MAHENDRA ARTS & SCIENCE COLLEGE

(AUTONOMOUS)

(Affiliated to Periyar University, Salem)

[Accredited by NAAC with "A^{++}" Grade & Recognized u/s 2(f) and 12(B) of the UGC act 1956]

KALIPPATTI – 637 501.

MASTER OF SCIENCE

SYLLABUS FOR M.Sc. CHEMISTRY

OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM

FOR THE STUDENTS ADMITTED FROM
THE ACADEMIC YEAR 2023 – 2024 ONWARDS

MAHENDRA ARTS & SCIENCE COLLEGE

(Autonomous)

(Affiliated to Periyar University)

DEPARTMENT OF CHEMISTRY

REGULATIONS FOR M.Sc. CHEMISTRY PROGRAMME

OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM

(Effective from the Academic Year 2023-2024)

I. PREAMBLE

Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The developments in chemistry during last few decades are phenomenal. It is also seen that these developments are crossing the traditional vertical boundaries of scientific disciplines. New branches of chemistry are emerging and gaining importance, such as bioorganic chemistry, materials chemistry, nano-chemistry, computational chemistry, etc. A chemist cannot isolate himself from other disciplines. Thus symbiotic interdisciplinary approach now seems to be more relevant. The practice of chemistry over a span of more than a century has also created concomitant and perhaps unavoidable impacts of human environment. The chemical industry is now pressurized from both the government and the society to develop eco - friendly processes and products which will reduce waste and prevent toxic substances from entering the environment. The principles and applications of chemistry should be learnt on this background.

II. GRADUATES ATTRIBUTES

- **In-depth knowledge and understanding of major concepts:** Understanding of theoretical principles and experimental findings in different sub-areas available in respective disciplines.
- **Creative and Critical thinking:** The capability of using creative and critical thinking in respective areas.
- **Analytical ability:** The ability to analyze issues and problems in all the disciplines.
- **Problem-solving skills:** The capability towards solving problems.
- **Entrepreneur skills:** The inclusion of leadership, business management, time management skills.
- **Communication skills:** The ability to transfer complicated/technical information in a precise manner.
- **Mutual and multidisciplinary competence:** The ability of teamwork in interdisciplinary fields.
- **Digital literacy:** The capability of utilizing modern digital tools to carry out the simulation process.

- **Moral and ethical awareness:** Ability to adopt moral ethics.
- **Social responsibility:** Creating socially responsible citizens.

III. PROGRAMME EDUCATIONAL OBJECTIVES

To develop

1. Positive approach towards Environment and Ecology from the Chemistry perspective.
2. Human Values and Social Responsibilities in the context of learning Chemistry.
3. Extension of Chemistry in the social context for solving social issues.
4. Analytical and Experimental Skills of the students capable of doing higher-level research works in the emerging fields of chemistry.
5. Entrepreneurial Skills to start their own industries/business in core chemistry and applied chemistry field.

IV. PROGRAM OUTCOMES

- **PO1: Problem Solving Skill -** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
- **PO2: Decision Making Skill -** Foster analytical and critical thinking abilities for data-based decision-making.
- **PO3: Ethical Value -** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
- **PO4: Communication Skill -** Ability to develop communication, managerial and interpersonal skills.
- **PO5: Individual and Team Leadership Skill -** Capability to lead themselves and the team to achieve organizational goals.
- **PO6: Employability Skill -** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
- **PO7: Entrepreneurial Skill -** Equip with skills and competencies to become an entrepreneur.
- **PO8: Contribution to Society -** Succeed in career endeavors and contribute significantly to society.
- **PO9: Multicultural competence -** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
- **PO10: Moral and ethical awareness/reasoning -** Ability to embrace moral/ethical values in conducting one's life.

V. PROGRAMME SPECIFIC OUTCOMES

- **PSO1: Placement -** To prepare the students who will demonstrate respectful engagement with others ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.

- **PSO2: Entrepreneur -** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
- **PSO3: Research and Development -** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
- **PSO4: Contribution to Business World -** To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
- **PSO5: Contribution to the Society -** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

VI. REGULATIONS

These regulations shall take effect from the academic year 2023-2024, i.e., for students who are to be admitted to the first year of the course during the academic year 2023-2024 and thereafter.

1. Eligibility for Admission

A candidate who has passed B.Sc., Chemistry degree of this University or any other University accepted by the Syndicate equivalent thereto, subject to such condition as may be prescribed therefore are eligible for admission to M.Sc., Chemistry programme and shall be permitted to appear and qualify for the Master of Science (M.Sc.) Degree Examination in Chemistry of Periyar University.

2. Duration of the Programme

The candidates shall complete all the courses of the programme in 2 years from the date of admission. The programme of study shall consist of four semesters and a total period of two years with a minimum of 91 credits. The programme of study will comprise the course according to the syllabus.

3. Programme of Study

The Programme of study for the M.Sc. Chemistry Programme consist of the following:

i). Core courses
ii). Electives courses
iii). Skill Enhancement Courses
iv). Extra Disciplinary Course
v). Project
vi). Enhancement Compulsory Courses
vii). Internship Course
viii). Extension Activities

4. Examinations

The Programme of study shall be based on semester pattern with Internal Assessment under Choice Based Credit System.

The examinations for all the papers consist of both Internal (Continuous Internal Assessment - CIA) and External (End Semester) theory examinations. The theory examinations shall be conducted for three hours duration at the end of each semester. The candidates failing in any subjects(s) will be permitted to appear for the same in the subsequent semester examinations.

VII. STRUCTURE OF THE PROGRAMME:

SEMESTER: I

Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
CORE-I	Organic Reaction Mechanism-I	M23PCH01	6	-	5	25	75	100
CORE-II	Structure and Bonding in Inorganic Compounds	M23PCH02	6	-	5	25	75	100
CORE PRACTICAL-I	Practical-I - Organic Chemistry	M23PCHP01	-	6	4	40	60	100
ELECTIVE-I	Pharmaceutical Chemistry	M23PCHE01	6	-	3	25	75	100
	Nanomaterials and Nanotechnology	M23PCHE02						
ELECTIVE-II	Electrochemistry	M23PCHE03	6	-	3	25	75	100
	Molecular Spectroscopy	M23PCHE04						
		Total	**24**	**06**	**20**	**140**	**360**	**500**

SEMESTER: II

Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
CORE -III	Organic reaction mechanism-II	M23PCH03	6	-	5	25	75	100
CORE-IV	Physical Chemistry-I	M23PCH04	6	-	5	25	75	100
CORE PRACTICAL –II	Practical-II - Inorganic Chemistry	M23PCHP02		6	4	40	60	100
ELECTIVE-III	Medicinal Chemistry	M23PCHE05	4	-	3	25	75	100
	Green Chemistry	M23PCHE06						
EXTRA DISCIPLINARY COURSE	EDC		4	-	4	25	75	100
SKILL ENHANCEMENT COURSE - I	SEC-I Industrial chemistry	M23PCHS01	2		2	25	75	100
ENHANCEMENT COMPULSORY COURSE	Human Rights	M23PHR01	2	-	2	25	75	100
		Total	**24**	**06**	**25**	**190**	**510**	**700**

SEMESTER: III

Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
CORE-V	Organic synthesis and Photochemistry	M23PCH05	6	-	5	25	75	100
CORE-VI	Coordination Chemistry-I	M23PCH06	6	-	5	25	75	100
CORE PRACTICAL-III	Practical-III - Physical Chemistry	M23PCHP03	-	6	4	40	60	100
ELECTIVE-IV	Pharmacognosy and Phytochemistry	M23PCHE07	4	-	3	25	75	100
	Biomolecules and Heterocyclic compounds	M23PCHE08						
ELECTIVE-V	Bioinorganic Chemistry	M23PCHE09	4	-	3	25	75	100
	Material Science	M23PCHE10						
SKILL ENHANCEMENT COURSE - II	SEC-II-Preparation of Consumer products	M23PCHS02	4		2	25	75	100
INTERNSHIP	Internship	M23PCHIS01	-	-	2	40	60	100
		Total	**24**	**06**	**24**	**205**	**495**	**700**

SEMESTER: IV

Course Category	Title of the Course	Course Code	Hrs / Week		No. of Credits	Max. Mark		
			L	P		Int.	Ext.	Total
CORE-VII	Coordination Chemistry-II	M23PCH07	6	-	5	25	75	100
CORE-VIII	Physical Chemistry-II	M23PCH08	6	-	5	25	75	100
CORE PRACTICAL-IV	Practical-IV Analytical Instrumentation technique	M23PCHP04	-	6	4	40	60	100
SKILL ENHANCEMENT COURSE - III	SEC-III - Chemistry for Advanced Research Studies	M23PCHS03	4	-	2	25	75	100
PROJECT	Core Project with viva voce	M23PCHPR1	-	8	5	40	60	100
EXTENSION ACTIVITIES	Extension Activities	M23PEX01	-	-	1	-	-	-
EXTRA CREDIT FOR SWAYAM / MOOC / APPROVED ONLINE CERTIFICATION COURSE*		-	-	-	-	-	-	-
Total			**16**	**14**	**22**	**155**	**345**	**500**
Grand Total			**88**	**32**	**91**	**690**	**1710**	**2400**

***** The students will gain extra credits for successful completion of online courses from SWAYAM / MOOC / Approved Online Certification Course.

Summary of Credits, Hours and Mark Distribution

Course Category	Credits				Total Credits	Total Hours	No. of Courses	Max. Marks
	I	II	III	IV				
Core	10	10	10	10	40	48	08	800
Core Practical	04	04	04	04	16	24	04	400
Elective	06	06	03	-	15	24	05	500
SEC	-	02	02	02	06	10	03	300
EDC	-	-	04	-	04	04	01	100
Project	-	-	-	05	05	08	01	100
Human Rights	-	02	-	-	02	02	01	100
Internship	-	-	02	-	02	-	01	100
Extension Activities	-	-	-	01	01	-	-	-
Additional Credit for Online Courses*	-	-	-	-	-	-	-	-
TOTAL	**20**	**24**	**25**	**22**	**91**	**120**	**24**	**2400**

***** The students will gain extra credits for successful completion of online courses from SWAYAM / MOOC / Approved Online Certification Course.

ELECTIVE COURSES FOR M.Sc. CHEMISTRY STUDENTS

Semester	ELECTIVE – I	
	Course Title	**Course Code**
I	Pharmaceutical Chemistry	M23PCHE01
	Nanomaterials and Nanotechnology	M23PCHE02
	ELECTIVE – II	
	Course Title	**Course Code**
I	Electrochemistry	M23PCHE03
	Molecular Spectroscopy	M23PCHE04
	ELECTIVE – III	
	Course Title	**Course Code**
II	Medicinal Chemistry	M23PCHE05
	Green Chemistry	M23PCHE06
	ELECTIVE – IV	
	Course Title	**Course Code**
III	Pharmacognosy and Phytochemistry	M23PCHE07
	Biomolecules and Heterocyclic compounds	M23PCHE08
	ELECTIVE – V	
	Course Title	**Course Code**
III	Bioinorganic Chemistry	M23PCHE09
	Material Science	M23PCHE10

SKILLED ENHANCEMENT COURSES FOR M.Sc. CHEMISTRY STUDENTS

Semester	Course Title	Course Code
II	Industrial chemistry	M23PCHS01
III	Preparation of Consumer products	M23PCHS02
IV	Chemistry For Advanced Research Studies	M23PCHS03

EXTRA DISCIPLINARY COURSES OFFERED FOR OTHER DEPARTMENT STUDENTS

Semester	Course Title	Course Code
II	Chemistry in Food Preservation	M23PCHED1
	Chemistry of consumer products	M23PCHED2

VIII. SCHEME OF EXAMINATION:

1. Question Paper Pattern for Theory Examination

Time: Three Hours Maximum Marks: 75

Knowledge Level	Sections		Marks	Total Marks	Meaning of K's
K1	**Part – A** 10 Questions - Objectives type *1 Marks (No Choice)	Two Questions from each unit	**10**	**75**	**K1- Memory Level** **K2 - Understanding Level** **K3 - Application Level** **K4 - Analytical Level** **K5 - Evaluation Level**
K1, K2	**Part – B** 5 Questions *2 Marks (No Choice)	One Question from each unit	**10**		
K2, K3, K4	**Part – C** 5 Questions (Either or type)	Two Question from each unit	**25**		
K2, K3, K4, K5	**Part – D** 3 out of 5 Questions	One Question from each unit	**30**		

2. Question Paper Pattern for Practical Examination

Time: Five Hours Maximum Marks: 60

Open Elective with following Scheme

Practical	:	55 Marks
Record	:	05 Marks
Total	:	60 Marks

3. Distribution of Marks:

The following are the distribution of marks for external and internal for End Semester Examinations and continuous internal assessment and passing minimum marks for Theory/Practical/Project/Internship courses of M.Sc. Chemistry programme.

