrode, Applications of EMF measurements, Potentiometric titrations, Acid-Base, Redox and Precipitation titrations, Numericals	**20%**	**12**
Unit 4: Polarography Principle, apparatus and electrodes systems, components of limiting current, residual current, migration current, diffusion current, catalytic current, convention current, adsorption current and kinetic current. Polarographic maxima, halfwave potential, derivation of relationship between half wave potential and diffusion coefficients, fractions governing diffusion current, Calibration curve method, standard addition method, effect of pH on polarography and applications	**20%**	**12**
Unit 5: Theory Amperometry Principle, apparatus and electrode system. Four different types of amperometric titrations, advantages and disadvantages of amperometry. Applications of amperometry. pH-metry Introduction, construction and working of different electrodes, Ion selective electrodes, Applications of pH measurements, acid-base titrations, polybasic acid base titrations, determination of dissociation constant of weak acids and weak bases, determination of hydrolysis constant and degree of hydrolysis	**20%**	**12**

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: (Max. 100 words)
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 concept of name reactions CO2. **Knowledge** on gas theory and its application. CO3. To **understand** thermodynamic parameters. CO4. Gain **knowledge** on symmetry of molecule CO5. Practical physical properties identification **knowledge**.	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.

<table>
<tr><th>Evaluation Scheme</th><th>Total Marks</th></tr>
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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>MCQs</td><td>10 marks</td></tr>
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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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of Inorganic chemistry topics which introduce basic knowledge of inorganic chemistry related topics to the students. The prime focus is given to lab practicals through action-based-learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1. **Understand** the concepts of bond formation in a molecule. 2. Acquire **knowledge** in metal complexes. 3. **Understand** the importance of metal complexes in nature 4. Able **to prepare** inorganic synthesis in lab. 5. **Knowledge** on structure of inorganic complexes.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Coordination Chemistry: Concept and scope of ligand fields, free ion configuration, terms and states, energy levels of transition metal ions, free ion terms, term wave functions, spin-orbit coupling. Ligand Field Theory of Coordination complexes, effect of ligand field on energy levels of transition metal ions	**20%**	**12**
Unit 2: weak cubic ligand field effect on Russill Saunders terms, strong field effect, correlation diagrams, TanabeSugano Diagrams, Spin-Pairing energies. Electronic spectra of Transition Metal Complexes. Introduction, band intensities, band energies, band with and shapes, spectra of 1st, 2nd and 3rd row ions and rare earth ion complexes, spectrochemical and nephlauxeetic series, charge transfer and luminescence, spectra, calculations of Dq, B, β parameters.	**20%**	**12**
Unit 3: Magnetic Properties of Coordination Complexes:	**20%**	**12**

Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexe sparamagnetism 1st and 2nd ordered Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A, E and T ground terms in complexes, spin free spin paired equilibria.		
Unit 4: : Inorganic Reaction Mechanism: rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods) Ligand substitution reactions of a) Octahedral complexes without breaking of metal ligand bond (use of isotopic labelling method), b) square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. Redox reaction: inner and outer sphere mechanisms, complementary and non-complementary reactions. Stereochemistry of substitution reactions of octahedral complexes. (Isomerization and racemisation reaction and applications)	**20%**	**12**
Unit 5: Organometallic Chemistry of Transition metals: Eighteen and sixteen electron rule and electron counting with examples. Preparation and properties of the following compounds: alkyl and aryl derivatives of Pd and Pt compounds, carbenes ancarbines of Cr, Mo and W, alkene derivatives of Pd and Pt, alkyne. derivatives of Pd and Pt, allyl derivatives of nickel, sandwich compounds of Fe, Cr and Half sandwich compounds of Cr, Mo. Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise's salt, bis(triphenylphosphine)diphenylacetylene platinum, diallyl nickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl(n2-butadiene)iron(0).	**20%**	**12**

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: (Max. 100 words)

PUtilizing 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: 1. **Understand** coordination chemistry 2. Gain **knowledge** on structure of metal complexes 3. To **understand** inorganic characterization and its application. 4. **Knowledg**e on symmetry of molecules. 5. **Apply** Practical based knowledge on inorganic synthesis and characterization knowledge.	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
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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	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

Teaching Scheme
Semester – II 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.	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	3	4	0	7	3	2	0	5	20	40	40	100	50	150
5.	MSCM212	Organic Chemistry – II	3	4	0	7	3	2	0	5	20	40	40	100	50	150
6.	MSCM213	Physical Chemistry – II	3	4	0	7	3	2	0	5	20	40	40	100	50	150
7.	MSCM214	Inorganic Chemistry – II	3	4	0	7	3	2	0	5	20	40	40	100	50	150
		Total	**13**	**18**	**03**	**24**	**13**	**10**	**03**	**26**						**750**

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	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	This course has played a critical role in the understanding of basic science to a variety of practical applications,such as biomedical applications,environmental monitoring,quality control of industrial manufacturing,forensic science and so on.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the basics of electroanalytical and chromatographic techniques. 2: Acquire **competency** to predict the patterns in thermal methods of analysis. 3: **Study** of mass spectroscopy for chemical identification. 4: **Understand** the electroanalytical methods. 5: **Application** of HPLC.

Course Content (Theory)	Weightage	Contact hours
Unit1: Chromatography: recapitulation of basic concepts in chromatography, classification of chromatographic methods, requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively, qualitative and quantitative analysis. Concept of plate and rate theories in chromatography: efficiency, resolution, selectivity and separation capability	**20%**	12 (TH) + 12 (PR)
Unit 2: Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions. Gas Chromatography: Instrumentation of GC with special reference to sample injection systems – split/splitless, column types, solid / liquid stationary phases, column switching techniques, temperature programming, thermionic and mass spectrometric detector, Applications.	**20%**	12 (TH) + 12 (PR)
Unit 3: 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).	**20%**	12 (TH) + 12 (PR)

Diode array type and fluorescence detector, Applications of HPLC. Chiral and ion chromatography.		
Unit 4: 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.	**20%**	12 (TH) + 12 (PR)
Unit 5: Electro analytical methods- 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%**	12 (TH) + 12 (PR)

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 given mixture and also to calculate the R f values of unknown compounds	10%	4
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: CO1: **Understand** the basics of electroanalytical and chromatographic techniques. CO 2: **Acquire** competency to predict the patterns in thermal methods of analysis. CO 3: **Knowledge** of mass spectroscopy for chemical identification. CO 4: **Understand** the electroanalytical methods. CO 5: **Application** of HPLC.	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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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 MSCM202	COURSE NAME Organic Chemistry – II	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 Organic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of organic chemistry topics like oxidation- reduction reactions, rearrangements and spectroscopy techniques. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the importance of pericyclic reactions.. 2: **Understand** the concept of different reaction mechanisms. 3: Gain **knowledge** on spectroscopy. 4: **Understand** the concepts of NMR. 5: **Understand** the NMR Spectroscopy.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Reactive Intermediates Preparation, structure, and stability of reactive intermediates Carbocation, carboanion, carbene, nitrine, benzyne, ylide. Reactions involving reactive intermediates: Rearrangement of carbocations, SN1, E1, ArSE,. Shapiro reaction, Reimer–Tiemann reaction, wolf rearrangement, insertion of carbene in pi and sigma bond, Simmon smith carbene (preparation and reaction), Tschitschibabin reaction.	**20%**	12 (TH) + 12 (PR)
Unit 2: Synthetic Organic Chemistry Oxidation reactions: CrO3, PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb (OAc)4, Pd-C, OsO4, mCPBA, O3, NaIO4, HIO4. Rearrangements: Beckmann, Hofmann, Curtius, Smith, Wolff, Lossen, Bayer-villiger, Sommelet, Favorskii, Pinacol-pinacolone, Benzil- benzilic acid, Calsien, Cope Fries rearrangement.	**20%**	12 (TH) + 12 (PR)
Unit 3: Reduction reactions: Boranes and hydroboration reactions, R3SiH, Bu3SnH, MPV, H2/Pd-C, Willkinsons, NaCNBH3, NH2NH2, DIBAL. Addition to carbon-heteroatom multiple bonds: Grignard, organo zinc, organo copper, organo lithium, reagents to carbonyl and unsaturated carbonyl compounds.	**20%**	12 (TH) + 12 (PR)

Unit 4: UV and IR Spectroscopy Theory and applications of UV and IR spectroscopy. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (Using Woodward-Fieser tables for values for substituents) Types and calculation of vibrational modes. Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.	**20%**	12 (TH) + 12 (PR)
Unit 5: NMR spectroscopy- Proton magnetic resonance spectroscopy: Principle, Chemical shift, Factors affecting chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin- spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal and long range coupling (allylic and aromatic). First order spectra, Karplus equation. 13C NMR spectroscopy: Theory and comparison with proton NMR, proton coupled and decoupled spectra, off resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons.	**20%**	12 (TH) + 12 (PR)

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: CO1: **Understand** the concept of reactive intermediates. CO2: **Understand** oxidation and reduction reactions. CO3:**Understand** organic reaction mechanism and rearrangement. CO4:**Apply** practical knowledge of UV and IR spectroscopy. CO5: **Apply** practical knowledge of NMR Spectroscopy.	Cognitive	Understand Understand Understand Apply Apply

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.

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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	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 Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of physical chemistry related topics like Thermodynamics, properties of solutions, partial molar properties, free energy and fugacity. The prime focus is given to lab practicals through action-based-learning.
Course Revision/ Approval Date:	11/04/2021
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the concept of Statistical Thermodynamics. 2: **Understand i**deal solutions and solution properties. 3: **Understand** the concept of fugacity.. 4: **Knowledge** of chemical equilibrium and free energy.. 5: **Understand** Justification of molar partial quantities.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Statistical Thermodynamics Introduction, Aspects of statistics, Definition of microscopic states, Statistical weight, Macroscopic states, Most probable distribution system, Assembly, Assembly of localized and non-localized systems, Ensemble, Micro-canonical ensemble, Macro canonical ensemble and grand canonical ensemble, Boltzmann and Planck equation, Partition function and its significance, Values of Translational, Rotational, Vibrational and Electronic partition functions, 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%**	12
Unit 2: The Properties of Solutions Ideal solutions & its properties, The Duhem-Margules equation, Application of Raoult's law to both constituents of an ideal solution, Vapour Pressure curves for an Ideal	**20%**	12

solution, Composition of liquid & vapour in equilibrium, Non-ideal solutions & its vapour pressure curves, Solubility of partially miscible liquids, Dilute solutions, Henry's Law. Solutions of electrolytes: Mean ionic activity, Mean ionic activity coefficient & mean ionic molality of the electrolyte, Listing of the methods determining mean ionic activities, Ionic strength principle, Numericals.		
Unit 3: Fugacity and Activity Fugacity and Activity: Introduction, Definition of fugacity, Methods of determining Fugacity of a gas: Graphical method, Equation of State method, Approximate and Generalized methods, Variation of Fugacity with temperature and pressure, Fugacity of solids and liquids, Mixture of Ideal and Real gases, Determination of Fugacity in gas mixtures, The Lewis-Randall rule, Variation of fugacity of a gas in a mixture with temperature and pressure, Numericals.	**20%**	12
Unit 4: Partial Molar Properties Introduction, Fundamental equations, Thermodynamic significance, Apparent molar property, Relation between Apparent molar property & Partial molar property in the case of an infinitely dilute solution, Methods of determining Partial molar properties: Direct method, Intercept method & Use of apparent molar property method, Partial molar volumes from density measurements, Determination of apparent molar volume of solute, Numericals.	**20%**	12
Unit 5: Free Energy and Chemical Reactions Chemical Equilibrium, The equilibrium constant, Equilibrium in homogeneous gaseous systems, The ammonia equilibrium, Homogeneous reactions in liquid solutions as well as in dilute solutions, The reaction isotherm, Standard free energy of reaction, The direction of chemical change, Variation of equilibrium constant with pressure and temperature, Integration of the Van't Hoff equation, Variation of standard free energy with temperature, Determination of standard free energies, Numericals.	**20%**	12

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 potasium 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: **Understand** the concept of Statistical Thermodynamics. CO2: **Evaluation** of solution property. CO3: **Understand** the concept of fugacity.. CO4: **Knowledge** of chemical equilibrium and free energy.. CO5: **Understand** physical properties of the systems. all properties of the systems.	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.

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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	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 is designed based on requirements and helps with getting the most exposure regarding the field of inorganic chemistry topics like symmetry, group theory and organometallic chemistry. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: To **Understand** the importance of quantum chemistry in developing the model of the atom. 2: **Understand** the origin of Schrodinger wave equation and its application. 3: **Calculations** of the energy and wave functions of various atomic and molecular systems. 4: **Understand** the concepts of metal complexes and its behavior. 5: **Justification** group chemistry.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Definitions and Theorems of Group Theory - I Theory: Molecular Symmetry and Symmetry Groups, Symmetry elements and operations, symmetry planes and reflections, the inversion center, proper axes and proper rotations, improper axes and improper rotations, products of symmetry operations, equivalent symmetry elements and equivalent atoms.	**20%**	**09**
Unit 2: Definitions and Theorems of Group Theory - II Theory: 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: Representation of Groups Theory: Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part) Group theory and quantum mechanics: Wave	**20%**	**09**

function as basis for irreducible representations. Symmetry adapted linear combinations: Projection operators and their use of construct SALC (Construction of SALC for sigma bonding for molecules belonging point groups: D2h, D3h, D4h, C4v, Td, Oh, normalization of SALC.		
Unit 4: Hydrogen and its compounds Theory: Hydrides Boron group, Bornaes, Carboraners and Metalloboranes, Classification, electron deficient, electron precise and electron rich hydrides. Alkali and alkaline earth metals: solutions in non-aqueous Media., solvent based theories	**20%**	**09**
Unit 5: Organometallic Chemistry: Organometallic chemistry of compounds of Si, Sn, Pb, Ga, As, Sb, Bi, Structure, synthesis, reactions. Organometallic Compounds of Li, Mg, Be, Ca, Na: Classification, synthesis properties uses and structures.	**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: To **Understand** the importance of quantum chemistry in developing the model of the atom. CO2: **Understand** the origin of Schrodinger wave equation and its application. CO3: **Calculations** of the energy and wave functions of various atomic and molecular systems. CO4: **Understand** the concepts of metal complexes and its behavior. CO5: **applications** of group theory.	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.

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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. Ability Enhancement Compulsory Course															
1.	MSCM307	Communication Skills – IV	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM308	Comprehensive Viva-III	1	1	0	2	1	1	0	2	0	0	0	0	0	50
3.	MSCM304/305	Computer application in Chemistry/Research Methodology	3	0	1	4	3	0	1	4	20	40	40	100	0	100
4.	MSCM306	Internship-III	0	1	1	2	0	1	1	2	0	0	0	0	0	50
5.	MSM309	Dissertation	0	1	1	2	0	1	1	2	0	0	0	0	0	50
	B. Core Course															
6.	MSCM301	Analytical Chemistry – III	4	2	0	6	4	2	0	6	20	40	40	100	50	150
7.	MSCM302	Analytical Chemistry – IV	4	2	0	6	4	2	0	6	20	40	40	100	50	150
8.	MSCM303	Analytical Chemistry – V	4	2	0	6	4	2	0	6	20	40	40	100	50	150
		Total	**17**	**09**	**04**	**30**	**17**	**9**	**4**	**22**						**750**

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

COURSE CODE	**COURSE NAME**	**SEMESTER**
MSCM301	Analytical Chemistry –III	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: ● Learn the fundamentals of Analytical Chemistry. ● To use technological concepts: of chemical instrumentation and its applications ● Analyse instrumental data for solving chemical problems Have effective skill to make informed and responsible decision that lead to resolve the analytical chemistry challenges of Medicinal Chemistry, Environmental Chemistry and Green Chemistry through electives
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 Learn the **fundamental** concepts of sampling. 2 **Understand** the measurements of uncertainty. 3 **Understand** the development of analytical methods and types of error 4 Gain **knowledge** on data validation 5 To **know** different method development techniques in spectroscopic measurements..

Course Content (Theory)	**Weightage**	**Contact hours**
Unit 1: Theory:Sampling: Definition, types of sample, sampling plan, quality of sample, subsampling,sampling of raw materials, intermediates and finished products. Sample preparation, dissolution technology and decomposition, storage of samples. Pre- treatment of samples:soil, food and cosmetics. Selection of the method: sources of methods, factors to consider when selecting a method, performance criteria for methods used, reasons for incorrect analytical results, method validation, and quality by design (PAT).	**20%**	**12**
Unit 2: Theory:Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. Signal to noise: Signal to noise ratio enhancement, hardware	**20%**	**12**

devices for noise reduction, software methods for noise reduction. Pharmaceutical legislation: introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration.		
Unit 3: Theory:Analytical method developments and validation: Assay validation and inter laboratory transfer: Introduction, fundamental definitions, essential principles of method transfer, method validation report, the interlaboratory qualification (ILQ) process. Statistical analysis and analytical figure of merit: Introduction, errors (gross errors, systematic errors, randomerrors), accuracy, validation parameters: Accuracy, precision, mean and standard deviation, calibration, {linear response functions (linear regression-errors in slope and the intercept, error in the estimate of concentration, standard additions),	**20%**	**12**
Unit 4: Theory:non-linear response functions and weighted regression analysis, internal standards}, single point vs multiple point calibration,selectivity and specificity (chromatographic methods), limits of detections(spectrophotometric methods, chromatographic methods and related techniques, receptor binding assay), limit of quantification, sensitivity, ruggedness and robustness, analyte stability in the sample matrix, how to reduce systematic errors, comparison of results, comparison oftwo means of two samples, experimental design	**20%**	**12**
Unit 5: Theory:Specific methods and applications: Dissolution studies, Introduction, dissolution test, apparatus – USP type – I and II, sampling and analytical instrumentation, Dissolution.	**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: (Max. 100 words) Powerpoint presentation, video, case study, demonstration, QUIZ , Chalk Board and Discussion.

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to/ have : CO1: **Understanding** on sampling CO2: **Knowledge** on measurement CO3: Deep **understanding** on data validation CO4: **Knowledge** on analytical assay. CO5: Practical **knowledge** on analytical data 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. 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

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<tr><td>Practical Exam</td><td>20 marks</td></tr>
<tr><td>Viva</td><td>10 marks</td></tr>
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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	COURSE NAME	SEMESTER
MSCM302	Analytical Chemistry –IV	**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: ● Learn the fundamentals of Analytical Chemistry. ● to use technological concepts: of chemical instrumentation and its applications ● analyse instrumental data for solving chemical problems ● have effective skill to make informed and responsible decision that lead to resolve the analytical chemistry challenges of Medicinal Chemistry, Environmental Chemistry and Green Chemistry through electives
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Understand** the principles of chromatographic techniques and various methods for the analysis. 2 **Explain** the importance separation techniques. 3 Gain sound **knowledge** in chromatographic techniques in the separation and identification of component 4 have **knowledge** of TGA and DTA techniques. 5 **Understand** the radioanalytical methods

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory: Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchanges, chelating resins and their applications for separation of inorganic and organic compounds. Ion chromatography; principle, instrumentation with special reference to separation and suppressor columns, applications. Exclusion chromatography: Theory, instrumentation and applications of gel permeation chromatography, retention behaviour, inorganic molecular sieves, determination of molecular weight of polymers.	**20%**	**12**
Unit 2: Theory: Supercritical fluid chromatography: Theory, concept of critical state of matter and supercritical state, types of supercritical fluids instrumentation, applications to	**20%**	**12**

environmental, food, pharmaceuticals and polymeric analysis. Affinity chromatography: principle, instrumentation and applications, Optimum pressure liquid chromatography (OPLC).		
Unit 3: Theory:Thermal methods of analysis: Principle, different methods of thermal analysis, Thermalgravimetric methods of analysis: instrumentation, thermogram and information from thermogram, factors affecting thermogram, applications TGA for quantitative analysis (TGanalysis of CaC2O4.H2O, CuSO4.5H2O, dolomite ore, etc) and problems based TGA. Differential thermal analysis (DTA); Instrumentation, general principles, differential thermogram, DT and TG curve together, Applications (DT analysis of CaC2O4, H2O DT analysis of sulphur, DT analysis of CuSO4.5H2O	**20%**	**12**
Unit 4: Theory: TGA and DTA curve for Mn(PH2O2)2 H2O. Differential Scanning Calorimetry (DSC): Principle, instrumentation, and applications (DSC curve of polyethylene terphthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetein), thermometric titrations, evolved gas analysis.	**20%**	**12**
Unit 5: Theory: Radioanalytical Methods of Analysis: Activation analysis, Neutron activation analysis, principle, technique, steps involved in neutron activation analysis. Radiochemical and instrumental methods of analysis, important applications of NAA. Isotope dilution analysis:Principle, types of isotope dilution analysis, typical applications of isotope dilution analysis.Radiometric titration: Principle, techniques based on complex formation and precipitation,radiometric titration curves for estimation of ions from their mixture.	**20%**	**12**

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: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ , Discussion(D)

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Subdomain**
After successful completion of the above course, students will be able to/ have :		
CO1: **Understanding** on ion exchange chromatography	Remember and understand	Define, Describe
CO2: **Knowledge** on supercritical fluid chromatography	Remember and understand	Define, Describe,Apply
CO3: Deep **understanding** on thermal analysis.	Remember and understand	Define, Describe,Apply
CO4: **Knowledge** on radio analytical methods.	Analysis & Apply	Define
CO5: Practical **knowledge** on operation of sophisticated analytical instruments		Define , Describe

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.

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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	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: 1. Learn the fundamentals of Analytical Chemistry. 2. to use technological concepts: of chemical instrumentation and its applications 3. analyse instrumental data for solving chemical problems 4. have effective skill to make informed and responsible decision that lead to resolve the analytical chemistry challenges of Medicinal Chemistry, Environmental Chemistry and Green Chemistry through electives
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Explain** the importance of separation techniques. 2 **Understand** the concept of spectroscopic analysis 3 Have the **knowledge** on electrochemical methods 4 Gain **knowledge** on atomic spectroscopy 5 **Understand** solid phase synthesis..

Course Content (Theory)	Weightage	Contact hours
Unit 1: Advanced Electroanalytical Techniques: Current sampled (TAST) polarography, normal and differential pulse polarography. Potential sweep methods, linear sweep voltammetry and cyclic voltammetry. Potential step method-Chronoamperometry, controlled potential technique-Chronopotentiometry, stipping voltammetry – anodic, cathodic and adsorption.. Chemically and electrolytically modified electrodes and ultra-micro electrodes in voltammetry.	**20%**	**12**
Unit 2: Theory: Atomic spectroscopy: Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission, absorption and fluorescence, electro thermal atomizers, Instrumentation for FES, radiation sources atomic absorption methods, instrumentation of AAS, spectral interference, standard	**20%**	**12**

addition and internal standard method of analysis, comparison of atomic absorption and emission methods, inductively coupled plasma and direct current plasma emission spectroscopy, cold vapour technique, applications of AAS, AES and ICPAES, analysis of micronutrients like Mo, B, Cu, Zn essentialtowards the healthy growth of crops, fruits, determination of these micronutrients from soils, plants and fruits		
Unit 3: Theory: Atomic mass spectroscopy, atomic weight in massspectroscopy, mass to charge ratio, types of atomic mass spectroscopy, mass spectrometers, transducer for mass spectroscopy, quadrapole mass analyzer, time of flight mass analyzer,inductively coupled mass spectroscopy (ICPMS), instrumentation for ICPMS, atomic massspectra and interferences, applications of ICPMS.	**20%**	**12**
Unit 4: Theory: Spectroscopy-II: Features of atomic mass Atomic Fluorescence Spectroscopy (AFS): Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasma,Wavelength selection for AFS, Detectors for AFS, theory of AFS, analysis with AFS, interferencewith AFS. Resonant Ionization Spectroscopy, Laser-enhanced ionization spectroscopy.	**20%**	**12**
Unit 5: Theory: Classical approach for aqueous extraction: Introduction, liquid – liquid extraction (LLE) (Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples. Solid Phase Extraction (SPE): Introduction, types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, automation and on line SPE. Solid Phase Micro-Extraction: Introduction, theoretical consideration, experimental, methods of analysis: SPME-GC, methods of analysis: SPME- HPLC-MS, automation of SPME, new development in micro extraction (liquid micro extraction, membrane micro extraction)	**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	12.5%	4 hr

determination of Rf values by thin layer or paper strip techniques		
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: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ, Discussion(D), Assignment, case study

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Subdomain**
After successful completion of the above course, students will be able to/ have : CO1: **Understanding** on on electrochemical methods CO2: **Knowledge** on volatametry and polarogr CO3: Deep **understanding** on atomic spectroscopy. CO4: **Knowledge** on symmetry of molecule CO5: Practical **knowledge** of analytical spectroscopy	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.

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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

COURSE CODE MSCM304	COURSE NAME COMPUTER APPLICATION IN CHEMISTRY	SEMESTER III

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

Course Prerequisites	Fundamental knowledge of computers and chemistry
Course Category	Generic Elective
Course focus	Skill development
Rationale	This course will make students equipped with the fundamental notions of the computers, their parts and their application in the field of chemistry.
Course Revision/ Approval Date:	11/04/2021
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: 1: **Understand** the fundamental notions of computers & computer language. 2: **Understand** the syntax/solution of a program and **Apply** rules/logic and **Construct** computer programs. 3: **Understand** & **Solve** numerical methods using conventional methods and computers. 4: **Understand** & **Solve** Numerical Differentiation and Integration and their applications. 5: **Understand** & **Apply** different curve fitting methods for data presentation and interpretation.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands	20%	12
Unit 2: Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.	20%	12
Unit 3: Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton Raphson method, Binary bisection and Regula-Falsi.	20%	12
Unit 4: Differential calculus: Numerical differentiation. Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values. Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Seidel method.	20%	12
Unit 5: Interpolation, extrapolation and curve fitting: Handling of experimental data. Conceptual background of molecular modeling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.	20%	12

Instructional Method and Pedagogy: (Max. 100 words)

Utilizing chalk-board/powerpoint presentations, films on various topics of the fundamentals of chemistry and computers, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the fundamental notions of the subject.