ESE	CIA Total	EA Total	Total Marks Allotted	Passing Minimum for EA	Passing Minimum (ESE)
Theory	25	75	100	38	50
Practical	40	60	100	30	50
Project / Intership	40	60	100	30	50

The following are the Distribution of marks for the Continuous Internal Assessment in Theory / Practical / Project / Internship courses of M.Sc. Chemistry programme.

THEORY

EVALUATION OF INTERNAL ASSESSMENT

Test	: 10 Marks
Seminar	: 05 Marks
Assignment	: 05 Marks
Attendance	: 05 Marks
Total	: 25 Marks

PRACTICAL

EVALUATION OF INTERNAL ASSESSMENT

Test	: 20 Marks
Attendance	: 10 Marks
Observation	: 10 Marks
Total	: 40 Marks

INTERNSHIP/PROJECT

EVALUATION OF INTERNAL ASSESSMENT

Review 1	: 10 Marks
Review 2	: 10 Marks
Review 3	: 10 Marks
Pre-Viva	: 10 Marks
Total	: 40 Marks

4. Passing Minimum:

The Candidates shall be declared to have passed the examination if he/she secures not less than 50 marks in total (CIA mark + Theory Exam mark) with minimum of 38 marks (out of 75 marks) in the End Semester Theory Examinations.

The Candidates shall be declared to have passed the examination if he/she secures not less than 50 marks in total (CIA mark + Practical Exam mark) with minimum of 38 marks (out of 75 marks) in the End Semester Practical Examinations.

5. Submission of Record Note Books for Practical Examinations

Candidates appearing for practical examinations should submit a bonafide record note books prescribed for practical examinations. The candidates failed to submit the record book shall not be permitted to appear for the practical examinations.

6. Internship/Project:

Internship

Internship training (Minimum two weeks period) is mandatory for M.Sc. Chemistry programmes during first year vacation period.

The Internship training should be valued by an External examiner; however the Viva-Voce examination should be conducted by the Internal and External examiner/Guide/Teacher concerned.

1. The Internship training Report may consist of minimum of 30 pages.
2. The candidate has to submit the Internship training Report 20 days before the commencement of the III Semester Examinations.

Project:

1. The following guidelines to be followed for the Project with Viva-voce:
   The project should be valued for 60 marks by an external examiner; however the Viva-Voce examination should be conducted by both the external examiner appointed by the College and the Internal examiner/Guide/Teacher concerned.
2. The Project Report may consist of minimum of 60 pages.
3. The candidate has to submit the Project Report 10 days before the commencement of the IV Semester Examinations.
4. A candidate who fails in the Project/Dissertation or is absent may resubmit the report, on the same topic, with necessary modification / correction/improvements in the subsequent Even Semester Examinations for evaluation and shall undergo viva-voce Examination.

IX. Note

a) SWAYAM / MOOC – Free Online Course

SWAYAM/MOOC is an instrument for self-actualisation providing opportunities for a life-long learning. Here the student can choose from hundreds of courses, virtually every course taught at the college level, offered by the best teachers in India and elsewhere.

The students can choose an online SWAYAM/MOOC course during their period of study which will earn an extra credit and it will be transferred to the academic records of the students.

SEMESTER – I

CORE - I	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH01	ORGANIC REACTION MECHANISM - I	Contact Hours Per Week: 6

OBJECTIVES

To understand the feasibility and the mechanism of various organic reactions, determination of reaction mechanisms, stereochemistry involved in organic compounds, correlate and appreciate the differences involved in the various types of organic reaction mechanisms and synthetic routes for the preparation of organic compounds.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the basic principles of organic chemistry.	K1
CO2	Understand the formation and detection of reaction intermediates of organic reactions.	K2
CO3	Predict the reaction mechanism of organic reactions and stereochemistry of organic compounds.	K3
CO4	Apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.	K4
CO5	Design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	K5

UNIT-I: Methods of Determination of Reaction Mechanism [18 Hours]

Reaction intermediates, the transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate. Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates - isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism. Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.

UNIT-II: Aromatic and Aliphatic Electrophilic Substitution [18 Hours]

Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-

Crafts alkylation, acylation and arylation reactions. Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.

UNIT-III: Aromatic and Aliphatic Nucleophilic Substitution [18 Hours]

Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet-Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon. S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain-Scott, Grunwald-Winstein relationship - Ambident nucleophiles.

UNIT-IV: Stereochemistry-I [18 Hours]

Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C,N,S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation. D,L system, Cram's and Prelog's rules: R,S-notations, proR, proS, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereoisomerism, chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.

UNIT-V: Stereochemistry-II [18 Hours]

Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle. Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Organic Chemistry	J. March and M. Smith	5th edn, John-Wiley and Sons.	2001
2	Mechanism and Structure in Organic Chemistry	E.S. Gould	Holt, Rinehart and Winston Inc.,	1959
3	Stereochemistry of carbon compounds	P.S. Kalsi	8th edn, New Age International Publishers	2015
4	Organic Chemistry	P.Y. Bruice	7th edn, Prentice Hall	2013
5	Organic Compounds	J. Clayden, N. Greeves and S. Warren	2nd edn, Oxford University Press	2014

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Organic Chemistry Part-A and B	F.A. Carey and R.J. Sundberg	5th edn, Kluwer Academic / Plenum Publishers	2017
2	Stereochemistry	D.G. Morris	RSC Tutorial Chemistry Text 1	2001
3	Physical Organic Chemistry	N.S. Isaacs	ELBS, Longman, UK	1987
4	Organic chemistry, Vol-1 & 2	I.L. Finar	6th edn, Pearson Education Asia	2004

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – I

CORE – II	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH02	STRUCTURE AND BONDING IN INORGANIC COMPOUNDS	Contact Hours Per Week: 6

OBJECTIVES

To determine the structural properties of main group compounds and clusters, gain fundamental knowledge on the structural aspects of ionic crystals, familiarize various diffraction and microscopic techniques, the effect of point defects and line defects in ionic crystals and evaluate the structural aspects of solids.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the geometry of main group compounds and clusters.	K1
CO2	Illustrate about the packing of ions in crystals, coordination number of cations.	K2
CO3	Compare the various types of ionic crystal systems and their structural features.	K3
CO4	Enumerate the crystal growth methods.	K4
CO5	Brief out the principles of diffraction techniques and microscopic techniques.	K5

UNIT-I: Structure of main group compounds and clusters [18 Hours]

VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster; main group clusters – zintl ions and mno rule.

UNIT-II: Solid state chemistry – I [18 Hours]

Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point

group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.

UNIT-III: Solid state chemistry – II [18 Hours]

Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels - normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.

UNIT-IV: Techniques in solid state chemistry [18 Hours]

X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.

UNIT-V: Band theory and defects in solids [18 Hours]

Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Solid state Chemistry and its applications	A.R. West	2nd edn., John Wiley & Sons Ltd.	2014
2	A textbook of inorganic polymers	A.K. Bhagi and G.R. Chatwal	Himalaya Publishing House	2001
3	Solid State Chemistry – An Introduction	L. Smart and E. Moore	4th edn, CRC Press.	2012
4	Inorganic Chemistry	K.F. Purcell and J.C. Kotz	W.B. Saunders Company: Philadelphia	1977
5	Inorganic Chemistry	J.E. Huheey, E.A. Keiter and R.L. Keiter	4th edn, Harper and Row, New York	1983

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Concepts and Models in Inorganic Chemistry	D.E. Douglas, D.H. McDaniel, J.J. Alexander	3rd edn, Wiley Publication	1994
2	Understanding Solids - The Science of Materials	R.J.D. Tilley	2nd edn, Wiley Publication	2013
3	New Directions in Solid State Chemistry	C.N.R. Rao and J. Gopala krishnan	2nd Edn, Cambridge University Press	1999
4	Inorganic Chemistry-A Modern Introduction	T. Moeller	John Wiley: New York	1982
5	Inorganic Chemistry	D.F. Shriver, P.W. Atkins and C.H. Langford	3rd edn, Oxford University Press: London	2001

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – I

CORE PRACTICAL - I	M.Sc. Chemistry	Credits: 4
Course Code: M23PCHP01	PRACTICAL-I - ORGANIC CHEMISTRY	Contact Hours Per Week: 6

OBJECTIVES

To understand the concept of separation, qualitative analysis and preparation of organic compounds, handling of chemical reagents for separation of binary and ternary organic mixtures, the separated organic components systematically and derivatize them suitably, suitable experimental setup for the organic preparations involving two stages and different purification and drying techniques for the compound processing.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the characteristics of separation of organic compounds by various chemical reactions.	K3
CO2	Bring out strategies to separate and prepare organic compounds.	K4
CO3	Evaluate a method of separation of organic mixtures and design suitable procedure for organic preparations.	K5

UNIT-I: Separation and analysis

a) Two component mixtures.
b) Three component mixtures.

UNIT-II: Estimations

a) Estimation of Phenol (bromination)
b) Estimation of Aniline (bromination)
c) Estimation of Ethyl methyl ketone (iodimetry)
d) Estimation of Glucose (redox)
e) Estimation of Ascorbic acid (iodimetry)
f) Estimation of Aromatic nitro groups (reduction)
g) Estimation of Glycine (acidimetry)
h) Estimation of Formalin (iodimetry)
i) Estimation of Acetyl group in ester (alkalimetry)
j) Estimation of Hydroxyl group (acetylation)
k) Estimation of Amino group (acetylation)

UNIT-III: Two stage preparations

a) p-Bromoacetanilide from aniline

b) p-Nitroaniline from acetanilide
c) 1,3,5-Tribromobenzene from aniline
d) Acetyl salicyclic acid from methyl salicylate
e) Benzilic acid from benzoin
f) m-Nitroaniline from nitrobenzene
g) m-Nitrobenzoic acid from methyl benzoate

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Organic Chemistry – Lab manual	N.S. Gnanapragasam G. Ramamurthy	S. Viswanathan Co. Pvt. Ltd.	1998
2	Comprehensive Practical Organic Chemistry: Quantitative Analysis	Ahluwalia	Universities Press	2004
3	Basic Principles of Practical Chemistry	V. Venkateswaran, R. Veeraswamy, A.R. Kulandaivelu	2nd edn, Sultan Chand & sons, New Delhi.	1997
4	Organic Chemistry Lab Manual	N.S. Ganapragasm and G. Ramamurthy	2nd Edn, S. Vishwanathan Printers and Publishers (P) Ltd., Chennai.	2007

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Text book of Practical Organic Chemistry	Vogel	2nd edn, ELBS/ Longman, England	1986
2	Vogel's Textbook of Practical Organic Chemistry,	B.S. Furniss, A.J. Hannaford, P.W. Smith and A.R. Tatchell	7th edn, ELBS / Longman, London	1984
3	Elementary Practical Organic Chemistry: Quantitative Organic Analysis	A.I. Vogel	Pearson Education India	2010
4	Methods of Organic Analysis	C.L. Wilson, D.W. Wilson and L. Mazor	Elsevier Science	1983

SEMESTER – I

ELECTIVE-I	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE01	PHARMACEUTICAL CHEMISTRY	Contact Hours Per Week: 6

OBJECTIVES

To understand the advanced concepts of pharmaceutical chemistry, the principle and biological functions of various drugs, the importance as well the consequences of various drugs, the various analysis and techniques and the drug dosage and its structural activities.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the suitable drugs for various diseases.	K1
CO2	Outline the principles of various drug action and drug design.	K2
CO3	Generalize the knowledge on product development based on SAR.	K3
CO4	Correlate the knowledge on applications of computers in chemistry.	K4
CO5	Plan synthesize new drugs after understanding the concepts SAR.	K5

UNIT-I: Physical properties in Pharmaceuticals [18 Hours]

Physical properties of drug molecule: physical properties. Refractive index - Definition, explanation, formula, importance, determination, specific & molar refraction. Optical activity\rotation- monochromatic & polychromatic light, optical activity, angle of rotation, specific rotation examples, measurement of optical activity. Dielectric constant & Induced Polarization - Dielectric constant explanation & determination. Rheology of pharmaceutical systems: Introduction, Definition, Applications, concept of viscosity, Newton's law of flow, Kinematic, Relative, Specific, Reduced & Intrinsic viscosity. Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow, Dilatent flow. Viscosity measurements- selection of viscometer for Newtonian and non-Newtonian system.

UNIT–II: Isotopic Dilution analysis [18 Hours]

Principle and applications, Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of

radiopharmaceuticals, Radiopharmaceuticals as diagnostics, as therapeutics, for research and sterilization. Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.

UNIT–III: Drug dosage and product development [18 Hours]

Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development. Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms.

UNIT-IV: Development of new drugs [18 Hours]

Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory, Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables.

UNIT-V: Computers in Pharmaceutical Chemistry [18 Hours]

Need of computers for chemistry. Computers for Analytical Chemists - Introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components. Application of computers in chemistry: Programming in high level language (C+) to handle various numerical methods in chemistry – least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Physical Chemistry	Bahl and Tuli	Vishal Publication	2013
2	Text Book of Physical Pharmaceutics	C.V.S. Subramanyam	2nd edn, Vallabh Prakashan	1997

3	Medicinal Chemistry Organic Pharmaceutical Chemistry	G.R. Chatwal	Himalaya Publishing house	2006
4	Instrumental method of Analysis	Hubert H. Willard	7th edn, Wiley	2015
5	Textbook of Pharmaceutical Chemistry	Jayshree Ghosh	Chand & company Ltd	1983
6	Pharmaceutical Chemistry	S. Lakshmi	Sultan chand & Sons	2012

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Computers in chemistry	K.V. Raman	Tata McGraw-Hill	1993
2	Computers for Chemists	S.K. Pundir, Anshu bansal	2nd edn, New age international (P) limited, New Delhi.	2017
3	Physical Pharmacy and Pharmaceutical Sciences	Martins, Patrick J. Sinko	Elsevier Science	2021
4	Cooper and Gunn's Tutorial Pharmacy	S.J. Carter	6th edn, CBS Publisher Ltd.	2012
5	pharmaceutical Dosage forms and Drug Delivery System	Allen Popvich and Ansel	Indian edition - B.I. Publication Pvt. Ltd	1985

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – I

ELECTIVE-I	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE02	NANO MATERIALS AND NANO TECHNOLOGY	Contact Hours Per Week: 6

OBJECTIVES

To understand the concept of nanomaterials and nano technology, the various types of nanomaterials and their properties, the applications of synthetically important nanomaterials, the characteristics of various nanomaterials synthesized by new technologies and design synthetic routes for synthetically used new nanomaterials.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Find methods of fabricating nanostructures.	K1
CO2	Interrelate the unique properties of nanomaterials to reduce dimensionality of the material.	K2
CO3	Analyze tools for properties of nanostructures.	K3
CO4	Bring out applications of nanomaterials.	K4
CO5	Determine the health and safety related to nanomaterial.	K5

UNIT-I: Introduction of nanomaterials and nanotechnologies [18 Hours]

Introduction - role of size, classification - 0D, 1D, 2D, 3D. Synthesis - Bottom Up, Top Down, consolidation of Nano powders. Features of nanostructures, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.

UNIT-II: Bonding and structure of the nanomaterials [18 Hours]

Predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis - Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and hydrothermal - CVD-types, metallo organic, plasma enhanced, and low pressure CVD. Microwave assisted and electrochemical synthesis.

UNIT-III: Properties of Nanoparticles [18 Hours]

Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials. Nanoparticles:

gold and silver, metal oxides: silica, iron oxide and alumina - synthesis and properties.

UNIT-IV: Electrical properties of Nanoparticles [18 Hours]

Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials. Classification of magnetic phenomena. Semiconductor materials – classification - Ge, Si, GaAs, SiC, GaN, GaP, CdS, PbS. Identification of materials as p and n–type semiconductor - Hall effect - quantum and anomalous, Hall voltage - interpretation of charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell.

UNIT-V: Synthesis and Characterization of Nanoparticles [18 Hours]

Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles - types, synthesis, and properties. Nanocomposites - metal-, ceramic- and polymer- matrix composites - applications. Characterization – SEM, TEM and AFM - principle, instrumentation and applications.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Nanotechnology	Mark Ratner, Daniel Ratne	Pearson Education	2008
2	Nanotechnology	S. Shanmugam	MJP Publishers	2011
3	Nanomaterials	B. Viswanathan	Narosa Publishing House	2014

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Nanoscale materials in Chemistry	K.J. Klabunde	2nd edn, Wiley-Interscience, New York.	2009
2	Nano Science and Technology – Novel Structures and Phenomena	T. Tang and P. Sheng	Taylor & Francis, New York	2004
3	Introduction to Nanotechnology	C.P. Poole and Jr. F.J. Owens	Wiley Interscience, New Jersey	2003

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – I

ELECTIVE-II	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE03	ELECTROCHEMISTRY	Contact Hours Per Week: 6

OBJECTIVES

To understand the behavior of electrolytes in terms of conductance, ionic atmosphere, interactions, the structure of the electrical double layer of different models, compare electrodes between current density and over potential, the mechanism of electrochemical reactions and the different types of over voltages and its applications in electroanalytical techniques.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the behaviour of electrolytes in solution and the structures of electrical double layer of different models.	K1
CO2	Express the kinetics of electrode reactions applying Butler-Volmer and Tafel equations.	K2
CO3	Categorize different thermodynamic mechanism of corrosion.	K3
CO4	Examine the theories of electrolytes, electrical double layer, electrodics and activity coefficient of electrolytes.	K4
CO5	Justify concept on storage devices and electrochemical reaction mechanism.	K5

UNIT-I: Ionics [18 Hours]

Arrhenius theory - limitations, van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion solvent and ion-ion interactions. Born equation. Debye-Huckel Bjerrum model. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications. Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations. Evidence for ionic atmosphere. Ion association and triple ion formations.

UNIT-II: Electrode-electrolyte interface [18 Hours]

Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena -

Lippmann equation electro capillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials, colloidal and poly electrolytes. Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer. Zeta potential and potential at zero charge. Applications and limitations.

UNIT-III: Electrodics of Elementary Electrode Reactions [18 Hours]

Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic currents, condition for the discharge of ions. Nernst equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Rates of simple elementary reactions. Butler-Volmer equation-significance of exchange current density, net current density and symmetry factor. Low and high field approximations. Symmetry factor and transfer coefficient Tafel equations and Tafel plots.

UNIT-IV: Electrodics of Multistep Multi Electron System [18 Hours]

Rates of multi-step electrode reactions, Butler - Volmer equation for a multi-step reaction. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Electrochemical reaction mechanisms-rate expressions, order, and surface coverage. Reduction of I^{3-}, Fe^{2+}, and dissolution of Fe to Fe^{2+}. Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH. Pourbiax and Evan's diagrams.

UNIT-V: Concentration Polarization, Batteries and Fuel cells [18 Hours]

Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography-principle and applications. Principle of square wave polarography. Cyclic voltammetry-anodic and cathodic stripping voltammetry and differential pulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Mechanism of charge storage: conversion and alloying. Capacitors-mechanism of energy storage, charging at constant current and constant voltage. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Principles and applications of electrochemistry	D.R. Crow	4th edn, Chapman & Hall/CRC	2014

2	Kinetics and Mechanism of chemical transformations	J. Rajaram and J.C. Kuriakose	Macmillan India Ltd., New Delhi	2011
3	Electro chemistry	S. Glasstone	Affiliated East-West Press, Pvt., Ltd., New Delhi	2008
4	Electrochemistry - Principles and applications	B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan	S. Viswanathan Printers, Chennai	2007
5	Analytical Electrochemistry	Joseph Wang	2nd edn, Wiley	2004

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Modern Electro chemistry, vol.1 & 2	J.O.M. Bockris and A.K.N. Reddy	Springer, Plenum Press, New York	2008
2	Modern Electro chemistry, vol.2	J.O.M. Bockris, A.K.N. Reddy and M.G. Aldeco	Springer, Plenum Press, New York	2008
3	Electrochemistry	Philip H. Rieger	2nd edn, Springer, New York	2010
4	Theoretical electrochemistry	L.I. Antropov	Mir Publishers	1997
5	A Text book of Physical chemistry volume-3	K.L. Kapoor	Macmillan	2001

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – I

ELECTIVE-II	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE04	MOLECULAR SPECTROSCOPY	Contact Hours Per Week: 6

OBJECTIVES

To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules, the principle of Raman & IR spectroscopy, the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions, interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY and the structural elucidation of molecules using different spectral techniques, fragmentation patterns in Mass spectroscopy. ESR and Mossbauer spectroscopy and their application.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	List the importance of rotational and Raman spectroscopy.	K1
CO2	Indicate the vibrational spectroscopic techniques to diatomic and polyatomic molecules.	K2
CO3	Evaluate different electronic spectra of simple molecules using electronic spectroscopy.	K3
CO4	Outline the NMR, ^{13}C NMR, 2D NMR – COSY, NOESY, Introduction to ^{31}P, ^{19}F NMR and ESR spectroscopic techniques.	K4
CO5	Assess instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	K5

UNIT-I: Rotational and Raman Spectroscopy [18 Hours]

Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure - O and S branches, Polarization of Raman scattered photons.

UNIT-II: Vibrational Spectroscopy [18 Hours]

Vibrations of molecules, harmonic and anharmonic oscillators - vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.

UNIT-III: Electronic spectroscopy [18 Hours]

Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, X-ray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.

UNIT-IV: NMR and Mass Spectrometry [18 Hours]

Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX_2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. ^{13}CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to ^{31}P, ^{19}F NMR. Mass Spectroscopy: Ionization techniques-Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum.