Course Outcome:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to:		
CO1: **Define** & **Describe** the fundamental notions of computers & computer language.	Understand & Remember	Understand & Remember
CO2: **Construct** the computer program for basic problem **solving.**	Analyze & Create	Solve & Construct
CO3: **Solve** numerical methods using conventional methods and computers.	Analyze	Solve
CO4: **Solve** Numerical Differentiation and Integration and their applications.	Analyze	Solve
CO5: **Apply** different curve fitting methods for data presentation and interpretation.	Apply	Illustrate & Interpret

Learning Resources	
1.	Reference/Text Books: 5. Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science;, 9th Edition, Khanna Publishers, New Delhi, 2007. 6. Spiegel. M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics;, Tata McGraw Hill Edition, 2004. 7. E. Balagurusamy, Programming in ANSI C (8^{th} Ed.), McGraw Hill, 2019.
2.	Other Electronic Resources: 1. Numerical Methods: https://onlinecourses.nptel.ac.in/noc21_ma45/preview 2. Learn Numerical Methods: Algorithms, Pseudocodes & Programs, https://www.codesansar.com/numerical-methods/ 3. Practical Course on Parallel Numerical Methods, https://www.scientific-computing.uni-bayreuth.de/en/Activities/Practical-Course-on-Parallel-Numerical-Methods/index.html 4. https://www.edx.org/learn/c-programming

<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>
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<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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<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>Industry/ University mentor's feedback on the Project/ Industrial.</td><td>10 marks</td></tr>
<tr><td>Attendance</td><td>10 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
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</td></tr>
</table>

Mapping of PSOs & COs

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

Mapping of POs & COs

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

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

COURSE CODE MSCM305	COURSE NAME RESEARCH METHODOLOGY	SEMESTER III

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

Course Prerequisites	Basic understanding of Science and Communication.
Course Category	Professional Elective Course
Course focus	Skill development
Rationale	To have an idea how research methodology lies in its ability to provide a systematic approach to investigating and answering research questions. It serves as a roadmap for researchers, helping them design and conduct their studies effectively and ensure the validity and reliability of their findings. Here are a few key points that highlight the rationale behind research methodology
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	1. **Create and analyze** To generate Curiosity about some ideological research work. 2. **Remember and Understand** Gain effective and interactive technical communication skill in science field. 3. **Apply** Knowledge on technical writing skills 4. **Understand** Able to understand about the safety protocols 5. **Remember** Knowledge on history of research work

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory- History of science and science methodologies: Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptivescience; reductionist vs holistic biology. Choosing a mentor, lab and research question; maintaining a lab notebook. Web resources, E-journals, Journal access, TOC alerts, Hotarticles, Citation index, Impact factor, H-index, Econsortium, UGC infonet, E-books, Internetdiscussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.	**20%**	**12**
Unit 2: Theory - Process of communication Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting nonverbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness	**20%**	**12**
Unit 3: Theory - Technical writing skills Types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct	**20%**	**12**
Unit 4: Theory- Chemical Safety and Ethical Handling of Chemicals: Safe working procedure and protective environment, protective apparel, Emergency procedure and first aid, laboratory ventilation.	**20%**	**12**
Unit 5: Theory- Safe storage and use of hazardous chemicals Procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**20%**	**12**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments.

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	Understanding on research methodology	Remember	Explain, Describe, Discuss, Recall, Locate
CO2	Knowledge on effective communication	Apply	Apply, Practice, Interpret, Select, Correlate
CO3	Deep understanding on technical writing skills	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4	Knowledge on history of modern discovery	Create	Construct, Develop, Produce
CO5	Practical presentation skill	Understand	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1.	**Reference Books:** 1. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall,London. 2. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3- 5. 3. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis.Cambridge Univ. Press (2001) 487 pages.
2.	**Journals & Periodicals** 1. Journal of the American Chemical Society 2. Chem Comm 3. Chemistry Today
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 Article Review: 10 marks **Total: 40 Marks**

Mapping of PSOs and CO

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

Mapping of POs and CO

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

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. Ability Enhancement Compulsory Course															
1.	MSCM407	Communication Skills – IV	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM409	Comprehensive Viva-IV	1	1	0	2	1	1	0	2	0	0	0	0	0	50
3.	MSCM404/415/406	Analysis and Characterization of polymers/Analytical Chemistry-IX/Environmental Analytical Chemistry	4	0	0	4	4	0	0	4	20	40	40	100	0	100
4.	MSCM408	Dissertation	0	1	1	2	0	0	0	2	0	0	0	0	0	50
	B. Core Course															
6.	MSCM401	Analytical Chemistry – VI	4	4	0	8	4	0	0	4	20	40	40	100	50	100
7.	MSCM402	Analytical Chemistry – VII	4	4	0	8	4	0	0	4	20	40	40	100	50	100
8.	MSCM403	Analytical Chemistry – VIII	4	4	0	8	4	0	0	4	20	40	40	100	50	100
		Total	**18**	**13**	**04**	**34**	**18**	**01**	**01**	**22**						**550**

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	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	Discuss subject importance (Max 100 words) Local, national, and international relevance should be highlighted
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1:**Understand** the role of FDA in pharmaceutical industries. 2:To **analyse** the vegetable drugs and some raw materials with respect to identification. 3:To **gain** the knowledge on biological tests 4: To **understand** the concept of vegetable drugs 5:To **learn** raw material characterization.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Apparatus for test and assay, cleaning of glassware's. Role of FDA in Pharmaceutical Industries: Definitions of drug and cosmetics, substandard drugs, role of FDA, introduction to new drug, development of new drugs selection of area, phase I, phase II, phase III, application of FDA for formulation and marketing for new drug, stability studies and self life fixation.	**20%**	**12**
Unit 2: Biological Tests and Assay: Introduction to biological assay, biological assay of Heparin sodium, determination of amylase activity, determination of photolytic activity, test for insulin in solution, biological assay of tetanus antitoxin, test for undue toxicity. Microbiological Tests andAssays: Microbiological test for antibiotic standard preparation and units of activity, test organisms and inoculums, cylinder-plat assay receptacles,	**20%**	**12**

turbidimetric assay receptacles, assay designs, cylinder plate or cup plate method, two level fractional assay, test for sterility.		
Unit 3: Physical test, determinations, limit tests and sterilization: Disintegration test for tablets and capsules, dissolution test for tablets and capsules, moisture/water content by Karl Fischer titration, limit test for arsenic, heavy metals, iron, lead, sulphate, chloride, ash, sulphated ash, methods for sterilization steam sterilization, dry heat sterilization, sterilization by filtration, gas sterilization, sterilization by ionizing radiation, sterilization by heating with bactericides, water for pharmaceutical use.	**20%**	**12**
Unit 4: Analysis of vegetable drugs: Vegetable drugs, sampling, foreign organic matter, ash value, acid soluble ash, acid insoluble ash, sulphated ash, extraction of alkaloids. Source of impurities in pharmaceutical raw materials and finished products, shelf life of pharmaceutical product. Raw materials, method of manufacture, atmospheric contaminations, cross contamination, microbial contamination, container contamination, packaging errors, chemical instability, temperature effect and physical changes, shelf life ofpharmaceutical product and determination of shelf life.	**20%**	**12**
Unit 5: Analysis of raw materials with respect to identification, other or related substances, loss on drying, and assay as per IP, adrenaline, niacinamide, cephalexin, ferrous fumarate, isoniazid and paracetamol. Problems based on assay of these materials. Brief introduction to different dosage forms with the IP requirements analytical methods for the following tablets, different types of tablets uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, (Rifampicin) powders (Sodium benzoate), solutions (Saline NaCl) suspensions (Barium Sulphate – limit test for impurity) Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), ophthalmic preparations (sulphacteamine), aerosols (salbutamol), Blood products and reporting protocols, Problems based on assay of these materials.	**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: (Max. 100 words)
Presentation, Video, Chalk Board, QUIZ

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to: CO1:Able to know about analytical tests and assays. CO2: Will gain knowledge on biological assays. CO3:Will have a clear vision on vegetable drugs. CO4: Able to determine the raw material characterization. CO5:Will gain an idea on sophisticated analytical 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.

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<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>Total</td><td>40 Marks</td></tr>
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<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>Project/ Industrial Internship Marks</td><td>
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<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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</td></tr>
</table>

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	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	Discuss subject importance (Max 100 words) Local, national, and international relevance should be highlighted
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1:**Understand** the principles of Fluorescence, Phosphorescence,Electron spectroscopy, X – ray spectroscopy, chemiluminescence. 2:**Interpret** given spectra to elucidate the structures of molecules. 3:To **gain knowledge** on X-ray crystallography. 4: To **understand** the concept of microscopy. 5:To **learn** about luminescence.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory: Electron spectroscopy: Introduction, principle of ESCA, electron spectroscopy for chemical analysis, ESCA satellite peaks, spectral splitting, ESCA chemical shifts, apparatus used for ESCA, X-ray source, samples, Analyzers, Detectors, chemical analysis using ESCA, Applications, Auger electron microscopy, ultraviolet photoelectron spectroscopy,	**20%**	**12**
Unit 2:.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,fluorescence – instrumentation and chemical analysis, X-ray diffraction, chemical analysis with X-ray diffraction, numerical problems.	**20%**	**12**
Unit 3: An introduction to microscopy: Limitation of the human eye, the X-ray microscope, the transmission electron microscope, the scanning electron microscope, scanning transmission electron	**20%**	**12**

microscope, analytical electron microscopy, scanning probe microscopes, the transmission electron microscope.		
Unit 4: Chemiluminescences: Introduction, principle, types, measurement of chemiluminescence, instrumentation quantitative chemiluminescences, gas phase chemiluminescence's analysis, Chemiluminescences titrations, electro- chemiluminescence.	**20%**	**12**
Unit 5: Fluorescence and phosphorescence: Introduction, Fluorescence, photo luminescent theory, electron transitions during photoluminescence, factors affecting photoluminescence, luminescent apparatus, optical extractive sources, wavelength selectors, detectors and readout devices, photo luminescent spectra, photo luminescent analysis, analysis of non-photoluminating compounds, determinations of mixtures, specific examples of analysis using photoluminescence, problems.	**20%**	**12**

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: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ , Assignment

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to: CO1:Able to know about several molecular spectroscopic techniques. CO2:Will gain knowledge on X- ray methods CO3:Will have a clear vision on electron spectroscopy. CO4: Able to get the concept of microscopy CO5:Will gain an idea on sophisticated analytical 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.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**	**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	Discuss subject importance (Max 100 words) Local, national, and international relevance should be highlighted
Course Revision/ Approval Date:	14/3/2020
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: 1: **Gain** knowledge on analysis of fertilisers, paints, soaps, detergents. 2: **Develop** knowledge in Water pollution and analysis of polluted water. 3: To **gain knowledge** on fertiliser analysis. 4: To **understand** the concept of pigments. 5: 5 To **learn** about inorganic additives used in the pigment industry.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Analysis of Fertilizers: Sampling and sample preparation, water, total nitrogen: Kjeldahl method, total nitrogen by reduced iron method, urea nitrogen, total Kjeldahll nitrogen methods and spectrophotometric method, Ammonia nitrogen. Phosphorus:	**20%**	**12**

total phosphorus, available and non-available, alkali metric ammonium molybdophosphate method, water soluble phosphorous, citrate insoluble phosphate, Potassium: potassium by sodium tetra phenyl borate method, flame photometric methods.		
Unit 2: Analysis of soaps and detergents: General scheme of analysis, sampling, alcohol soluble material, moisture and volatile matter, active ingredient and equivalent combined SO 3- , Tests for soaps: total fatty acids, 3 fatty anhydride combined alkali, and anhydrous soap, Unsponified and unsaponifiable matter, free alkali or free acid, titer test, Iodine value, saponification value, free glycerol, tests for synthetic detergents: Unsulfonated or unsulfated matter ester SO3, Combined alchohols, total combined SO3, alkalinity, chorides, silicate, phosphate, borates, UV Spectroscopic analysis of detergents: Biodegradability of detergents, determination of sodium alkyl benzene sulfonate, determination of sodium toluene sulfonate, determination of sodium xylene sulfonate, determinatiion of germicides in soaps and detergents.	**20%**	**12**
Unit 3: Water pollution and analysis of polluted water: Water pollutants, waste water treatment: domestic wastewater treatment, aerobic treatment process, anaerobic treatment process, industial waste water treatment.	**20%**	**12**
Unit 4: The purpose of chemical analysis,sampling of water, pH of water, specific conductance, determination of acidity and alkalinity, chemical oxygen demand, biological oxygen demand, dissolved oxygen, turbidity, determination of aluminium, arsenic, boron, cadmium, calcium, carbon dioxide, chloride, residual chlorine, chlorine demand, chromium, chromium, cyanide, total hardness, iron, lead manganese, Zn, methane, nitrate, nitrite, ammonia nitrogen, phenols, phosphates, silica, sulphate, sulphide anionic detergents, tannin and lignin.	**20%**	**12**
Unit 5: Analysis of paints and pigments: Introduction, test on the total coating, water content, separation of pigment binder and thinner of solvent type coating, separation of pigment binder and thinner of latex paints, Identification of the binder, indentification of polymer resins and oils, identification of plasticiser, analysis of the vehicle, identification and analysis of pigments, indentification of inorganic pigments, analysis of white and tinted pigment, outline of general procedure, HCL insoluble, titanium dioxide, total lead, acid soluble Al and Fe, acid soluble calcium, total zinc, antimony oxide, total sulphate, total carbonate) analysis of colored pigments, black pigments, other pigments, identification and analysis of thinners.	**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: (Max. 100 words)

PPT, Video,ChalkBoard, QUIZ, Discussion(D),Student seminars, Case study

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: CO1: Know about the techniques of analysis of fertilizers. CO2: Gain knowledge on soaps and detergent chemistry. CO3: .Have a clear vision on water pollution. CO4: .Get the concept of pigments.	Remember and understand Analysis & Apply Remember and understand Remember and understand	Define, Describe Define, Describe,Apply Define, Describe,Apply Define Define , Describe

CO5: Gain an idea on sophisticated analytical techniques.		