UNIT-V: ESR and Mossbauer Spectroscopy [18 Hours]

ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g-tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectra of magnetically dilute samples. Structural elucidation

of organic compounds by combined spectral techniques. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Fundamentals of Molecular Spectroscopy	C.N. Banwell, E.M. McCash	4th edn, Tata McGraw Hill, New Delhi	2000
2	Spectroscopic Identification of Organic Compounds	R.M. Silverstein, F.X. Webster	6th edn, John Wiley & Sons, New York	2003
3	Physical Methods in Chemistry	R.S. Drago	Saunders: Philadelphia	1992
4	Applications of Spectroscopy	W. Kemp	English Language Book Society	1987
5	Spectroscopic Methods in Organic Chemistry	D.H. Williams, I. Fleming	4th edn, Tata McGraw-Hill Publishing Company, New Delhi	1988

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Physical Chemistry	P.W. Atkins and J. de Paula	7th edn, Oxford University Press.	2002
2	Molecular Spectroscopy	I.N. Levine	John Wiley & Sons, New York	1974
3	Nuclear Magnetic Resonance-Basic Principles	A. Rahman	Springer-Verlag, New York	1986
4	Infrared and Raman Spectra of Inorganic and coordination Compounds, Part-B	K. Nakamoto	5th edn, John Wiley & Sons Inc., New York	2017
5	Electron Paramagnetic Resonance	J.A. Weil, J.R. Bolton and J.E. Wertz	Wiley Interscience	1994

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – II

CORE - III	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH03	ORGANIC REACTION MECHANISM-II	Contact Hours Per Week: 6

OBJECTIVES

To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic and annulene compounds, the mechanism involved in various types of organic reactions with evidences, the applications of synthetically important reagents, the reactivity between aliphatic and aromatic compounds and design synthetic routes for synthetically used organic reactions.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the basic principles of aromaticity of organic and heterocyclic compounds.	K1
CO2	Represent the mechanism of various types of organic reactions.	K2
CO3	Examine the suitable reagents for the conversion of selective organic compounds.	K3
CO4	Categorize the principles of substitution, elimination, and addition reactions.	K4
CO5	Plan new routes to synthesis organic compounds.	K5

UNIT-I: Elimination and Free Radical Reactions Mechanisms [18 Hours]

E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radical reactions and free radical, reactions of radicals; polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.

UNIT-II: Oxidation and Reduction Reactions [18 Hours]

Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions. Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate lead tetraacetate,

permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.

UNIT-III: Rearrangements [18 Hours]

Rearrangements to electron deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements -applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements. Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements. Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements. Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.

UNIT-IV: Addition to Carbon Multiple Bonds [18 Hours]

Mechanisms: (a) Addition to carbon-carbon multiple bonds- Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms - Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen; (b) Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction, Prins reaction. Stereochemical aspects of addition reactions. Addition to Carbon-Hetero atom multiple bonds: Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates – Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

UNIT-V: Reagents and Modern Synthetic Reactions [18 Hours]

Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride (NaBH3CN), meta-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu_3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), N-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethyl ammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate

(DEM), Copper diacetylacetonate ($Cu(acac)_2$), $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Organic Chemistry	J. March and M. Smith	5th edn, John-Wiley and Sons.	2001
2	Mechanism and Structure in Organic Chemistry	E.S. Gould	Holt, Rinehart and Winston Inc.,	1959
3	Stereochemistry of carbon compounds	P.S. Kalsi	8th edn, New Age International Publishers	2015
4	Organic Chemistry	P.Y. Bruice	7th edn, Prentice Hall	2013
5	Organic Chemistry	R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee	7th edn, Pearson Education	2010

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Organic Chemistry	S.H. Pine	5th edn, McGraw Hill International Edition	1987
2	Organic Chemistry	L.F. Fieser and M. Fieser	Asia Publishing House, Bombay	2000
3	Mechanism and Structure in Organic Chemistry	E.S. Gould	Holt, Rinehart and Winston Inc	1959
4	Heterocyclic Chemistry	T.L. Gilchrist	Longman Press	1989
5	Heterocyclic Chemistry	J.A. Joule and K. Mills	4th edn., John-Wiley	2010

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER - II

CORE - IV	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH04	PHYSICAL CHEMISTRY-I	Contact Hours Per Week: 6

OBJECTIVES

To recall the fundamentals of thermodynamics and the composition of partial molar quantities, the classical and statistical approach of the functions, compare the significance of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein, the theories of reaction rates for the evaluation of thermodynamic parameters and study the mechanism and kinetics of reactions.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Relate the classical and statistical concepts of thermodynamics.	K1
CO2	Compare and correlate the thermodynamic concepts to study the kinetics of chemical reactions.	K2
CO3	Show the various thermodynamic and kinetic determination.	K3
CO4	Evaluate the thermodynamic methods for real gases ad mixtures.	K4
CO5	Discover the theories of reactions rates and fast reactions.	K5

UNIT-I: Classical Thermodynamics [18 Hours]

Partial molar properties - Chemical potential, Gibb's - Duhem equation, binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases – Fugacity - determination of fugacity by graphical and equation of state methods - dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states – determination - vapour pressure, EMF and freezing point methods.

UNIT-II: Statistical thermodynamics [18 Hours]

Introduction of statistical thermodynamics concepts of thermodynamic and mathematical probabilities - distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics - comparison and applications. Partition functions - evaluation of translational, vibrational

and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and di atomic gases - ortho and para hydrogen. Heat capacity of solids - Einstein and Debye models.

UNIT-III: Irreversible Thermodynamics [18 Hours]

Theories of conservation of mass and energy entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory - validity and verification - Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects - Application of irreversible thermodynamics to biological systems.

UNIT-IV: Kinetics of Reactions [18 Hours]

Theories of reactions - effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions - Lindeman and Christiansen hypothesis- molecular beams, collision cross sections, effectiveness of collisions, Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules, time and true order - kinetic parameter evaluation. Factors determine the reaction rates in solution - primary salt effect and secondary salt effect, Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions-Bronsted catalysis law, enzyme catalysis - Michelis-Menton catalysis.

UNIT-V: Kinetics of complex and fast reactions [18 Hours]

Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions - chain length, kinetics of H_2–Cl_2 & H_2–Br_2 reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions - relaxation methods - temperature and pressure jump methods electric and magnetic field jump methods - stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization - free radical, cationic, anionic polymerization - Polycondensation.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Thermodynamics for Students of Chemistry	J. Rajaram and J.C. Kuriacose	2nd edn, S.L.N. Chand and Co., Jalandhar	1986

2	Chemical thermodynamics	I.M. Klotz and R.M. Rosenberg	6th edn, W.A. Benjamin Publishers, California	1972
3	Statistical Thermodynamics	M.C. Gupta	New Age International, Pvt. Ltd., New Delhi	1995
4	Chemical Kinetics	K.J. Laidler	3rd edn, Pearson, Reprint	2013
5	Kinetics and Mechanisms of chemical transformation	J. Rajaram and J.C. Kuriokose	Macmillan India Ltd, Reprint	2011

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Physical Chemistry - A Molecular Approach	D.A. Mcqurrie and J.D. Simon	Viva Books Pvt. Ltd., New Delhi.	1999
2	Classical Thermodynamics	R.P. Rastogi and R.R. Misra	Vikas Publishing, Pvt. Ltd., New Delhi	1990
3	Fundamentals of Physical Chemistry	S.H. Maron and J.B. Lando	Macmillan Publishers, New York	1974
4	Kinetic Methods of Analysis	K.B. Ytsiimiriski	Pergamom Press	1996
5	Phase rule	Gurdeep Raj	Goel Publishing House	2011

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – II

CORE PRACTICAL-II	M.Sc. Chemistry	Credits: 4
Course Code: M23PCHP02	PRACTICAL-II - INORGANIC CHEMISTRY	Contact Hours Per Week: 6

OBJECTIVES

To understand and enhance the visual observation as an analytical tool for the quantitative estimation of ions, the principle and theory in preparing standard solutions, estimating the amount of ion accurately present in the solution, estimate metal ions, present in the given solution accurately without using instruments and determine the amount of ions, present in a binary mixture accurately.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Show the qualitative analytical skills by selecting suitable confirmatory tests and spot tests.	K3
CO2	Select the appropriate chemical reagents for the detection of anions and cations.	K4
CO3	Evaluate synthesized coordination compounds in good quality.	K5

UNIT-I: Analysis of mixture of cations

Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.

Group-I : W, Tl and Pb.
Group-II : Se, Te, Mo, Cu, Bi and Cd.
Group-III : Tl, Ce, Th, Zr, V, Cr, Fe, Ti and U.
Group-IV : Zn, Ni, Co and Mn.
Group-V : Ca, Ba and Sr.
Group-VI : Li and Mg.

UNIT-II: Preparation of metal complexes

Preparation of inorganic complexes:

a) Preparation of tristhioureacopper(I)sulphate
b) Preparation of potassium trioxalate chromate(III)
c) Preparation of tetramminecopper(II) sulphate
d) Preparation of Reineck's salt
e) Preparation of hexathioureacopper(I) chloridedihydrate
f) Preparation of cis-Potassium tri oxalate diaquachromate(III)
g) Preparation of sodium trioxalatoferrate(III)

h) Preparation of hexathiourealead(II) nitrate

UNIT-III: Complexometric Titration

a) Estimation of zinc, nickel, magnesium, and calcium.
b) Estimation of mixture of metal ions-pH control, masking and demasking agents.
c) Determination of calcium and lead in a mixture (pH control).
d) Determination of manganese in the presence of iron.
e) Determination of nickel in the presence of iron.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis	A. Jeya Rajendran	United global publishers	2021
2	Inorganic Semimicro Qualitative Analysis	V.V. Ramanujam	3rd edn., The National Publishing Company, Chennai	1974
3	Vogel's Text book of Inorganic Qualitative Analysis	B.S. Furniss, A.J. Hannaford, P.W. Smith and A.R. Tatchell	4th edn., ELBS, London	1986

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Practical Inorganic Chemistry	G. Pass, and H. Sutcliffe	Chapman Hall.	1965
2	Experimental Inorganic Chemistry	W.G. Palmer	Cambridge University Press.	1954

SEMESTER – II

ELECTIVE-III	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE05	MEDICINAL CHEMISTRY	Contact Hours Per Week: 4

OBJECTIVES

To study the chemistry behind the development of pharmaceutical materials, the mechanism and action of drugs, the need of antibiotics and usage of drugs, the mode of action of diabetic agents and treatment of diabetes and identify and apply the action of various antibiotics.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Label a drugs properties based on its structure.	K1
CO2	Illustrate the factors that affect its absorption, distribution, metabolism, and excretion.	K2
CO3	Explain the relationship between drug's chemical structure and its therapeutic properties.	K3
CO4	Simplify the knowledge of different theories of drug actions at molecular level.	K4
CO5	Decide different targets for the development of new drugs for the treatment of infectious and GIT.	K5

UNIT-I: Introduction to receptors [12 hours]

Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug – receptor interaction, Drug synergism, Drug resistance, physicochemical factors influencing drug action.

UNIT-II: Antibiotics [12 hours]

Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicllins and tetracyclins, clinical application of penicillins, cephalosporin. Current trends in antibiotic therapy.

UNIT-III: Antihypertensive agents and diuretics [12 hours]

Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.

UNIT-IV: Antiviral and Antibacterial [12 hours]

Classification of antiviralagents, Mechanism of action - Chloroquine Phosphate, Amodiaquine hydrochloride and Pyrimethamine. Antibacterial: Classification and mechanism of action - Sulphanilamide, Sulphapyridine, Sulphadiazine and Sulphisoxazole.

UNIT-V: Analgesics, Antipyretics and Anti-inflammatory Drugs [12 hours]

Introduction, Mechanism of inflammation, classification and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of diabetic mellitus. Chemistry of insulin, sulfonyl urea.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry	Wilson, Charles Owens, Beale, John Marlowe, Block, John H	Lipincott William, 12th edition	2011
2	An Introduction to Medicinal Chemistry	Graham L. Patrick	5th edition, Oxford University Press	2013
3	A text book of Pharmaceutical Chemistry	Jayashree Ghosh	S. Chand and Co. Ltd	1999
4	Natural and synthetic organic medicinal compounds	O. LeRoy	Ealemi	1976
5	Medicinal Chemistry	S. Ashutosh Kar	Wiley Eastern Limited, New Delhi	1993

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Foye's Principles of Medicinal Chemistry	Foye	7th edn, Lipincott Williams.	2012
2	Burger's Medicinal Chemistry, Drug Discovery and Development	Donald J. Abraham, David P. Rotella	Alfred Burger, Academic press	2010

3	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry	John M. Beale Jr and John M. Block	12th edn, Wolters Kluwer,	2011
4	A Textbook of Medical Chemistry	P. Parimoo	CBS Publishers, New Delhi.	1995
5	Textbook of Medical Biochemistry	S. Rama krishnan, K.G. Prasannan and R. Rajan	3rd edn, Orient Longman, Hyderabad.	2001

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – II

ELECTIVE-III	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE06	GREEN CHEMISTRY	Contact Hours Per Week: 4

OBJECTIVES

To understand the principles of green chemistry, green solutions for chemical energy storage and conversion, Propose green solutions for industrial production of Petroleum & Petrochemicals, solutions for pollution prevention in Industrial chemical, fuel production, automotive industry, Shipping industries and green solutions for industrial production of Surfactants, Organic & inorganic chemicals.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the basic chemical techniques used in conventional industrial preparations and in green innovations.	K1
CO2	Demonstrate the various techniques used in chemical industries and in laboratory.	K2
CO3	Compare the advantages of organic reactions assisted by renewable energy sources and non-renewable energy sources.	K3
CO4	Apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.	K4
CO5	Plan and synthesize new organic compounds by green methods.	K5

UNIT-I: Introduction for Green Chemistry [12 hours]

Need for Green Chemistry. Goals of Green Chemistry. Limitations/ of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and twelve principles of Green Chemistry with examples.

UNIT-II: Green Reagents [12 hours]

Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis - green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids - criteria, general methods of preparation, effect on organic reaction. Supercritical carbon

dioxide - properties, advantages, drawbacks and a few examples of organic reactions in $ScCO_2$. Green synthesis - adipic acid and catechol.

UNIT-III: Green Catalysis [12 hours]

Environmental pollution, Green Catalysis - Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts - Poly styrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.

UNIT-IV: Phase transfer catalysis in green synthesis [12 hours]

Phase transfer catalysis in green synthesis - oxidation using hydrogen peroxide, crown ethers - esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.

UNIT-V: Green synthetic methods [12 hours]

Micro wave induced green synthesis - Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	New Trends in Green Chemistry	V.K. Ahluwalia, and M.R. Kidwai	Anamalaya Publishers	2005
2	Unit Operations of Chemical Engineering	W.L. McCabe, J.C. Smith and P. Harriott	7th edn, McGraw-Hill, New Delhi	2005
3	Organometallics in Organic Synthesis	J.M. Swan and D.St.C. Black	Chapman Hall	1974
4	Organic Synthesis: Special Techniques	V.K. Ahluwalia and R. Aggarwal	Narosa Publishing House, New Delhi	2001
5	Environmental Chemistry	A.K. De	New Age Publications	2017

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Green Chemistry - Theory and Practical	P.T. Anastas and J.K. Warner	University Press	1998
2	Introduction to Green Chemistry	A.S. Matlack	Marcel Dekker	2001

3	Real-World Cases in Green Chemistry	M.C. Cann and M.E. Connely	American Chemical Society, Washington	2000
4	Introduction to Green Chemistry	M.A. Ryan and M. Tinnesand	American Chemical Society, Washington	2002
5	An Insight into Green Chemistry	Chandrakanta Bandyopadhyay	Books and Allied (P) Ltd	2019

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M** - Medium

SEMESTER – II

SEC-I	M.Sc. Chemistry	Credits: 2
Course Code: M23PCHS01	INDUSTRIAL CHEMISTRY	Contact Hours Per Week: 2

OBJECTIVES

To gain the Knowledge of important chemical and reagents used in chemical industries, the basic principle behind various mixtures used in chemical industries and their selection in respective applications, the safety and Hazardous criteria related to unit process and fertilizer.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	State the principles of chemical technology.	K1
CO2	Cite the raw Materials and Energy for Chemical Industry	K2
CO3	Organize small scale chemical industries such as soaps and detergents.	K3
CO4	Point out the large scale chemical industries.	K4
CO5	Importance of the safety signs and colours used in Industries.	K5

UNIT-I: Principles of Chemical Technology [6 hours]

Introduction – basic principles of chemical technology – importance of chemical technology – classification of technological process – designing and modeling of chemical plants – unit process and unit operations. Basic requirements of industrial reactors – choice and selectivity of reactor – basic principles of homogeneous and heterogeneous processes and reactors with examples.

UNIT-II: Raw Materials and Energy for Chemical Industry [6 hours]

Raw materials – Characteristics of raw materials and their resources – methods of raw material concentration – integral utilization of raw materials. Energy for chemical industry – power and fuels – classification of fuels – coal – fuel gases and liquid fuels – petroleum – cracking – chemical corrosion – types of corrosion and preventive measures.

UNIT-III: Small Scale Chemical Industries [6 hours]

Electro-thermal and electro-chemical industries: electroplating – surface coating industries – oils, fats and waxes – soaps and detergents – cosmetics. Match industries and Fire Works: Manufacture of some

industrially important chemicals like potassium chlorate, potassium nitrate, barium nitrate and red phosphorous – metal powders.

UNIT-IV: Large Scale Chemical Industries [6 hours]

Manufacturing process – raw materials – composition and uses of products in Portland cement – ceramics – plastics, synthetic fibres – synthetic rubber – fertilizers – insecticides and pesticides – photo film industries – commercial aspects of starting an industry.

UNIT-V: Safety Signs and Colours used in Industries [6 hours]

Industrial Hazards and Accidents – Classification of Hazards – Physical, chemical Biological, Ergonomic and stress Hazards – Causes, prevention and control – case study on industrial accidents – Bhopal gas Tragedy – Heat stress – sources and control – Noise pollution in industry – sources and control.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Chemical Technology, Vol.1	Mukhlynov	Mir Publication, Moscow, III edn	1979
2	Environmental Chemistry	A.K. De	2nd edn, Wiley Eastern Ltd, Meerut	1986
3	Process know-how and material of construction for Chemical Industries	R.K. Goel	S.B. Publ., New Delhi	1977
4	Industrial Chemistry	B.N. Chakrabarthy	Oxford and IBH Publ., Now Delhi	1984
5	Chemical Process Industries	R. Norris Shreve and J.A. Brink	4th edn, McGraw Hill, Tokyo	1977

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Encyclopedia of Chemical Technology	Kirk Othmer	John Wiley and Sons, New York	1999
2	Industrial Chemistry	B.K. Sharma	1st edn, Goel Publishing House, Meerut.	2014
3	Engineering chemistry fundamentals and applications	Shikha Agarwal	Cambridge University Press	2016

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M –** Medium

SEMESTER – II

ECC	M.Sc. Chemistry	Credits: 2
Course Code: M23PHR01	ECC-HUMAN RIGHTS	Contact Hours Per Week: 2

OBJECTIVES

This course provides knowledge on the different aspects of human rights and can learn the rights for the duties to be carried out in the days to come.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO	Statement	Knowledge Level
CO1	Define Human Rights, theories and relevant social legislations.	K1
CO2	Outline the Classification of Human Rights.	K2
CO3	Show competent knowledge about Women and Children rights.	K3
CO4	Point out the Rights of Labour.	K4, K5
CO5	Import sensitize the National and State level human Rights Commissions and their policies.	K4, K5

UNIT - I: Introduction to Human Rights [6 hours]

Human Rights: Meaning – Definitions – Origin and Growth of Human Rights in the World – Need and types of Human Rights – Theories of Human Rights – UNHRC (United Nations Human Rights) – Human Rights in India – Duties and Responsibilities of Indian Citizens.

UNIT - II: Classification of Human Rights [6 hours]

Right to Liberty – Right to Life – Right to Equality – Right to dignity – Right to against Exploitation – Educational Rights – Cultural Rights – Economic Rights – political Rights – Social Rights.

UNIT - III: Rights of Women and Children [6 hours]

Rights of Women – Female feticide and Infanticide and selective abortion – Physical assault and sexual harassment – Domestic Violence – Violence at work place – Remedial Measures. Rights of Children – Protection rights - Survival rights – Participation rights – Development rights – Role of UN on convention on rights of children.

UNIT – IV: Multi-Dimensional aspects of Human Rights [6 hours]

Labour rights – Bodend Labour – Child Labour – Contract Labour – Migrant Labour – Domestic Women Labour – Gender Equity – Rights of Ethnic refugees – Problems and remedies – Role of trade union in protecting the unorganized labourers.

UNIT – V: Grievance and Redressal Mechanism [6 hours]

Redressal Mechanism at national level – Structure and functions of National and State level human Rights Commission – Constitutional remedies – Public Interest Litigation (PIL) – Protection of Human Rights Act 1993.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Human Rights in a post Human World	Upendra Baxi	Cambridge university Press, New Delhi	2007
2	Human Rights in India	Asish Kumar Das and Prasant Kumar Monaty	Sarup and Sons, New Delhi	2007
3	Human Rights Social justice and political change	Bani Bargohain	Kanishka publishers and distributors, New Delhi	2007
4	Human Rights and Development Issues	G. Velan	Ambala Cantt	2008
5	Human rights Theory and Practice	P.K. Meena	Murali lal and Sons, New Delhi	2008

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1	Teaching of Human Rights	Barat Sergio and Swaronjali Ghosh	Dominant Publishers and distributors, New Delhi	2009
2	Human Rights Achievements and Challenges	A.N. Roy	Vista International Publishing House, Delhi	2005
3	Human Rights Development and Environmental Law	Bhavani Prasad Panda	Academic Excellence, Delhi.	2007

4	Human Rights – Twenty first Century Challenges	V.N. Vishvanathan	Kalpaz Publications, New Delhi.	2008
5	Protecting Human Rights	M.R. Ansari	Max Ford Books, New Delhi.	2006
6	Social Movements in Indi – Social Movements and Social Transformation in India	M.S.A. Rao	Vol 1& 2: Manohar Publications, New Delhi.	1978

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – III

CORE - V	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH05	**ORGANIC SYNTHESIS AND PHOTOCHEMISTRY**	**Contact Hours Per Week: 6**

OBJECTIVES

To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions, various synthetically important reagents for any successful organic synthesis, disconnection approach and identifying suitable synthons to effect successful organic synthesis, the concepts of pericyclic reaction mechanisms and photochemical organic reactions.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the basic principles of organic chemistry and the various reactions of organic compounds with reaction mechanisms.	K1
CO2	Understand the versatility of various special reagents and their reactivity with various reaction conditions.	K2
CO3	Implement the synthetic strategies in the preparation of various organic compounds.	K3
CO4	Predict the suitability of reaction conditions in the preparation of tailor-made organic compounds.	K4
CO5	Design and synthesize novel organic compounds with the methodologies learnt during the course.	K5

UNIT-I: Planning an Organic Synthesis and Control elements [18 Hours]

Preliminary Planning – knowns and unknowns of the synthetic system studied, analysis of the complex and interrelated carbon framework into simple rational precursors, retrosynthetic analysis, alternate synthetic routes, key intermediates that would be formed, available starting materials and resulting yield of alternative methods. Linear Vs convergent synthesis. Synthesis based on umpolung concepts of Seeback, regiospecific control elements. Use of protective groups, activating groups and bridging elements. Examples on retrosynthetic approach, calculation of yield, advantages of convergent synthesis, synthesis of stereochemistry-controlled products.