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

COURSE CODE	COURSE NAME	SEMESTER
MSCM405	Communication Skills IV	IV

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

Course Prerequisites	Basic Knowledge of English Grammar & communication Basic English Grammar & Intermediate communication skills
Course Category	Mandatory Course
Course focus	Communicational Skills
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: Communication Skills Shannon & Weaver Model of Communication, Helical Model of Communication, Audience focused Communication, Barriers and Challenges	**25%**	7
Unit 2: Corporate Communication Definitions, Strategies of Corporate Communication, Role of Corporate Communication, Benefits of	**25%**	8

Corporate Communication, Scope of Corporate Communication		
Unit 3: Official Correspondence What is Official Correspondence, Memo, Notice and Circulars, Agenda of the meeting and Minutes of the meeting	**25%**	7
Unit 4: Social Networking What is Social Networking, types of Social networking, Advantages of Social Networking, Opportunities of Social Networking, Managing Social Networking	**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. Murphy, Raymond "Murphy's English Grammar with CD" Cambridge University Press, 2004. 2. Thorpe, Edgar and Showick Thorpe "Basic Vocabulary" Pearson Education India, 2012. 3. Green, David. "Contemporary English Grammar Structures and Composition" MacMillan Publishers, New Delhi, 2010. 4. Wren &Martin (2001), English Grammar & Composition, New York
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

COURSE CURRICULUM

M.Sc. Organic Chemistry

Batch:2022-2023
Academic Year: 2023-24
Updated on: July, 2023

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	Understan dEvaluate 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	Understan d 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	MSCM101	Analytical Chemistry – I	I	3	4	0	7	3	2	0	5
2	MSCM102	Organic Chemistry - I	I	3	4	0	7	3	2	0	5
3	MSCM103	Physical Chemistry - I	I	3	4	0	7	3	2	0	5
4	MSCM104	Inorganic Chemistry -I	I	3	4	0	7	3	2	0	5
5	MSCM201	Analytical Chemistry – II	II	3	4	0	7	3	2	0	5
6	MSCM202	Organic Chemistry - II	II	3	4	0	7	3	2	0	5
7	MSCM203	Physical Chemistry - II	II	3	4	0	7	3	2	0	5
8	MSCM204	Inorganic Chemistry -II	II	3	4	0	7	3	2	0	5
9	MSCM311	Organic Chemistry – III	III	4	4	0	8	4	2	0	6
10	MSCM312	Organic Chemistry – IV	III	4	4	0	8	4	2	0	6
11	MSCM313	Organic Chemistry – V	III	4	4	0	8	4	2	0	6
12	MSCM411	Organic Chemistry – VI	IV	4	4	0	8	4	2	0	6
13	MSCM412	Organic Chemistry – VII	IV	4	4	0	8	4	2	0	6
14	MSCM413	Organic 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
	B. Core Course															
4.	MSCM111	Analytical Chemistry – I	4	4	0	8	4	2	0	6	20	40	40	100	50	150
5.	MSCM112	Organic Chemistry – I	4	4	0	8	4	2	0	6	20	40	40	100	50	150
6.	MSCM113	Physical Chemistry – I	4	4	0	8	4	2	0	6	20	40	40	100	50	150
7.	MSCM114	Inorganic Chemistry – I	4	4	0	8	4	2	0	6	20	40	40	100	50	150
		Total	**17**	**18**	**03**	**38**	**17**	**10**	**03**	**30**						**750**

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

COURSE CODE MSCM 111	COURSE NAME Analytical Chemistry-I	SEMESTER I

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	Professional core course
Course focus	Skill Development
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of analytical chemistry topics which introduce basic knowledge of analytical chemistry to the students. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	10/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the basic analytical methods and have a sound knowledge of chemistry involved in an analysis. 2: **Understand** the concept of analytical techniques 3. Able to **apply** knowledge on perform data handling 4: **Understanding** on spectroscopic technique 5: **Able to perform** analytical characterization of unknown sample

Course Content (Theory)	Weightage	Contact hours
Unit 1: Language of Analytical Chemistry: Analytical perspective, Common analytical problems, terms involved in analytical chemistry (analysis, determination, measurement, techniques, methods, procedure and protocol). Data Handling Spreadsheet in Analytical Chemistry: Accuracy and Precision, determinate error, Independent errors, Significant numbers, expressing accuracy, standard deviations, propagation of errors, confidence limits. Rejection of results and problems. Standardization and Calibration: Analytical samples and methods of sampling, sample handling, gross sample, preparation of laboratory samples, automated sample handling comparison with standards numerical problems.	**20%**	**12**
Unit 2: Calculations based on chemical principles: The following topics are to be covered in the form of numerical problems only: concentration of a solution based on volume and mass units, calculations of ppm, ppb and dilution of the solutions, concepts of mol, stoichiometry of chemical reactions, concepts of kg mol, limiting reactant, theoretical and practical yield, solubility and	**20%**	**12**

solubility equilibria, effect of presence of common ion, calculations of pH of acids, bases acidic and basic buffers, concept of formation constants, stability and instability constants, stepwise formation constants, oxidation number, rules for assigning oxidation number, redox reaction in term of oxidation number, oxidizing, and reducing agents, equivalent weight of oxidizing and reducing agents, stoichiometry of redox titration (Normality of a solution of a oxidizing /reducing agent and its relationship with molarity).		
Unit 3: Spectroscopic Methods: Recapitulation of basic concepts, electromagnetic spectrum, sources, detectors. Sample containers, laser as source of radiation, fiber 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%**	**12**
Unit 4: 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%**	**12**
Unit 5: Thermal methods: 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.	**20%**	**12**

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 sample by Winkler's method.	**12.5%**	4
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: (Max. 100 words) 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: **knowledge** for the processes of data handling CO2: **Knowledge** of spectroscopy techniques. CO3: **Understanding** of data analysis in depth. CO4: **Knowledge** of symmetry of different kinds of errors. CO5:**Perform** Practical analytical characterization	Cognitive	Remember & Understand Remember & Analyse Undestand Analyse 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
2.	Journals & Periodicals: Analyst, Journal of Analytical Chemistry.
3.	Other Electronic Resources: Unacademy, NPTEL etc

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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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of organic chemistry topics like basics of organic chemistry, stereochemistry and reaction mechanism. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: To **understand** The concepts of stereochemistry 2: To **understand** the reaction mechanism and its evaluation. 3: Able to **analyze** stereochemistry of molecules. 4: **Knowledge** of organic synthesis and characterization . 5: **Understand** the concept of aromaticity

Course Content (Theory)	Weightage	Contact hours
Unit 1: Structure and reactivity: Chemical bonding and basis of reactivity- Chemical bond, delocalization, conjugation, resonance, hyperconjugation, tautomerism, inductive effects, MOT and VBT approach. Bonding other than covalent bonding: Ionic, hydrogen bond, inclusion compounds, rotaxanes, catenanes, cyclodextrins, cryptands, fullerenes, crown ethers. Acidity and basicity: various structural effects, hard and soft acid and base concept.	**20%**	**12**
Unit 2: Aromaticity: Benzenoid and nonbenzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, and Current concepts of aromaticity. Structure and stability of reactive intermediates, carbenes, nitrenes, carbocations, carbanions and free radicals.	**20%**	**12**
Unit 3: Stereochemistry: Stereochemical principles, enantiomeric relationship, diastereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds,	**20%**	**12**

Prochiral relationship, stereospecific and stereoselective reactions, optical activity in biphenyls, spiranes, allenes and helical structures. Conformational analysis of cyclic and acyclic compounds.		
Unit 4: Organic reactions-Substitution reaction, Aliphatic nucleophilic substitution. SN1, SN2, SET and SNV mechanism, NGP by pi and sigma bonds, classical and nonclassical carbocations, phenonium ions, norbornyl system, carbocation rearrangement in NGP, SNi mechanism, nucleophilic substitution in allylic,Trigonal and vinylic carbon, effect of structure, nucleophile, leaving group, solvent on rate of SN1 and SN2 reactions, ambident nucleophile and regioselectivity. Aromatic Electrophilic substitution. Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, 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.	**20%**	**12**
Unit 5: Aromatic nucleophilic substitution- SNAr, SN1, Benzyne and SNR1 reactions, reactivity: effect of substrate structure, leaving group and attacking nucleophile. Addition reactions - Addition to C-C multiple bonds - mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radicals, Regio and chemo selectivity, orientation and reactivity, conjugate addition. Elimination reactions - E1, E2, E1cb mechanisms, orientation and stereochemistry in elimination reaction, reactivity effect of structure, attacking and leaving group, competition between elimination and substitution, syn eliminations.	**20%**	**12**

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: (Max. 100 words)
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: To **understand** The concepts of stereochemistry CO2: To **understand** reaction mechanism and its evaluation. CO3: **Knowledge** on symmetry of molecules. CO4: **Knowledge** of organic synthesis and characterization CO5: **Understand** the concept of aromaticity.	Cognitive	Understand Remember Understand Apply Apply

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.

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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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	**Practical**	**Tutorial**	**Total Hours**	**Lecture**	**Practical**	**Tutorial**	**Total Credit**
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of Physical chemistry topics which introduce basic knowledge of physical chemistry to the students. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1. **Understand** the importance of various fundamental concepts of physical chemistry 2. **Knowledge of various** industrial applications of phenomena like catalysis and electrochemistry.. 3. Develop **understanding** of limitations of classical thermodynamics. 4. Able to **understand** gas theory and equations 5. Will have **knowledge** of Maxwell distribution.

Course Content (Theory)	Weightage	Contact hours
Unit 1: The Gaseous state & The Kinetic Molecular Theory The gaseous state, General characteristics of gases, The gas laws: Boyle's law, Charles' law, Gay Lussac's law, Avogadro's law, The Idealgas equation, Dalton's Topics –Law of Partial Pressures, Graham's law of Diffusion, Assumptions of the Kinetic Molecular Theory of Gases, Statement of Kinetic Gas Equation and the significance of the terms involved in it, Kinetic Gas Equation in terms of Kinetic Energy, Deduction of Gas Laws (Boyle's law, Charles' law, Avogadro's law & Graham's law of diffusion) as well as Ideal gas equation and Dalton's law of Partial Pressures from the Kinetic Gas Equation	**20%**	**12**
Unit 2: Statement of the Maxwell Distribution Law of Molecular Velocities and its explanation, Different types of molecule velocities and their expressions, Collision Properties (Parameters), Transport phenomena viz. viscosity, thermal	**20%**	**12**

conductivity and diffusion in gases, Derivation of the different relationships between the mean free path and the coefficients of viscosity, thermal conductivity and the diffusion, Influence of temperature and pressure on coefficients of viscosity, thermal conductivity and diffusion, Degrees of Freedom (rotational and vibrational) and their calculations, Principle of Equipartition of Energy, Numericals.		
Unit 3: Electromotive Force (EMF) of Galvanic Cells Introduction, Galvanic Cells, Reversible cells, Reversible electrodes, Single electrode potential, Electrical energy in a galvanic cell, Electrical energy and Free energy change of cell reaction, Relation between Electrical energy and Enthalpy of a cell reaction, Determination of ΔHo , ΔGo and ΔSo of a cell reaction, EMF and Equilibrium constant of a cell reaction, Standard EMF and Equilibrium constant, The Nernst equation, ElectrodeConcentration Cells, ElectrolyteConcentration Cells, Concentration cells with and without transference, Liquid Junction Potential, Hydrogen electrode, Calomel electrode, Silver- Silver electrode, Glass electrode, Quinhydrone electrode, Applications of EMF measurements, Potentiometric titrations, Acid-Base, Redox and Precipitation titrations, Numericals	**20%**	**12**
Unit 4: Polarography Principle, apparatus and electrodes systems, components of limiting current, residual current, migration current, diffusion current, catalytic current, convention current, adsorption current and kinetic current. Polarographic maxima, halfwave potential, derivation of relationship between half wave potential and diffusion coefficients, fractions governing diffusion current, Calibration curve method, standard addition method, effect of pH on polarography and applications	**20%**	**12**
Unit 5: Theory Amperometry Principle, apparatus and electrode system. Four different types of amperometric titrations, advantages and disadvantages of amperometry. Applications of amperometry. pH-metry Introduction, construction and working of different electrodes, Ion selective electrodes, Applications of pH measurements, acid-base titrations, polybasic acid base titrations, determination of dissociation constant of weak acids and weak bases, determination of hydrolysis constant and degree of hydrolysis	**20%**	**12**

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: (Max. 100 words)
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 concept of name reactions CO2. **Knowledge** on gas theory and its application. CO3. To **understand** thermodynamic parameters. CO4. Gain **knowledge** on symmetry of molecule CO5. Practical physical properties identification **knowledge**.	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
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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	SEMESTER I

Teaching Scheme (Hours)				Teaching Credit			
Lecture	Practical	Tutorial	Total Hours	Lecture	Practical	Tutorial	Total Credit
60	60	00	120	4	2	0	6

Course Pre-requisites	Basic B.Sc. Level Inorganic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of Inorganic chemistry topics which introduce basic knowledge of inorganic chemistry related topics to the students. The prime focus is given to lab practicals through action-based-learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1. **Understand** the concepts of bond formation in a molecule. 2. Acquire **knowledge** in metal complexes. 3. **Understand** the importance of metal complexes in nature 4. Able **to prepare** inorganic synthesis in lab. 5. **Knowledge** on structure of inorganic complexes.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Coordination Chemistry: Concept and scope of ligand fields, free ion configuration, terms and states, energy levels of transition metal ions, free ion terms, term wave functions, spin-orbit coupling. Ligand Field Theory of Coordination complexes, effect of ligand field on energy levels of transition metal ions	**20%**	**12**
Unit 2: weak cubic ligand field effect on Russill Saunders terms, strong field effect, correlation diagrams, TanabeSugano Diagrams, Spin-Pairing energies. Electronic spectra of Transition Metal Complexes. Introduction, band intensities, band energies, band with and shapes, spectra of 1st, 2nd and 3rd row ions and rare earth ion complexes, spectrochemical and nephlauxeetic series, charge transfer and luminescence, spectra, calculations of Dq, B, β parameters.	**20%**	**12**
Unit 3: Magnetic Properties of Coordination Complexes:	**20%**	**12**

Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexe sparamagnetism 1st and 2nd ordered Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A, E and T ground terms in complexes, spin free spin paired equilibria.		
Unit 4: : Inorganic Reaction Mechanism: rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods) Ligand substitution reactions of a) Octahedral complexes without breaking of metal ligand bond (use of isotopic labelling method), b) square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. Redox reaction: inner and outer sphere mechanisms, complementary and non-complementary reactions. Stereochemistry of substitution reactions of octahedral complexes. (Isomerization and racemisation reaction and applications)	**20%**	**12**
Unit 5: Organometallic Chemistry of Transition metals: Eighteen and sixteen electron rule and electron counting with examples. Preparation and properties of the following compounds: alkyl and aryl derivatives of Pd and Pt compounds, carbenes ancarbines of Cr, Mo and W, alkene derivatives of Pd and Pt, alkyne. derivatives of Pd and Pt, allyl derivatives of nickel, sandwich compounds of Fe, Cr and Half sandwich compounds of Cr, Mo. Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise's salt, bis(triphenylphosphine)diphenylacetylene platinum, diallyl nickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl(n2-butadiene)iron(0).	**20%**	**12**

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: (Max. 100 words)

PUtilizing 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: 1. **Understand** coordination chemistry 2. Gain **knowledge** on structure of metal complexes 3. To **understand** inorganic characterization and its application. 4. **Knowledg**e on symmetry of molecules. 5. **Apply** Practical based knowledge on inorganic synthesis and characterization knowledge.	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
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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	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

Teaching Scheme
Semester – II 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.	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	4	4	0	8	4	2	0	6	20	40	40	100	50	150
5.	MSCM212	Organic Chemistry – II	4	4	0	8	4	2	0	6	20	40	40	100	50	150
6.	MSCM213	Physical Chemistry – II	4	4	0	8	4	2	0	6	20	40	40	100	50	150
7.	MSCM214	Inorganic Chemistry – II	4	4	0	8	4	2	0	6	20	40	40	100	50	150
		Total	**17**	**18**	**03**	**38**	**17**	**10**	**03**	**30**						**750**

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	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	This course has played a critical role in the understanding of basic science to a variety of practical applications,such as biomedical applications,environmental monitoring,quality control of industrial manufacturing,forensic science and so on.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the basics of electroanalytical and chromatographic techniques. 2: Acquire **competency** to predict the patterns in thermal methods of analysis. 3: **Study** of mass spectroscopy for chemical identification. 4: **Understand** the electroanalytical methods. 5: **Application** of HPLC.

Course Content (Theory)	Weightage	Contact hours
Unit1: Chromatography: recapitulation of basic concepts in chromatography, classification of chromatographic methods, requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively, qualitative and quantitative analysis. Concept of plate and rate theories in chromatography: efficiency, resolution, selectivity and separation capability	**20%**	12 (TH) + 12 (PR)
Unit 2: Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions. Gas Chromatography: Instrumentation of GC with special reference to sample injection systems – split/splitless, column types, solid / liquid stationary phases, column switching techniques, temperature programming, thermionic and mass spectrometric detector, Applications.	**20%**	12 (TH) + 12 (PR)
Unit 3: 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.	**20%**	12 (TH) + 12 (PR)

Chiral and ion chromatography.		
Unit 4: 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.	**20%**	12 (TH) + 12 (PR)
Unit 5: Electro analytical methods- 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%**	12 (TH) + 12 (PR)

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 given mixture and also to calculate the R f values of unknown compounds	10%	4
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: CO1: **Understand** the basics of electroanalytical and chromatographic techniques. CO 2: **Acquire** competency to predict the patterns in thermal methods of analysis. CO 3: **Knowledge** of mass spectroscopy for chemical identification. CO 4: **Understand** the electroanalytical methods. CO 5: **Application** of HPLC.	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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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	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 Organic Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of organic chemistry topics like oxidation- reduction reactions, rearrangements and spectroscopy techniques. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the importance of pericyclic reactions.. 2: **Understand** the concept of different reaction mechanisms. 3: Gain **knowledge** on spectroscopy. 4: **Understand** the concepts of NMR. 5: **Understand** the NMR Spectroscopy.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Reactive Intermediates Preparation, structure, and stability of reactive intermediates Carbocation, carboanion, carbene, nitrine, benzyne, ylide. Reactions involving reactive intermediates: Rearrangement of carbocations, SN1, E1, ArSE,. Shapiro reaction, Reimer–Tiemann reaction, wolf rearrangement, insertion of carbene in pi and sigma bond, Simmon smith carbene (preparation and reaction), Tschitschibabin reaction.	**20%**	12 (TH) + 12 (PR)
Unit 2: Synthetic Organic Chemistry Oxidation reactions: CrO3, PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb (OAc)4, Pd-C, OsO4, mCPBA, O3, NaIO4, HIO4. Rearrangements: Beckmann, Hofmann, Curtius, Smith, Wolff, Lossen, Bayer-villiger, Sommelet, Favorskii, Pinacol-pinacolone, Benzil- benzilic acid, Calsien, Cope Fries rearrangement.	**20%**	12 (TH) + 12 (PR)
Unit 3: Reduction reactions: Boranes and hydroboration reactions, R3SiH, Bu3SnH, MPV, H2/Pd-C, Willkinsons, NaCNBH3, NH2NH2, DIBAL. Addition to carbon-heteroatom multiple bonds: Grignard, organo zinc, organo copper, organo lithium, reagents to carbonyl and unsaturated carbonyl compounds.	**20%**	12 (TH) + 12 (PR)

Unit 4: UV and IR Spectroscopy Theory and applications of UV and IR spectroscopy. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (Using Woodward-Fieser tables for values for substituents) Types and calculation of vibrational modes. Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.	**20%**	12 (TH) + 12 (PR)
Unit 5: NMR spectroscopy- Proton magnetic resonance spectroscopy: Principle, Chemical shift, Factors affecting chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin- spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal and long range coupling (allylic and aromatic). First order spectra, Karplus equation. 13C NMR spectroscopy: Theory and comparison with proton NMR, proton coupled and decoupled spectra, off resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons.	**20%**	12 (TH) + 12 (PR)

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: CO1: **Understand** the concept of reactive intermediates. CO2: **Understand** oxidation and reduction reactions. CO3:**Understand** organic reaction mechanism and rearrangement. CO4:**Apply** practical knowledge of UV and IR spectroscopy. CO5: **Apply** practical knowledge of NMR Spectroscopy.	Cognitive	Understand Understand Understand Apply Apply

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.

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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	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 Physical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	This course is designed based on requirements and helps with getting the most exposure regarding the field of physical chemistry related topics like Thermodynamics, properties of solutions, partial molar properties, free energy and fugacity. The prime focus is given to lab practicals through action-based-learning.
Course Revision/ Approval Date:	11/04/2021
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: **Understand** the concept of Statistical Thermodynamics. 2: **Understand i**deal solutions and solution properties. 3: **Understand** the concept of fugacity.. 4: **Knowledge** of chemical equilibrium and free energy.. 5: **Understand** Justification of molar partial quantities.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Statistical Thermodynamics Introduction, Aspects of statistics, Definition of microscopic states, Statistical weight, Macroscopic states, Most probable distribution system, Assembly, Assembly of localized and non-localized systems, Ensemble, Micro-canonical ensemble, Macro canonical ensemble and grand canonical ensemble, Boltzmann and Planck equation, Partition function and its significance, Values of Translational, Rotational, Vibrational and Electronic partition functions, 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%**	12
Unit 2: The Properties of Solutions Ideal solutions & its properties, The Duhem-Margules equation, Application of Raoult's law to both constituents of an ideal solution, Vapour Pressure curves for an Ideal	**20%**	12

solution, Composition of liquid & vapour in equilibrium, Non-ideal solutions & its vapour pressure curves, Solubility of partially miscible liquids, Dilute solutions, Henry's Law. Solutions of electrolytes: Mean ionic activity, Mean ionic activity coefficient & mean ionic molality of the electrolyte, Listing of the methods determining mean ionic activities, Ionic strength principle, Numericals.		
Unit 3: Fugacity and Activity Fugacity and Activity: Introduction, Definition of fugacity, Methods of determining Fugacity of a gas: Graphical method, Equation of State method, Approximate and Generalized methods, Variation of Fugacity with temperature and pressure, Fugacity of solids and liquids, Mixture of Ideal and Real gases, Determination of Fugacity in gas mixtures, The Lewis-Randall rule, Variation of fugacity of a gas in a mixture with temperature and pressure, Numericals.	**20%**	12
Unit 4: Partial Molar Properties Introduction, Fundamental equations, Thermodynamic significance, Apparent molar property, Relation between Apparent molar property & Partial molar property in the case of an infinitely dilute solution, Methods of determining Partial molar properties: Direct method, Intercept method & Use of apparent molar property method, Partial molar volumes from density measurements, Determination of apparent molar volume of solute, Numericals.	**20%**	12
Unit 5: Free Energy and Chemical Reactions Chemical Equilibrium, The equilibrium constant, Equilibrium in homogeneous gaseous systems, The ammonia equilibrium, Homogeneous reactions in liquid solutions as well as in dilute solutions, The reaction isotherm, Standard free energy of reaction, The direction of chemical change, Variation of equilibrium constant with pressure and temperature, Integration of the Van't Hoff equation, Variation of standard free energy with temperature, Determination of standard free energies, Numericals.	**20%**	12

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 potasium 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: **Understand** the concept of Statistical Thermodynamics. CO2: **Evaluation** of solution property. CO3: **Understand** the concept of fugacity.. CO4: **Knowledge** of chemical equilibrium and free energy.. CO5: **Understand** physical properties of the systems. all properties of the systems.	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.