UNIT-II: Organic Synthetic Methodology [18 Hours]

Retrosynthetic analysis; Alternate synthetic routes. Synthesis of organic mono and bifunctional compounds via disconnection approach. Key intermediates, available starting materials and resulting yields of alternative methods. Convergent and divergent synthesis, Synthesis based on umpolung concepts of Seebach. Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis. Control elements: Regiospecific control elements. Use of protective groups, activating groups, and bridging elements. Stereospecific control elements. Functional group alterations and transposition.

UNIT-III: Pericyclic Reactions [18 Hours]

Woodward Hoffmann rules; The Mobius and Huckel concept, FMO, PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions; [2+2], [2+4], [4+4], Cationic, anionic, and 1,3-dipolar cycloadditions. Cheletropic reactions. Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1,3), (1,5), (3,3) and (5,5)-carbon migrations, degenerate rearrangements. Ionic sigmatropic rearrangements. Group transfer reactions. Regioselectivity, stereoselectivity and periselectivity in pericyclic reactions.

UNIT-IV: Organic Photochemistry-I [18 Hours]

Photochemical excitation: Experimental techniques; electronic transitions; Jablonskii diagrams; intersystem crossings; energy transfer processes; Stern Volmer equation. Reactions of electronically excited ketones; $\pi \rightarrow \pi^*$ triplets; Norrish type-I and type-II cleavage reactions; photo reductions; Paterno-Buchi reactions.

UNIT-V: Organic Photochemistry-I [18 Hours]

Photochemistry of α,β-unsaturated ketones; cis-trans isomerisation. Photon energy transfer reactions, Photo cycloadditions, Photochemistry of aromatic compounds; photochemical rearrangements; photo-stationery state; di-π-methane rearrangement; Reaction of conjugated cyclohexadienone to 3,4-diphenyl phenols; Barton's reactions.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Organic Chemistry	F.A. Carey and Sundberg	5th edn, Tata McGraw-Hill, New York	2003
2	Advanced Organic Chemistry	J. March and M. Smith	5th ed, John-Wiley and sons	2007
3	Organic synthesis	R.E. Ireland	Prentice Hall India, Goel publishing house	1990

4	Organic Chemistry	Clayden, Greeves, Warren	Oxford University Press, Second Edition	2016
5	Organic Synthesis	M.B. Smith	3rd edn, McGraw Hill International Edition	2011

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Pericyclic Reactions	Gill and Wills	Chapman Hall, London	1974
2	Heterocyclic Chemistry	J.A. Joule, G.F. Smith	Garden City Press, Great Britain	2004
3	Some Modern Methods of Organic Synthesis	W. Caruthers	4th edn, Cambridge University Press, Cambridge	2007
4	Modern Synthetic reactions	H.O. House	W.A. Benjamin Inc	1972
5	Photochemistry and Pericyclic Reactions	Jagdamba Singh and Jaya Singh	New Age International Publishers, New Delhi	2012

Mapping with Programme Specific Outcomes

COs/POSs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – III

CORE - VI	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH06	COORDINATION CHEMISTRY – I	Contact Hours Per Week: 6

OBJECTIVES

To gain insights into the modern theories of bonding in coordination compounds, various methods to determine the stability constants of complexes, construct correlation diagrams and predict the electronic transitions that are taking place in the complexes, substitution and electron transfer mechanistic pathways of reactions in complexes and the reactions of octahedral and square planar complexes.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand and comprehend various theories of coordination compounds.	K1
CO2	Represent the spectroscopic and magnetic properties of coordination complexes.	K2
CO3	Clarify the stability of complexes and various experimental methods.	K3
CO4	Predict the electronic transitions in a complex based on correlation diagrams and UV-visible spectral details.	K4
CO5	Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes.	K5

Unit-I: Modern theories of coordination compounds [18 Hours]

Crystal field theory - splitting of d orbitals in octahedral, tetrahedral and square planar symmetries - measurement of 10Dq - factors affecting 10Dq - Spectrochemical series - crystal field stabilisation energy for high spin and low spin complexes- evidences for crystal field splitting - site selections in spinels and antispinels - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.

Unit-II: Spectral characteristics of complexes [18 Hours]

Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation

diagrams - Sugano-Tanabe energy level diagrams - Nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.

UNIT-III: Stability and Magnetic property of the complexes [18 Hours]

Stability of complexes: Factors affecting stability of complexes, Thermodynamic aspects of complex formation, Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method, Spectrophotometric method, Ion exchange method, Polorographic method and Continuous variation method (Job's method) Magnetic property of complexes: Spin-orbit coupling, effect of spin-orbit coupling on magnetic moments, quenching of orbital magnetic moments.

UNIT-IV: Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes [18 Hours]

Inert and Labile complexes; Associative, Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square planar complexes: Trans effect, theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.

UNIT-V: Electron Transfer reactions in octahedral complexes [18 Hours]

Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox, photo-substitution and photo-isomerisation reactions in complexes and their applications.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Inorganic Chemistry – Principles of structure and reactivity	J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi	4th edn, Pearson Education Inc.	2006
2	Inorganic Chemistry	G.L. Meissler and D.A. Tarr	3rd edn, Pearson Education Inc.	2008
3	Co-ordination Chemistry	D. Bannerjea	TATA Mcgraw Hill	1993
4	Introduction to Ligand Fields	B.N. Figgis	Wiley Eastern Ltd	1976

5	Advanced Inorganic Chemistry	F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann	6th edn, Wiley Inter-science, New York	1988

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Inorganic Chemistry	Keith F. Purcell and John C. Kotz	Saunders Publications, USA	1977
2	Shriver and Atkin's Inorganic Chemistry	Peter Atkins and Tina Overton	5th edn, Oxford University Press	2010
3	Basic Inorganic Chemistry	F.A. Cotton, G. Wilkinson, P.L. Guas	3rd edn, John Wiley	2002
4	Concepts and Models of Inorganic Chemistry	B. Douglas, D. McDaniel, J. Alexander	3rd edn, John Wiley	1994
5	Inorganic Chemistry	D.F. Shriver, P.W. Atkins	W.H. Freeman and Co, London	2010

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – III

CORE PRACTICAL - III	M.Sc. Chemistry	Credits: 4
Course Code: M23PCHP03	PRACTICAL-III - PHYSICAL CHEMISTRY	Contact Hours Per Week: 6

OBJECTIVES

To understand the principle of conductivity experiments through conductometric titrations, the order of the reaction, temperature coefficient, and activation energy of the reaction by pseudo first order kinetics, the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions, the kinetics of adsorption of oxalic acid on charcoal, the potential energy diagram of hydrogen ion, charge density distribution and Maxwell's speed distribution by computational calculation.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Scientifically plan and perform all the experiments.	K3
CO2	Calculate and process the experimentally measured values and compare with graphical data.	K4
CO3	Interpret the experimental data scientifically to improve student's efficiency for societal developments.	K5

UNIT-I: Conductivity Experiments

1. Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.
2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.
3. Verification of Kohlrausch's Law for weak electrolytes.
4. Determination of solubility of a sparingly soluble salt.
5. Acid-base titration (strong acid and weak acid vs NaOH).
6. Precipitation titrations (mixture of halides only).

UNIT-II: Kinetics

1. Study the kinetics of acid hydrolysis of an ester, determine the temperature coefficient and also the activation energy of the reaction.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.

UNIT-III: Phase diagram

Construction of phase diagram for a simple binary system

1. Naphthalene-phenanthrene
2. Benzophenone- diphenyl amine

Adsorption

1. Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Practical Physical Chemistry	B. Viswanathan P.S. Raghavan	Viva Books, New Delhi	2009
2	Practical Chemistry (Part II)	Sundaram, Krishnan, Raghavan	S. Viswanathan Co. Pvt.	1996
3	Experimental Physical Chemistry	V.D. Athawale Parul Mathur	New Age International (P) Ltd., New Delhi	2008
4	Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics	E.G. Lewers	2nd edn, Springer, New York	2011

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Practical Physical Chemistry	J.B. Yadav	Goel Publishing House	2001
2	Elementary Practical Experiments in Physical Chemistry	G.W. Garland, J.W. Nibler, D.P. Shoemaker	8th edn, McGraw Hill	2009
3	Advanced Experimental Chemistry	J.N. Gurthu and R. Kapoor	S. Chand and Co.	1987
4	Physical Chemistry: A laboratory Manual	Shailendra K Sinha	Narosa Publishing House Pvt, Ltd., New Delhi	2014
5	Introduction to Computational Chemistry	F. Jensen	3rd edn, Wiley-Blackwell	2004

SEMESTER – III

ELECTIVE - IV	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE07	PHARMOCOGNOSY AND PHYTOCHEMISTRY	Contact Hours Per Week: 4

OBJECTIVES

To develop the knowledge on natural products, biological functions and pharmacological uses, primary, secondary metabolites and their sources, isolation methods and separation of bioactive compounds, glycosides and marine drugs, WHO and different sampling techniques.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the sources of natural medicines and analysis of crude drugs.	K1
CO2	Understand the methods of evaluation based on various parameters.	K2
CO3	Analyze the isolated drugs	K3
CO4	Apply various techniques to discover new alternative medicines.	K4
CO5	Evaluate the isolated drugs for various pharmacological activities	K5

UNIT-I: Pharmacognosy and Standardization of Herbal drugs [12 hours]

Introduction, definition, development classification and Source of Drugs: Biological, mineral, marine and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines, Sampling of crude drug, Methods of drug evaluation. Determination of foreign matter, moisture Ash value. Phytochemical investigations-General chemical tests.

UNIT-II: Extraction Techniques [12 hours]

General methods of extraction, types – maceration, Decoction, percolation, Immersion and soxhlet extraction. Advanced techniques- counter current, steam distillation, supercritical gases, sonication, Microwaves assisted extraction. Factors affecting the choice of extraction process.

UNIT-III: Drugs containing terpenoids and volatile oils [12 hours]

Terpenoids: Classification, Isoprene rule, Isolation and separation techniques, General properties Camphor, Menthol, Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations, Classifications of Volatile oils, Camphor oil, Geranium oil, Citral - Structure uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.

UNIT-IV: Drugs containing alkaloids [12 hours]

Occurrence, function of alkaloids in plants, pharmaceutical applications. Isolation, Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine, Reserpine, papaverine - chemical properties, structure and uses. papaverine - structure, chemical properties and uses.

UNIT-V: Plant Glycosides and Marine drugs [12 hours]

Glycosides: Basic ring system, classification, isolation, properties, qualitative analysis. Pharmacological activity of Senna glycosides, Cardiac glycosides-Digoxin, digitoxin, Steroidal saponins glycosides- Diosgenin, hecogenin. Plant pigments: Occurrence and general methods of structure determination, isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected Drug Molecules: Cardiovascular active substances, Cytotoxic compounds, antimicrobial compounds, antibiotic compounds, Anti-inflammatory agents. Marine toxins.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Organic chemistry of Natural products, Volume I & II	Gurdeep R Chatwal	5th edn, Himalaya publishing House	2016
2	Chemistry of Natural Products	S.V. Bhat and B.A. Nagasampagi	Revised edition, Narosa Publishers	2014

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Phytochemical methods: A Guide to Modern Techniques of Plant Analysis	Jeffrey B. Harborne	4th edn, Indian reprint, Springer	2012
2	Pharmacognosy and Pharmacobiotechnology	Ashutosh kar	New age international (P) limited, New Delhi	2007

Mapping with Programme Specific Outcomes

COs/PSOs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – III

ELECTIVE - IV	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE08	BIOMOLECULES AND HETEROCYCLIC COMPOUNDS	Contact Hours Per Week: 4

OBJECTIVES

To learn the basic concepts and biological importance of biomolecules such as carbohydrates, proteins, nucleic acids, steroids and hormones, the functions of alkaloids and terpenoids, the structure determination of biomolecules and natural products, the structure of new alkaloids and terpenoids from different methods.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the basic concepts of biomolecules and natural products.	K1
CO2	Integrate and assess the different methods of preparation of structurally different biomolecules and natural products.	K2
CO3	Illustrate the applications of biomolecules and their functions in the metabolism of living organisms.	K3
CO4	Analyse the structure and synthesis of heterocyclic compounds.	K4
CO5	Justify the structure of biologically important heterocyclic compounds by different methods.	K5

UNIT-I: Chemistry and metabolism of carbohydrates [12 hours]

Definition, classification and biological role of carbohydrates. Monosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structure determination not required), physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) – occurrence, physical and chemical properties of maltose, lactose and sucrose. Polysaccharides: Starch, glycogen and cellulose – structure and properties, glycolysis of carbohydrates.