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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	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 is designed based on requirements and helps with getting the most exposure regarding the field of inorganic chemistry topics like symmetry, group theory and organometallic chemistry. The prime focus is given to lab practicals through action-based- learning.
Course Revision/ Approval Date:	14/3/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1: To **Understand** the importance of quantum chemistry in developing the model of the atom. 2: **Understand** the origin of Schrodinger wave equation and its application. 3: **Calculations** of the energy and wave functions of various atomic and molecular systems. 4: **Understand** the concepts of metal complexes and its behavior. 5: **Justification** group chemistry.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Definitions and Theorems of Group Theory - I Theory: Molecular Symmetry and Symmetry Groups, Symmetry elements and operations, symmetry planes and reflections, the inversion center, proper axes and proper rotations, improper axes and improper rotations, products of symmetry operations, equivalent symmetry elements and equivalent atoms.	**20%**	**09**
Unit 2: Definitions and Theorems of Group Theory - II Theory: 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: Representation of Groups Theory: Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part) Group theory and quantum mechanics: Wave	**20%**	**09**

function as basis for irreducible representations. Symmetry adapted linear combinations: Projection operators and their use of construct SALC (Construction of SALC for sigma bonding for molecules belonging point groups: D2h, D3h, D4h, C4v, Td, Oh, normalization of SALC.		
Unit 4: Hydrogen and its compounds Theory: Hydrides Boron group, Bornaes, Carboraners and Metalloboranes, Classification, electron deficient, electron precise and electron rich hydrides. Alkali and alkaline earth metals: solutions in non-aqueous Media., solvent based theories	**20%**	**09**
Unit 5: Organometallic Chemistry: Organometallic chemistry of compounds of Si, Sn, Pb, Ga, As, Sb, Bi, Structure, synthesis, reactions. Organometallic Compounds of Li, Mg, Be, Ca, Na: Classification, synthesis properties uses and structures.	**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: To **Understand** the importance of quantum chemistry in developing the model of the atom. CO2: **Understand** the origin of Schrodinger wave equation and its application. CO3: **Calculations** of the energy and wave functions of various atomic and molecular systems. CO4: **Understand** the concepts of metal complexes and its behavior. CO5: **applications** of group theory.	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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<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>
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<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>Practical understanding of the subject on the Project/Industrial.</td><td>30 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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</table>

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. Organic 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. Ability Enhancement Compulsory Course															
1.	MSCM307	Communication Skills – IV	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM308	Comprehensive Viva-III	1	1	0	2	1	1	0	2	0	0	0	0	0	50
3.	MSCM304/305	Computer application in Chemistry/Research Methodology	3	0	1	4	3	0	1	4	20	40	40	100	0	100
4.	MSCM306	Internship-III	0	1	1	2	0	1	1	2	0	0	0	0	0	50
5.	MSM309	Dissertation	0	1	1	2	0	1	1	2	0	0	0	0	0	50
	B. Core Course															
6.	MSCM311	Organic Chemistry – III	4	2	0	6	4	2	0	6	20	40	40	100	50	150
7.	MSCM312	Organic Chemistry – IV	4	2	0	6	4	2	0	6	20	40	40	100	50	150
8.	MSCM313	Organic Chemistry – V	4	2	0	6	4	2	0	6	20	40	40	100	50	150
		Total	**17**	**09**	**04**	**30**	**17**	**9**	**4**	**22**						**750**

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

COURSE CODE MSCM311	**COURSE NAME** Organic Chemistry –III	**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 Organic Chemistry Concept
Course Category	Core Professional
Course focus	Employability/ Entrepreneurship/ Skill development
Rationale	Learn the fundamentals of Organic reaction and their mechanism. Importance of Radicals in organic synthesis. knowledge and application of stereochemistry and photochemistry.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 Learn the **fundamentals** of Organic reaction mechanism. 2 **Know** the **application** of stereochemistry and photochemistry. 3 Will have idea radical in organic chemistry 4 Deep **knowledge** on stereochemistry 5 Learn inside of photochemistry

Course Content (Theory)	**Weightage**	**Contact hours**
Unit 1: Theory: Organic Reaction Mechanism- Alkylation of Nucleophilic Carbon Intermediates: Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. Alkylation of aldehydes, ketones, esters, amides and nitriles. Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines.	**20%**	**12**
Unit 2: Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. Alkylation of carbon nucleophiles by conjugate addition (Michael reaction). Reaction of carbon nucleophiles with carbonyl groups: Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation. Addition reactions with amines and iminium ions; Mannich reaction. Amine catalyzed condensation reaction: Knoevenagel reaction. Acylation of	**20%**	**12**

carbanions.		
Unit 3: Radicals in organic synthesis - Introduction: Generation, stability, reactivity and structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radicals. Radical Initiators: azobisisobutyronitrile (AIBN) and dibenzoyl peroxide. Characteristic reactions - Free radical substitution, addition to multiple bonds. Radical chain reactions, Radical halogenation of hydrocarbons (Regioselectivity), radical cyclizations, autoxidations: synthesis of cumene hydroperoxide from cumene. Radicalsin synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors. Cleavage of C-X, C- Sn, C-Co, C-S, O-O bonds. Oxidative coupling, C-C bond formation in aromatics: SRNAr reactions. Hunsdiecker reaction, Pinacol coupling, McMurry coupling, Sandmeyerreaction, Acyloin condensation.	**20%**	**12**
Unit 4: Stereochemistry-I - Classification of point groups based on symmetry elements with examples (nonmathematical treatment). Conformational analysis of medium rings: Eight to ten membered rings and their unusual properties, I-strain, transannularreactions. Stereochemistry of fused ring and bridged ring compounds: decalins, hydrindanes, perhydroanthracenes, steroids, and Bredt's rule. Anancomeric systems, Effect of conformation on reactivity of cyclohexane derivatives in the following reactions (including mechanism): electrophilic addition, elimination, molecular rearrangements, reduction of cyclohexanones (with LiAlH4, selectride and MPV reduction) and oxidation of cyclohexanols.	**20%**	**12**
Unit 5: Photochemistry - Principles of photochemistry: quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process. Photochemistry of Discussion carbonyl compounds:π→ ́ π*, n→́ π* transitions, Norrish- I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction. Photochemistry of olefins: cis-trans isomerizations, dimerizations, hydrogen abstraction, addition and Di- π- methane rearrangement including aza-di- π - methane. Photochemical Cross- Coupling of Alkenes, Photodimerisation of alkenes. Photochemistry of arenes: 1, 2- , 1, 3- and 1, 4- additions. Photocycloadditions of aromatic Rings. Singlet oxygen and photo-oxygenation reactions. Photochemically induced Radical Reactions. Chemiluminescence.	**20%**	**12**

List of Practical	Weightage	Contact hours
1:Separation and identification of organic mixtures containing up to three components.(One component should water soluble)	25%	4
2:Preparation of organic compounds involving several stages, characterization of intermediates and final products	25%	4
3:Techniques of organic chemistry: Special practical's involving distillation, and thin layer and column chromatography etc.	25%	4
4: Any other experiment can be carried out in class/ Laboratory.	25%	4

Instructional Method and Pedagogy: (Max. 100 words)
Powerpoint presentation, video, case study, demonstration, QUIZ , Chalk Board and Discussion.

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: CO1: 1.**Understanding** on photochemistry CO2: 2.**Knowledge** on stereochemistry CO3: 3.Deep **understanding** on radical mechanism CO4: 4.**Knowledge** on symmetry of molecule CO5: 5.Practical organic synthesis and characterization **knowledge**	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.March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, JohnWiley and sons. 2.Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002). Textbook: 1.Organic Chemistry –by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 1.
2.	Journals: JACS, JOC etc. Periodicals: Chemistry Today
3.	Other Electronic Resources: Unacademy NPTEL etc.

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<tr><td>Attendance</td><td>05 marks</td></tr>
<tr><td>Practical Exam</td><td>20 marks</td></tr>
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<tr><td>Journal</td><td>10 marks</td></tr>
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Mapping of PSOs & COs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	0	1	1	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	2	1	1	1	0	1
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	COURSE NAME	SEMESTER
MSCM312	Organic Chemistry –IV	**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 Organic/Analytical Chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	Learn the fundamentals of Organic reaction and their mechanism. Importance of pericyclic reaction in organic synthesis. knowledge and application of metals and non metals in organic synthesis. understanding of enamines.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Understand** the concept of name reactions 2 **Explanation** of pericyclic reaction 3 Roles of metals and non metals in organic synthesis 4 To make the clear **understandin**g enamines 5 Able to **explain** the reaction mechanism of organic synthesis

Course Content (Theory)	Weightage	Contact hours
Unit 1: Name reactions with mechanism and application- Mukaiyama esterification, Mitsonobu reaction, Darzen's Glycidic Ester syntheis, Ritter reaction, Yamaguchi esterification, Peterson olefination. Nazerov cyclization, Multicomponent reactions: Strecker Synthesis, Ugi 4CC, Biginelli synthesis, Hantzsch synthesis, Pictet-Spengler synthesis, click chemistry	**20%**	**12**
Unit 2: Pericyclic reactions- Pericyclic reactions: Classification of pericyclic reactions; thermal and photochemical reactions. Three approaches: Evidence for the concertedness of bond making and breaking Symmetry-Allowed and Symmetry-Forbidden Reactions – The Woodward- Hoffmann Rules-Class by Class The generalised Woodward- Hoffmann Rule Explanations for Woodward-Hoffmann Rules The Aromatic Transition structures [Huckel and Mobius] Frontier Orbitals Correlation Diagrams, FMO and PMO approach Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 butadiene, 1,3,5 hexatriene and allyl system. Cycloaddition reactions: Supra and antra facial additions, 4n and 4n+2 systems, 2+2	**20%**	**12**

additions of ketenes. Diels- Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction, regioselectivity, peri selectivity, torquoselectivity,		
Unit 3: Site selectivity and effect of substituents in Diels-Alder reactions. Other Cycloaddition Reactions- [4+6] Cycloadditions, Ketene Cycloaddition, Allene Cycloadditions, Carbene Cycloaddition, Epoxidation and Related Cycloadditions. Other Pericyclic reactions: Sigmatropic Rearrangements, Electrocyclic Reactions, Alder 'Ene' Reactions. Electrocyclic reactions: Conrotatory and disrotatary motions, 4nπ and (4n+2)π electron and allyl systems. Sigmatropic rearrangements: H-shifts and C- shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxyCope and aza-Cope) and Claisen rearrangements. Formation of Vitamin D from 7-dehydrocholesterol, synthesis of citral using pericyclic reaction, conversion of Endiandric acid E to Endiandric acid A	**20%**	**12**
Unit 4: Metals/ Non-metalsin organic synthesis - Mercury in organic synthesis: Mechanism and regiochemistry of oxymercuration and demercuration of alkenes, mercuration of aromatics, transformation of aryl mercurials to aryl halides. Organomercurials as carbene transfer reagents. Organoboron compounds: Mechanism and regiochemistry of hydroboration of alkenes and alkynes, asymmetric hydroboration using chiral boron reagents, 9-BBN hydroboration, oxazaborolidine (CBS catalyst) and functional group reduction by diborane. Organosilicons: Salient features of silicon governing the reactivity of organosilicons, preparation and important bond-forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. β-silyl cations as intermediates. Iodotrimethylsilane in organic synthesis. Silyl enol ethers: Application: As nucleophiles (Michael reaction, Mukaiyama aldol reaction), in ring contraction reactions. Organotin compounds: Preparation of alkenyl and allyl tin compounds;application in C-C bond formation, in replacement of halogen by H at the same C atom. Selenium in organic synthesis: Preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno acetals as α-C-H activating groups	**20%**	**12**
Unit 5: Enamines and α-C-H functionalization- Enamines: Generation & application in organic synthesis with mechanistic pathways, Stork enamine reaction. Reactivity, comparison between enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from chiral secondary amines. Wittig reaction, Horner-Wadsworth- Emmons Reaction, Barton-Kellogg olefination. α-	**20%**	**12**

C-H functionalization: By nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases(LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens reaction, Julia olefination and its modification, Seyferth–Gilbert homologation,Steven's rearrangement		

Sr. No.	List Of Practical	Weightage	Contact Hrs
1	To prepare TLC plates, and identify unknown compounds in the given mixture and also to calculate the R_f values of unknown compounds.	12.5%	4 hr
2	Synthesis of 1, 4-dihydropyridine derivative via Hantzsch reaction.	12.5%	4 hr
3	Synthesis of 3,4-dihydropyrimidin-2(1H)-ones derivatives via biginelli reaction.	12.5%	4 hr
4	Performing an experiment involving the fluorescence spectroscopy of a Hantzsch product and biginelli product.	12.5%	4 hr
5	Performing an experiment involving the UV VIS spectroscopy of a Hantzsch product and biginelli product.	12.5%	4 hr
6	Preparation of Resacetophenone (**2,4 dihydroxy acetophenone)** and its characterization by IR	12.5%	4 hr
7	Synthesis of 2,4,5 triphenyl imidazole.	12.5%	4 hr
8	Monitering og organic synthesis via TLC	12.5%	4 hr

Instructional Method and Pedagogy: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ , Discussion(D)

Course Objectives:	**Blooms' Taxonomy Domain**	**Blooms' Taxonomy Sub Domain**
After successful completion of the above course, students will be able to: CO1: 1.**Understanding** on role of metal in organic synthesis CO2: 2.**Knowledge** on pericyclic reaction CO3: 3.Deep **understanding** on name reactions CO4: 4.**Knowledge** on reaction mechanism CO5: 5.Practical organic synthesis and characterization **knowledge.**	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.March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, JohnWiley and sons. 2Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002). Textbook: 1.Organic Chemistry –by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 1.
2.	Journals: JACS, JOC, ORG LETT. ETC. Periodicals: Chemistry Today
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	2	1	1	1	1	0
CO2	2	2	2	1	1	0
CO3	3	1	1	2	1	0
CO4	3	1	1	2	1	0
CO5	3	2	1	1	1	2

Mapping of POs & COs

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

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

COURSE CODE MSCM313	**COURSE NAME** Organic Chemistry –V	**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 Organic chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	Learn the fundamentals of heterocyclic molecules reaction and their mechanism. Importance of natural products and extraction. knowledge and application of biomolecules and enzyme chemistry.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Understand** and synthesize the heteromolecules independently at laboratory scale and try to know their importance 2 **Understand** the techniques involved in extraction and methods of determinationof structure of natural products. 3 Gain the **knowledge** of detailed outline of biomolecules 4 **Knowledge** on enzyme chemistry 5 **Understanding** on heterocycles

Course Content (Theory)	**Weightage**	**Contact hours**
Unit 1: Heterocycle-I, Nomenclature of heterocyclic compounds of bicyclic/tricyclic (5-6 Membered) fused heterocycles(up to three hetero atoms). (Common, systematic (Hantzsch-Widman) and replacement nomenclature) Nucleophilic ring opening reactions of oxiranes, aziridines. Structure, reactivity, synthesis and reactions of coumarins, quinoxalines, cinnolines, indole, benzimidazoles, benzoxazoles, benzothiazoles, Purines and acridines.	**20%**	**12**
Unit 2: Natural products-I -Carbohydrates: Introduction to naturally occurring sugars: Deoxysugars, aminosugars, branched sugars. Structure elucidation of lactose and D glucosamine (synthesis not expected). Structural features and applications of inositol,starch, cellulose, chitin and heparin. Natural pigments: General structural features, occurrence, biological importance and applications of: carotenoids, anthocyanins, quinones, flavones, pterins and porphyrins (chlorophyll).	**20%**	**12**

Unit 3: Insect pheromones: General structural features and importance. Types of pheromones (aggregation, alarm, releaser, primer, territorial, trail, sex pheromones etc.), advantage of pheromones over conventional pesticides. Synthesis of bombykol from acetylene, disparlurefrom 6-methylhept-1-ene, grandisol from 2- methyl-1, 3-butadiene. Alkaloids: Occurrence and physiological importance of morphine and atropine. Structure elucidation, spectral data and synthesis of coniine.	**20%**	**12**
Unit 4: Biomolecules-I, Amino acids, peptides and proteins: Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, α- helix, βsheets, super secondary structure. Tertiary structure of protein: folding and domain structure. Quaternary structure. Nucleic acids: Structure and function of physiologically important nucleotides (c-AMP, ADP, ATP) and nucleic acids (DNA and RNA), replication, genetic code, mutation.	**20%**	**12**
Unit 5: Biomolecules-II, Chemistry of enzymes: Introduction, nomenclature, classes and general types of reactions catalyzed by enzymes. Properties of enzymes: a) enzyme efficiency/ catalytic power b) enzyme specificity; Fischer's 'lock and key' and Koshland 'induced fit' hypothesis.Concept and identification of active site. Factors affecting enzyme kinetics: Substrate concentration, enzyme concentration, temperature, pH, product concentration etc. Reversible and irreversible inhibition. Mechanism of enzyme action.	**20%**	**12**

Instructional Method and Pedagogy: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ, Discussion(D), Assignment, case study

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to: CO1: **Understanding** on heterocycles CO2: **Knowledge** on natural product chemistry CO3: Deep **understanding** on biomolecules CO4: **Knowledge** on enzyme chemistry CO5: Practical organic synthesis and characterization **knowledge.**	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe Define, Describe,Apply Define Define , Apply

Learning Resources	
1.	Reference Books: 1. March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, JohnWiley and sons. 2. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002). Textbook: 1.Organic Chemistry –by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 1.
2.	Journals: JACS, JOC, ORG LETT. ETC. Periodicals: Chemistry Today
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	3	2	1	1	1	1
CO2	3	1	1	1	1	1
CO3	3	2	1	1	1	1
CO4	2	2	1	1	1	0
CO5	3	2	1	1	1	2

Mapping of POs & COs

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

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

COURSE CODE MSCM304	COURSE NAME COMPUTER APPLICATION IN CHEMISTRY	SEMESTER III

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

Course Prerequisites	Fundamental knowledge of computers and chemistry
Course Category	Generic Elective
Course focus	Skill development
Rationale	This course will make students equipped with the fundamental notions of the computers, their parts and their application in the field of chemistry.
Course Revision/ Approval Date:	11/04/2021
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: 1: **Understand** the fundamental notions of computers & computer language. 2: **Understand** the syntax/solution of a program and **Apply** rules/logic and **Construct** computer programs. 3: **Understand** & **Solve** numerical methods using conventional methods and computers. 4: **Understand** & **Solve** Numerical Differentiation and Integration and their applications. 5: **Understand** & **Apply** different curve fitting methods for data presentation and interpretation.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands	20%	12
Unit 2: Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.	20%	12
Unit 3: Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton Raphson method, Binary bisection and Regula-Falsi.	20%	12
Unit 4: Differential calculus: Numerical differentiation. Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values. Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Seidel method.	20%	12
Unit 5: Interpolation, extrapolation and curve fitting: Handling of experimental data. Conceptual background of molecular modeling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.	20%	12

Instructional Method and Pedagogy: (Max. 100 words)

Utilizing chalk-board/powerpoint presentations, films on various topics of the fundamentals of chemistry and computers, group discussions and seminars are some of the methods adopted to improve the student ability to grasp the fundamental notions of the subject.

Course Outcome:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to:		
CO1: **Define** & **Describe** the fundamental notions of computers & computer language.	Understand & Remember	Understand & Remember
CO2: **Construct** the computer program for basic problem **solving.**	Analyze & Create	Solve & Construct
CO3: **Solve** numerical methods using conventional methods and computers.	Analyze	Solve
CO4: **Solve** Numerical Differentiation and Integration and their applications.	Analyze	Solve
CO5: **Apply** different curve fitting methods for data presentation and interpretation.	Apply	Illustrate & Interpret

Learning Resources	
1.	Reference/Text Books: 1. Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science;, 9th Edition, Khanna Publishers, New Delhi, 2007. 2. Spiegel. M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics;, Tata McGraw Hill Edition, 2004. 3. E. Balagurusamy, Programming in ANSI C (8th Ed.), McGraw Hill, 2019.
2.	Other Electronic Resources: 1. Numerical Methods: https://onlinecourses.nptel.ac.in/noc21_ma45/preview 2. Learn Numerical Methods: Algorithms, Pseudocodes & Programs, https://www.codesansar.com/numerical-methods/ 3. Practical Course on Parallel Numerical Methods, https://www.scientific-computing.uni-bayreuth.de/en/Activities/Practical-Course-on-Parallel-Numerical-Methods/index.html 4. https://www.edx.org/learn/c-programming

<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>
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<tr><td>Industry/ University mentor's feedback on the Project/ Industrial.</td><td>10 marks</td></tr>
<tr><td>Attendance</td><td>10 marks</td></tr>
<tr><td>Total</td><td>50 Marks</td></tr>
</table>
</td></tr>
</table>

Mapping of PSOs & COs

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

Mapping of POs & COs

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

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

COURSE CODE MSCM305	COURSE NAME RESEARCH METHODOLOGY	SEMESTER III

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

Course Prerequisites	Basic understanding of Science and Communication.
Course Category	Professional Elective Course
Course focus	Skill development
Rationale	To have an idea how research methodology lies in its ability to provide a systematic approach to investigating and answering research questions. It serves as a roadmap for researchers, helping them design and conduct their studies effectively and ensure the validity and reliability of their findings. Here are a few key points that highlight the rationale behind research methodology
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	1. **Create and analyze** To generate Curiosity about some ideological research work. 2. **Remember and Understand** Gain effective and interactive technical communication skill in science field. 3. **Apply** Knowledge on technical writing skills 4. **Understand** Able to understand about the safety protocols 5. **Remember** Knowledge on history of research work

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory- History of science and science methodologies: Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptivescience; reductionist vs holistic biology. Choosing a mentor, lab and research question; maintaining a lab notebook. Web resources, E-journals, Journal access, TOC alerts, Hotarticles, Citation index, Impact factor, H-index, Econsortium, UGC infonet, E-books, Internetdiscussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.	**20%**	**12**
Unit 2: Theory - Process of communication Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting nonverbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness	**20%**	**12**
Unit 3: Theory - Technical writing skills Types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non- blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct	**20%**	**12**
Unit 4: Theory- Chemical Safety and Ethical Handling of Chemicals: Safe working procedure and protective environment, protective apparel, Emergency procedure and first aid, laboratory ventilation.	**20%**	**12**
Unit 5: Theory- Safe storage and use of hazardous chemicals Procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**20%**	**12**

Instructional Method and Pedagogy:

Audio-Visual Lectures, Quizzes, Debates, Project works, Case studies, and Assignments.

Course Objectives:		Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
CO1	Understanding on research methodology	Remember	Explain, Describe, Discuss, Recall, Locate
CO2	Knowledge on effective communication	Apply	Apply, Practice, Interpret, Select, Correlate
CO3	Deep understanding on technical writing skills	Analyses and Evaluation	Compare, Classify, Select, Investigate
CO4	Knowledge on history of modern discovery	Create	Construct, Develop, Produce
CO5	Practical presentation skill	Understand	Explain, Describe, outline, Predict, Summarize

Learning Resources	
1.	**Reference Books:** 1. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall,London. 2. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3- 5. 3. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis.Cambridge Univ. Press (2001) 487 pages.
2.	**Journals & Periodicals** 1. Journal of the American Chemical Society 2. Chem Comm 3. Chemistry Today
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 Article Review: 10 marks **Total: 40 Marks**

Mapping of PSOs and CO

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

Mapping of POs and CO

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

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

Teaching Scheme
Semester – IV M. Sc. Organic 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. Ability Enhancement Compulsory Course															
1.	MSCM407	Communication Skills – IV	1	0	1	2	1	0	1	2	20	10	20	50	00	50
	B. Skill Enhancement Courses															
2.	MSCM409	Comprehensive Viva-IV	1	1	0	2	1	1	0	2	0	0	0	0	0	50
3.	MSCM404/415/406	Analysis and Characterization of polymers/Analytical Chemistry-IX/Environmental Analytical Chemistry	4	0	0	4	4	0	0	4	20	40	40	100	0	100
4.	MSCM408	Dissertation	0	1	1	2	0	0	0	2	0	0	0	0	0	50
	B. Core Course															
6.	MSCM411	Organic Chemistry – VI	4	4	0	8	4	0	0	4	20	40	40	100	50	100
7.	MSCM412	Organic Chemistry – VII	4	4	0	8	4	0	0	4	20	40	40	100	50	100
8.	MSCM413	Organic Chemistry – VIII	4	4	0	8	4	0	0	4	20	40	40	100	50	100
		Total	**18**	**13**	**04**	**34**	**18**	**01**	**01**	**22**						**550**