UNIT-II: Steroids and Hormones [12 hours]

Steroids: Introduction, occurrence, nomenclature, configuration of substituents. Diels' hydrocarbon, stereochemistry, classification, Diels' hydrocarbon, biological importance, colour reactions of sterols, cholesterol-occurrence, tests, physiological activity, biosynthesis of cholesterol from squalene. Hormones: Introduction, classification, functions of sex hormones-

androgens and estrogens, adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones - adrenaline and thyroxin.

UNIT-III: Proteins and nucleic acids [12 hours]

Separation and purification of proteins – dialysis, gel filtration and electrophoresis. Catabolism of amino acids - transamination, oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and urea cycle. Structure, methods for the synthesis of nucleosides - direct combination, formation of heterocyclic base and nucleoside modification, conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA, Watson - Crick Model, solid phase synthesis of oligonucleotides.

UNIT-IV: Vitamins [12 hours]

Introduction, Classification, Sources and deficiency diseases. Structural determination and synthesis of Vitamin A1, Vitamin B6, Vitamin B12, Folic acid, Vitamin H, Vitamin E and Vitamin K2.

UNIT-V: Fused Ring Heterocyclic Compounds [12 hours]

Benzofused five membered rings: Indole, isoindole, benzofuran and benzothiophene, Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions, Reactions: Mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Essentials of Carbohydrate Chemistry and Biochemistry	T.K. Lindhorst	Wiley VCH, North America	2007
2	Organic Chemistry Vol-2	I.L. Finar	5th edn, Pearson Education Asia	1975
3	Textbook of Heterocyclic compounds	V.K. Ahluwalia and M. Goyal	Narosa Publishing, New Delhi	2000
4	Modern Organic Chemistry	M.K. Jain and S.C. Sharma	Vishal Publishing Co., Jalandhar, Delhi	2014
5	Steroids and Hormones	V.K. Ahluwalia	Ane books pub., New Delhi.	2009

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Organic Chemistry Vol-1	I.L. Finar	6th edn, Pearson Education Asia	2004
2	Chemistry of Alkaloids	Pelletier	Van Nostrand Reinhold Co	2000
3	Chemistry of the steroids	Shoppe	Butterworthes	1994
4	Role of Biotechnology in medicinal & aromatic plants, Vol-I and Vol-II	I.A. Khan and A. Khanum	Ukkaz Publications, Hyderabad	2004
5	Medicinal Herbs with their formulations	M.P. Singh and H. Panda	Daya Publishing House, Delhi	2005

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER-III

ELECTIVE-V	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE09	BIO-INORGANIC CHEMISTRY	Contact Hours Per Week: 4

OBJECTIVES

To understand the role of trace elements, the biological significance of iron, sulphur, the toxicity of metals in medicines, diagnostic agents and various metalloenzymes properties.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the trace elements.	K1
CO2	Classify the biological redox systems.	K2
CO3	Apply skill in analyzing the toxicity in metals.	K3
CO4	Inspect experience in diagnosis.	K4
CO5	Explain the nitrogen fixation and photosynthetic mechanism.	K5

UNIT-I: Essential trace elements [12 hours]

Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins. Metalloenzymes: Zinc enzymes – carboxypeptidase and carbonic anhydrase. Iron enzymes – catalase, peroxidase. Copper enzymes – superoxide dismutase, Plast ocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.

UNIT-II: Transport Proteins [12 hours]

Oxygen carriers - Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN^- to Myoglobin and Hemoglobin. Biological redox system: Cytochromes - Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers - Hemerythrin and hemocyanin. Iron-sulphur proteins - Rubredoxin and Ferredoxin - Structure and classification.

UNIT-III: Nitrogen fixation [12 hours]

Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase - redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem-II-chlorophylls structure and function.

UNIT-IV: Metals in medicine **[12 hours]**

Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic compounds: Vanadium based diabetes drugs; Platinum containing anticancer agents. Chelation therapy; Cancer treatment. Diagnostic agents: Technetium imaging agents; Gadolinium MRI Imaging Agents. Temperature and critical magnetic Field.

UNIT-V: Enzymes **[12 hours]**

Introduction and properties - nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Introduction to Bioinorganic chemistry	D.R. Williams	John Wiley	2000
2	The Principles of Bioinorganic Chemistry	F.M. Fiabre and D.R. Williams	Royal Society of Chemistry	2010
3	Inorganic chemistry	K.F. Purcell and Kotz	WB Saunders Co., USA.	1998
4	Elements of Bioinorganic Chemistry	G.N. Mugherjea and Arabinda Das	S. Chand	1993
5	Concise Coordination Chemistry	R. Gopalan and V. Ramalingam	S. Chand	2001

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Bioinorganic Chemistry	M. Satake and Y. Mido	Discovery Publishing House, New Delhi	1996
2	The Inorganic Chemistry of Biological processes	M.N. Hughes	2nd edn, Wiley London	1982
3	Bio Inorganic Chemistry	R.W. Hay	Ellis Horwood	1987
4	Bio Inorganic Chemistry	R.M. Roat-Malone	John Wiley	2002
5	Iron carriers and Iron proteins	T.M. Loehr	VCH	1989

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER-III

ELECTIVE-V	M.Sc. Chemistry	Credits: 3
Course Code: M23PCHE10	MATERIAL SCIENCE	Contact Hours Per Week: 4

OBJECTIVES

To understand the crystal structure, growth methods and X-ray scattering, the optical, dielectric and diffusion properties of crystals, the basis of semiconductors, superconductivity materials and magnets, the synthesis, classification and applications of nanomaterials, the importance of materials used for renewable energy conversion.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	K1
CO2	Assess the structure of different materials and their properties.	K2
CO3	Analyze new materials for energy applications.	K3
CO4	Explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.	K4
CO5	Plan new materials with improved property for energy applications.	K5

UNIT-I: Crystallography [12 hours]

Symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X-ray diffraction-Laue equations-Bragg's law - reciprocal lattice and its application to geometrical crystallography. Crystal structure – powder and single crystal applications. Electron charge density maps, neutron diffraction method and applications.

UNIT-II: Crystal growth methods [12 hours]

Nucleation – equilibrium stability and metastable state. Single crystal – Low and high temperature, solution growth-gel and sol-gel. Crystal growth methods – nucleation – equilibrium stability and metastable state. Single crystal – Low and high temperature, solution growth-gel and sol-gel. Melt growth - Bridgeman-Stockbarger, Czochralski methods. Flux technique,

physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.

UNIT-III: Properties of crystals [12 hours]

Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies-Polarization - electronic, ionic, orientation, and space charge polarization. Effect of temperature. Dielectric constant, dielectric loss. Types of dielectric breakdown – intrinsic, thermal, discharge, electrochemical and defect breakdown.

UNIT-IV: Special Materials: Superconductivity [12 hours]

Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and gian magneto resistance. Ferro, ferri and antiferromagnetic materials-applications, magnetic parameters for recording applications. Ferro-, Piezo-, and pyro electric materials – properties and applications. Shape memory Alloys-characteristics and applications, Non-linear optics-Second Harmonic Generators, mixing of Laser wavelengths by quartz, ruby and $LiNbO_3$.

UNIT-V: Materials for Renewable Energy Conversion [12 hours]

Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO_2 and N_2. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Principles of Materials Science	S. Mohan and V. Arjunan	MJP Publishers	2016
2	Materials Science	Arumugam	Anuradha Publications	2007
3	Fundamentals of Crystallography	Giacavazzo	Oxford Science Publications	2010
4	An Introduction to Crystallography	Woolfson	Cambridge University Press	2012

5	Introduction to Materials Science for Engineers	J.F. Shackelford M.K. Muralidhara	6th edn, Pearson Press	2007

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Solid State Chemistry	M.G. Arora	Anmol Publications, New Delhi	2001
2	Solid State Physics	R.K. Puri and V.K. Babbar	S. Chand and Company Ltd	2001
3	Solid State Physics	C. Kittel	John-Wiley and sons, NY	1966
4	Introductory Solid State Physics	H.P. Meyers	Viva Books Private Limited	1998
5	Solid State Chemistry and Applications	A.R. West	John-Wiley and sons	1987

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S - Strong, **M -** Medium

SEMESTER – III

SEC-II	M.Sc. Chemistry	Credits: 2
Course Code: M23PCHS02	**PREPARATION OF CONSUMER PRODUCTS**	**Contact Hours Per Week: 2**

OBJECTIVES

To this course focuses on provide basic knowledge in consumer product chemistry and modern trends in the cosmetic products such as soaps, detergents, shampoos, hair dye, perfumes, candles, inks etc.,

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the basic formulation methods of cleansing agents, hair care products, perfumes, candles, inks, dental care and cosmetic products.	K1
CO2	Compare the kind of chemicals used in the manufacturing of cleansing agents, hair dyes, hair colorants, candles, inks, dental preparations and cosmetics.	K2
CO3	Examine the mechanism of action of detergents, manufacture of conditioners, extraction of essential oils, skin bleaching agents and making of dust-free chalks.	K3
CO4	Inspect the significance of non-ionic detergents, vegetable dyes, solvent extraction methods, optical brighteners, turmeric and neem preparations.	K4
CO5	Evaluate the applications of liquid detergents, temporary hair colorants, manufacture of fruit flavored perfumes, functions of mouth washes and Sun screen preparations.	K5

UNIT-I: Soaps and Detergents [12 hours]

Soaps: Saponification of oils and fats. Basic principle and mechanism of cleansing action of soap. Manufacture of soaps. Chemicals used in soap formation and their structure. Difference between soaps and detergents - Laboratory preparation of soaps and detergents.

Detergents: Classification of detergents - Anionic detergents, cationic detergents, non-ionic detergents with examples. Manufacture and applications. Mechanism of action of detergents. Synthesis of LAB (linear alkyl benzene). Sulphonation of LAB – preparation of acid slurry. Different ingredients in the formulation of detergent powders and soaps. Liquid

detergents. Foam boosters. AOS (alpha olefin sulphonates). Biodegradation – environmental effects.

UNIT-II: Shampoos, Hair dye and Hair colorants [12 hours]

Shampoos: Manufacture of shampoos - Ingredients and Functions. Different kinds of shampoos – anti-dandruff, anti-lice, herbal and baby shampoos. Manufacture of conditioners. Coco betaines or coco diethanolamides – ISI specifications. Testing procedures and limits.

Hair dye and Hair colorants: Hair lighteners and bleaches -temporary colorants - semi and permanent colorants - vegetable dyes -oxidation dyes and modifiers.

UNIT-III: Natural and Artificial Perfumes [12 hours]

Natural perfumes: plant and animal sources – examples – components of perfume – vehicle – characteristics of good vehicle - fixatives and its types, odoriferous compounds, extraction of essential oils by distillation, enflurege and solvent extraction methods.