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

COURSE CODE MSCM411	COURSE NAME Organic Chemistry –VI	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 Organic chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	Understand the concept of steroids and vitamins and design of organic synthesis. Structure determination of bio organic molecules from NMR. To gain knowledge of the structure and function of antibiotics.Learn other spectroscopic techniques like ESR etc.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Understand** and appreciate the concept of steroids and vitamins 2 **Understand** the design of organic synthesis. 3 To **gain** the structure determination of bio organic molecule from NMR 4 To **understand** the structure and function of antibiotics 5 To **learn** other spectroscopic techniques like ESR etc.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory: Generalstructure, classification, Occurrence, biologicalrole, important stucturaland stereochemal features of the following: corticosteroids, steroidal hormones,steicroidal alkaloids, sterols and bile acids. Synthesis of 16-DPA from cholesterol and plant sapogenin Synthesis of the following from 16- DPA:andosterone,testosterone, oestrone, oestriol,oestradiol and projesterone. Synthesis of cinerolone, jasmolone, allethrolone, exaltone and muscone.	**20%**	**12**
Unit 2: Theory: Classification , sources and boilogical importance of vitamin B1,B2,B6, folic acid, B12,C,D1,E (α-tocopherol) ,K1,K2 ,H (β- biotin), Synthesis of the following :Vitamin B1 including synthesis of pyrimidine and thiazole moities Vitamin B2 from 3,4- dimethyl aniline and D(-) ribose Vitamin B6 from : 1) ethoxyacetylacetone and cyanoacetamide Ethyl ester of N- formyl - DL-alanine (Harn's	**20%**	**12**

synthesis) Vitamin E (α-tocopherol) from trimethylquinol and phytyl bromide Vitamin K1 from 2- methyl-1,4-naphthaquinone and phytol.		
Unit 3: Theory: Classification based on the basis of activity, structure elucidationof penicillin-G and cephalosporin C. Synthesis of penicillin-G and phenoxymethylpenicillin from D - penillamine and t- butyl phthalimide malonaldehyde (synthesis of D-penicillamine and t-butyl phthalimide malonaldehyde expected) Naturally occurring insecticides : Sources, structure and biological properties of pyrethrums (pyrethrin I), rotenoids (rotenone), azadirachtin. Synthesis of pyrethrin I	**20%**	**12**
Unit 4: Theory: Introduction 13C - chemical shifts, calculation of 13C -chemical shifts,proton couples 13C -spectra. Proton decoupled 13C .Off resonance decoupling, DEPT technique heteronuclear coupling of carbon to 19F, 31P.Two - dimensional NMR spectroscopy : Introduction COSY and HETCOR techniques(including interpretation of COSY and HETCOR spectra) NOESY and ROESY techniques Problem : Based on combined use of spectroscopic techniques /advanced techniques. ESR and Fluorescence spectroscopy: Principles and applications. Application of NMR in medicine.	**20%**	**12**
Unit 5: Theory: Protection and de-protection of hydroxyl, amino, carboxyl,ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide, enamines, Umpolung in organic synthesis Retrosynthesis.Principles and applications of aymmetric synthesis: Stereoselectivity in cyclic compounds,enantio- selectivity,diastereo-selectivity. Enantiometric and diastereomeric excess, stereoselective aldol reactions.Cram's rule. Felkin Anh rule. Cram's chelate model. Asymmetric synthesis.use of chiral auxiliaries. Chiral reagents and catalyst,asymmetric hydrogenataion,asymmetric epoxidation and asymmetric dihydroxylation Synthesis of some complex molecules: synthetic routes based on retrosynthetic analysis for following molecules: prostaglandin A2 .atropine and camphor.	**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	11%	4

measuring their Rf values.		
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: (Max. 100 words)
Presentation, Video, Chalk Board, QUIZ

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to: CO1: Able to **know** about biomolecules CO2: .Will gain **knowledge** on vitamins CO3: Will have a clear vision on antobiotics and steroids CO4: Able to **determine** the biomolecule structure from NMR CO5: Will **gain** an idea how design some strategy for chemical synthesis	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe Define Define , Describe

Learning Resources	
1.	Reference Books: 1. Organic Spectroscopy: Principles And Applications, Jag Mohan, Alpha ScienceInternational Ltd., 30-Mar-2004. 2.Natural products chemistry and applications, Sujata V. Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011. Textbook: 1. Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5thEdition, W. H. Freeman and Company, NY., USA. 2.Spectrometric Identification of Organic compounds, R.M. Silverstein and others, John Wiley and Sons Inc., 5th ed., 1991.
2.	Journals: JACS, JOC, ORG LETT. ETC. Periodicals: Chemistry Today
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>
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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>
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<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>
</table>
</td></tr>
</table>

Mapping of PSOs & COs

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

Mapping of POs & COs

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

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

COURSE CODE	COURSE NAME	SEMESTER
MSCM412	Organic Chemistry –VII	**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 Organic chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	Synthesis of drug. understanding of chiral drugs and concept of biogenesis, and the importance of the chiron approach.
Course Revision/ Approval Date:	14/03/2020
Course Objectives (As per Blooms' Taxonomy)	To enable the student to: 1 **Understand** the importance of chiron approach. 2 **Understand** and learn the concept of Biogenesis. 3 To **gain** the idea about chiral drug 4 To **understand** the concept on biogenesis 5 To **learn** drug synthesis procedure.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory: Chiron approach - Introduction, The concept of chiral templates and chirons wherein the carbon skeletonis the chiral precursor, Utilization of the basic concepts for rerosynthetic strategy and synthesis of the following- (S) Propanediol, (R) and (S) - Epichlorohydrin. L(+) - Alanine. (-) Multistratin.(-) Pentenomycin.(-) Shikimic acid	**20%**	**12**
Unit 2: Theory: Introduction to drugs,their action and discovery, Relation of drug structure and its chemical and biological properties, Structure,activity and quantitative relationship, Drug targets, Antimicrobial drugs, Antibactaerials : Discovery and developement of penicillins,Cephalosporins,Suiphones and sulphonamides,Teracyclins, Macrolides Polypeptides,Chloromycetin, Antifungals : Fungal Diseases and anti fungal agents, Antivirals : Viral diseases and anti-viral drugs, Anti-protozoals : Anti-malarials, Anti-amoebic	**20%**	**12**
Unit 3: Theory: Introduction of chiral drugs,Eutomer, Distomer and eudesmic ratio Distomers- a) with no side effects b) with undesirable side effects synthesis andpharmacological activity of S-Ibuprofen. S-Metaprolol.Ininvir sulfate. Dextropropoxyphen.(+) Ephedrine.	**20%**	**12**
Unit 4: Theory: Gresiofulvin.RIndacrinnone,hydrochloride,S-S-	**20%**	**12**

captopril Structure and stereochemistry of Hardwickiic acid,Camptothecin and podophyllotoxin Synthesis of Taxol Estrone and Mifepristone Juvabione (K.Mori and Matsui,Pawson and Cheung Synthesis) Fredericamycin A		
Unit 5: Theory: Biogenesis - The building blocks and construction mechanism of Terpenoids- Mono,Sesqui,Dt and Triterpenoids and cholesterol Alkaloids derived from ornithine,lysine,nicotinic acid,tyrosine and tryptophan. The shikimate pathway-cinnamic acids,lignans and lignin,coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinones. Synthesis and application of the following drugs : Fluoxetine, oxyphenbutazone, cetrizine, esomeprazole, fluconazole, zidovudine, methotrexate, diclofenac, labetalol, fenofibrate.	**20%**	**12**

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: (Max. 100 words)
PPT, Video,ChalkBoard, QUIZ , Assignment

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Subdomain
After successful completion of the above course, students will be able to: CO1: Able to **know** about biomolecules CO2: Will gain **knowledge** on chirons CO3: Will have a **clear vision** on drug design CO4: Able to **know** about biogenesis CO5: Will **gain** an idea how design some strategy for chemical synthesis	Remember and understand Remember and understand Remember and understand Analysis & Apply	Define, Describe Define, Describe,Apply Define, Describe Define Define , describe

Learning Resources	
1.	Reference Books: 1. Voet, D. and J. G. Voet (2004) Biochemistry, 3rd Edition, John Wiley &sons, Inc. USA. 2. Heterocyclic chemistry, 3rd edition, Thomas L. Gilchrist, Pearson Education, 2007. Textbook: 1. Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5thEdition, W. H. Freeman and Company, NY., USA. 2. Stryer, Lubert; Biochemistry; W. H. Freeman publishers.
2.	Journals: JACS, JOC, ORG LETT. ETC. Periodicals: Chemistry Today
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	2	1	1	1	1	1
CO2	2	1	1	1	0	0
CO3	2	1	1	1	1	1
CO4	2	1	1	1	1	1
CO5	2	2	1	1	0	0

Mapping of POs & COs

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

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

COURSE CODE	COURSE NAME	SEMESTER
MSCM413	Organic Chemistry –VIII	**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 Organic chemistry Concept
Course Category	Core Professional
Course focus	Employability
Rationale	Understanding of supramolecular chemistry. knowledge about natural products and pheromones. Understanding and application of mass spectroscopy and NMR in organic and medicinal chemistry.
Course Revision/ Approval Date:	14/03/2020
Course Objectives **(As per Blooms' Taxonomy)**	To enable the student to: 1 **Understand** the nature of addition in pericyclic reactions. 2 **Understand** the spectroscopic techniques involved in organic chemistry. 3 To **gain** the idea on supramolecular chemistry 4 To **understand** the concept on mass spectroscopy 5 To **learn** techniques on NMR spectroscopy.

Course Content (Theory)	Weightage	Contact hours
Unit 1: Theory: Supramolecular Organic Chemistry: Introduction, host-guest interactions, classification of host-guest compounds, intermolecular forces, nature of supramolecular interactions, molecular recognition, chiral discrimination, molecular receptors and design principles, template effect, biomimetic chemistry, cryptands, cyclodextrins, calixarenes, catenanes and rotaxanes, molecular capsules, molecular self-assembly.	**20%**	**12**
Unit 2: Theory: Pheromones: Introduction and applications, total synthesis of 3,11- dimethyl-2- nonacosanone and its 29-hydroxy derivative, grandisol, exobravicomine, frontaline and juvenile hormone. Introduction to plant hormones: structure determination and synthesis of auxins. Prostaglandins: Introduction. Occurance, nomenclature, classification and physiological effects, synthesis of PGE2 and PGF2, biosynthesis and biological importance.	**20%**	**12**
Unit 3: Theory: Mass spectrometry: Molecular ion peak, base peak, isotopic abundance, metastable ions. Nitrogen rule, Determination of molecular formula of organic compounds based on isotopic abundance and HRMS. Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels- Alder reaction, ortho effect. Structure determination involving individual or combined use of the above spectral techniques.	**20%**	**12**
Unit 4: Theory: Proton NMR spectroscopy: Recapitulation, chemical and magnetic equivalence of protons, First order, second order, Spin system notations (A2, AB, AX, AB2, AX2, AMX and A2B2- A2X2 spin systems with suitable examples). Long range coupling (Allylic coupling, 'W' coupling and Coupling in aromatic and heteroaromatic systems), Temperature effects, Simplification of complex spectra, nuclear magnetic double resonance, chemical shift reagents.	**20%**	**12**
Unit 5: Theory: 13C –NMR spectroscopy: Recapitulation, equivalent and non- equivalent carbons (examples of aliphatic and aromatic compounds), 13C- chemical shifts, calculation of 13C- chemical shifts of aromatic carbons, heteronuclear coupling of carbon to 19F and 31P. Spectral problems based on UV, IR, 1HNMR and 13CNMR and Mass spectroscopy .	**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: (Max. 100 words)

PPT, Video,ChalkBoard, QUIZ, Discussion(D),Student seminars, Case study

Course Objectives:	Blooms' Taxonomy Domain	Blooms' Taxonomy Sub Domain
After successful completion of the above course, students will be able to:		
CO1: .Able to **know** about advanced organic chemistry	Remember and understand	Define, Describe
CO2: .Will gain **knowledge** on NMR spectroscopy	Analysis & Apply	Define, Describe,Apply
CO3: .Will have a clear vision on mass spectroscopy	Remember and understand	Define, Describe,Apply
CO4: Able to **know** concept on supra molecular chemistry	Remember and understand	Define
CO5: Will **gain** an idea on pheromones.		Define , Describe

Learning Resources	
1	Reference Books: 1. Organic Spectroscopy: Principles And Applications, Jag Mohan, Alpha ScienceInternational Ltd., 30-Mar-2004. 2.Natural products chemistry and applications, Sujata V. Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011. Textbook: 1. Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5thEdition, W. H. Freeman and Company, NY., USA. 2.Spectrometric Identification of Organic compounds, R.M. Silverstein and others, John Wiley and Sons Inc., 5th ed., 1991.
2	Journals: JACS, JOC, ORG LETT. ETC. Periodicals: Chemistry Today
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	2	1	1	1	1	0
CO2	2	1	1	0	0	0
CO3	2	0	1	1	0	0
CO4	2	1	1	1	0	0
CO5	3	2	1	1	1	1

Mapping of POs & COs

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

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

COURSE CODE	COURSE NAME	SEMESTER
MSCM405	Communication Skills IV	IV

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

Course Prerequisites	Basic Knowledge of English Grammar & communication Basic English Grammar & Intermediate communication skills
Course Category	Mandatory Course
Course focus	Communicational Skills
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: Communication Skills Shannon & Weaver Model of Communication, Helical Model of Communication, Audience focused Communication, Barriers and Challenges	**25%**	7
Unit 2: Corporate Communication Definitions, Strategies of Corporate Communication,	**25%**	8

Role of Corporate Communication, Benefits of Corporate Communication, Scope of Corporate Communication		
Unit 3: Official Correspondence What is Official Correspondence, Memo, Notice and Circulars, Agenda of the meeting and Minutes of the meeting	**25%**	7
Unit 4: Social Networking What is Social Networking, types of Social networking, Advantages of Social Networking, Opportunities of Social Networking, Managing Social Networking	**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. Murphy, Raymond "Murphy's English Grammar with CD" Cambridge University Press, 2004. 2. Thorpe, Edgar and Showick Thorpe "Basic Vocabulary" Pearson Education India, 2012. 3. Green, David. "Contemporary English Grammar Structures and Composition" MacMillan Publishers, New Delhi, 2010. 4. Wren &Martin (2001), English Grammar & Composition, New York
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