Artificial perfumes: Preparation and uses of methyl anthranilate, methyl salicylate, methyl cinnamate, phenyl ethanol, citronellol, vanillin, coumarin and heliotrope. Composition and manufacture of perfumery compounds: Rose and Jasmine – Composition and preparation of rose and jasmine perfumes – manufacture of fruit flavors – fruit syrup preparation and composition of apple and pineapple flavors.

UNIT-IV: Candles, Inks, Dental cares, Optical brighteners and Bleacher [12 hours]

Candles: Types of candles – raw materials – machinery – method of candle making. Chalk – dust free chalk. Crayons – machines and method. Inks: Types-blue, red, black, green and rubber stamp ink – composition-preparation shoe polish – basic ingredients – preparation method.

Dental care preparations: Classifications - tooth paste – toothpowder - oral rinses - mouth washes: Ingredients, their characteristics and functions – Mouth washes. Optical brighteners and bleachers – Classification and the chemicals used in their formulations.

UNIT-V: Skin Protectors, Nail Polishes and Deodorants [12 hours]

Skin Protectors: Face and skin powders - ingredients, functions. Different types. Snows and face creams. Chemical ingredients used. Anti perspirants. Sun screen preparations. UV absorbers. Skin bleaching agents. Depilatories. Turmeric and Neem preparations. Vitamin oil.

Nail polishes: nail polish preparation, nail polish removers. Article removers. Lipsticks, roughes, eyebrow pencils. Ingredients and functions – hazards. Deodorants – Antiperspirants - distinction between astringents and deodorants – formulation – lotions – perfumes - formulation. Lipsticks - classification and formulation.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Industrial Chemistry: including chemical – engineering	B.K. Sharma	16th edn, Goel publishing house, Meerut.	2011
2	Textbook of Cosmetics	R.K. Nema	CBS, Publisher	2017
3	Outlines of chemical technology	S. Gobala Rao	Affiliated East West press.	1998

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Engineering chemistry fundamentals & Applications	Shikha, Agarwal	Cambridge University Press.	2016
2	Cosmetic Formulation: Principles and Practice	Heather A.E. Benson, Michael S. Roberts, Vania Rodrigues Leite-Silva, Kenneth Walters	CRC Press Publisher.	2021
3	Encyclopedia of Chemical Technology	Kirk Othmer	John Wiley and Sons, New York	1999

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – IV

CORE - VII	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH07	COORDINATION CHEMISTRY – II	Contact Hours Per Week: 6

OBJECTIVES

To recognize the fundamental concepts, structural aspects, reaction and their catalytic behaviour of organometallic compounds and to identify or predict the structure of coordination compounds using spectroscopic tools.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify 18 and 16 electrons organometallic compounds.	K1
CO2	Illustrate the structure and bonding in olefin, allyl, cyclopentadienyl and carbonyl containing organometallic compounds.	K2
CO3	Show the reactions of organometallic compounds and apply them.	K3
CO4	Elaborate the catalytic cycles.	K4
CO5	Predict the structure of coordination complexes using spectroscopic tools such as IR, NMR, ESR, Mossbauer and optical rotatory dispersion studies.	K5

UNIT-I: Chemistry of organometallic compounds [18 Hours]

Classification of organometallic compounds based on M-C bond – 18 and 16 electron rule; Bonding in metal – olefin complexes (example: Zeisel's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples and MO approach to bonding in metallocenes; fluxional isomerism. Metal – carbonyl complexes: MO diagram of CO; Structure and bonding − bonding modes, MO approach of M-CO bonding, π-acceptor nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters – Structures based on polyhedral skeleton electron pair theory or Wade's rule.

UNIT-II: Reactions and catalysis of organometallic compounds [18 Hours]

Reactions of organometallic compounds: Oxidative addition, reductive elimination (α and β eliminations), migratory insertion reaction and metathesis reaction. Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium

catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclo-oligomerisation of acetylenes using Reppe's catalysts, Monsonto process.

UNIT-III: Inorganic spectroscopy –I [18 Hours]

IR spectroscopy: Effect of coordination on the stretching frequency- sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes; IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction, applications of ^{1}H, ^{15}N, ^{19}F, ^{31}P-NMR spectroscopy in structural identification of inorganic complexes, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy.

UNIT-IV: Inorganic spectroscopy-II [18 Hours]

Introductory terminologies: g and A parameters-definition, explanation and factors affecting g and A; Applications of ESR to coordination compounds with one and more than one unpaired electrons – hyperfine and secondary hyperfine splitting and Kramer's doublets; ESR spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II), Cu(II) complexes, bis(salicylaldimine)copper(II) and $[(NH_3)_5Co\text{-}O_2\text{-}Co(NH_3)_5]^{5+}$. Mossbauer spectroscopy – Mossbauer effect, Recoil energy, Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.

UNIT-V: Photo Electron Spectroscopy [18 Hours]

Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules (N_2, O_2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H_2O, CO_2, CH_4, NH_3) – evaluation of vibrational constants of the above molecules. Koopman's theorem- applications and limitations. Optical Rotatory Dispersion – Principle of CD and ORD; Δ and λ isomers in complexes, Assignment of absolute configuration using CD and ORD techniques.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Inorganic Chemistry – Principles of structure and reactivity	J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi	4th Edn, Pearson Education Inc.	2006
2	Inorganic Chemistry	G.L. Meissler and D.A. Tarr	3rd Edn, Pearson Education Inc.	2008
3	Coordination Chemistry	D. Bannerjea	TATA Mcgraw Hill	1993

4	Basic Organometallic Chemistry: Concepts, Syntheses and Applications	B.D Gupta and A.K. Elias	University Press	2013
5	Advanced Inorganic Chemistry	F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann	6th edn, Wiley Inter-science, New York	1988

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	The Organometallic Chemistry of the Transition Metals	Crabtree, Robert H	3rd edn, John Wiley, New York	2000
2	Mossbauer Spectroscopy and Transition Metal Chemistry: Fundamentals and Applications	P Gütlich, E. Bill, A.X. Trautwein	Springer-Verlag Berlin Heidelberg	2011
3	Inorganic Chemistry	K.F. Purcell, J.C. Kotz	Saunders: Philadelphia	1976
4	Concepts and Models of Inorganic Chemistry	B. Douglas, D. McDaniel, J. Alexander	3rd edn, John Wiley	1994
5	PhysicaI Methods in Chemistry	R.S. Drago	Saunders: Philadelphia	1977

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – IV

CORE - VIII	M.Sc. Chemistry	Credits: 5
Course Code: M23PCH08	PHYSICAL CHEMISTRY-II	Contact Hours Per Week: 6

OBJECTIVES

To understand the essential characteristics of wave functions and need for the quantum mechanics, quantum mechanical models of particle in a box, rigid rotor and harmonic oscillator, the quantum mechanics to hydrogen and polyelectronic systems, the symmetry in molecules and predict the point groups, the vibrational modes, hybridization using he concepts of group theory.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Discuss the characteristics of wave functions and symmetry functions.	K1
CO2	Classify the symmetry operation and wave equations.	K2
CO3	Apply the concept of quantum mechanics and group theory to predict the electronic structure.	K3
CO4	Specify the appropriate irreducible representations for theoretical applications.	K4
CO5	Develop skills in evaluating the energies of molecular spectra.	K5

UNIT-I: Quantum Mechanics [18 Hours]

Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, orthonormal, Eigen values, Eigen functions, Hermitian properties of operators. Introduction to quantum mechanics - black body radiation, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent and time dependent.

UNIT-II: Quantum models [18 Hours]

Particle in a box - 1D, two dimensional and three - dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator-wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of rotational constants and bond length of diatomic molecules.

UNIT-III: Applications to Hydrogen and Poly electron atoms [18 Hours]

Hydrogen atom and hydrogen like ions, Hamiltonian - wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods – variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hatrefock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, Paulis exclusion principle and Slater determination.

UNIT-IV: Group theory [18 Hours]

Groups, sub groups, symmetry elements, operations, classification - axial and non-axial. Dihedral point groups - C_n, C_{nh}, D_n, D_{nh}, D_{nd}, Td and Oh. Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for C_{2v}, C_{2h}, C_{3v} and D_{2h} point groups.

UNIT-V: Applications of quantum and group theory [18 Hours]

Hydrogen Molecule - Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Quantum Chemistry	R.K. Prasad	4th revised edn, New Age International Publishers, New Delhi.	2010
2	Chemical Applications of Group Theory	F.A. Cotton	2nd edn, John Wiley & Sons.	2003
3	Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications	A. Vincent	2nd edn, John and Willy & Sons Ltd.	2013
4	Quantum Chemistry and Spectroscopy	T. Engel & Philip Reid	4th edn, Pearson, New Delhi.	2018
5	Physical Chemistry	G.K. Vemulapalli	Prentice Hall of India Pvt. Ltd.	2001
6	Quantum Chemistry	D.A. McQuarrie	2nd edn, Viva Books PW. Ltd.	2013

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Quantum Chemistry	N. Levine	Allyn & Bacon Inc	1983
2	Physical Chemistry- A Molecular Approach	D.A. McQuarrie, J.D. Simon	Viva Books Pvt. Ltd, New Delhi	2012
3	An Introduction to Quantum Mechanics of Chemical Systems	R.P. Rastogi V.K. Srivastava	Oxford & IBH Publishing Co., New Delhi	1999
4	Symmetry Group Theory and Chemical applications	R.L. Flurry	Prentice Hall. Inc	1980
5	Symmetry in Molecules	J.M. Hollas	Chapman and Hall, London, Reprint.	2011

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – IV

CORE PRACTICAL - IV	M.Sc. Chemistry	Credits: 4
Course Code: M23PCHP04	PRACTICAL-IV - ANALYTICAL INSTRUMENTATION TECHNIQUES	Contact Hours Per Week: 6

OBJECTIVES

To design chromatographic methods for identification of species, different constituents through instrumental methods of analysis, contaminants in materials using turbidimetry and conductivity measurements, experiments for analysis of inorganic and organic materials, constituents in materials using emission and absorption techniques.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Observe and record systematically the readings in all the experiments	K3
CO2	Calculate and process the experimentally measured values and compare with graphical data.	K4
CO3	Interpret the experimental data scientifically to improve student's efficiency for societal developments.	K5

UNIT-I:

1. Determination of the equivalent conductance of a weak acid at different concentrations and verifying Ostwald dilution law. Calculation of the dissociation constant of the acid.
2. Determination of the equivalent conductance of a strong electrolyte at different concentrations and examining the validity of the Onsager's theory as limiting law at high dilutions.
3. Conductometric titration of a mixture of HCl and CH_3COOH Vs NaOH.
4. Conductometric titration of NH_4Cl Vs NaOH.
5. Conductometric titration of CH_3COONa Vs HCl.
6. Potentiometric titration of a mixture of HCl and CH_3COOH Vs NaOH
7. Determination of pKa of weak acid by EMF method.
8. Potentiometric titration of FAS Vs $K_2Cr_2O_7$.
9. Potentiometric titration of KI Vs $KMnO_4$.
10. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$.
11. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.

12. Study of the inversion of cane sugar in the presence of acid by Polarimetric method.

UNIT-II:

1. Estimation of Fe, Cu and Ni by colorimetric method.
2. Estimation of Na and K by flame photometric method.
3. Determination of spectrophotometrically the mole ratio of the ferrithiocyanate complex and equilibrium constant for the complex formation.
4. Determination of the amount (mol/L) of ferricyanide present in the given solution using cyclic voltammetry.
5. Determination of the diffusion coefficient of ferricyanide using cyclic voltammetry.
6. Determination of the standard redox potential of ferri-ferrocyanide redox couple using cyclic voltammetry.
7. Estimation of the amount of sulphate present in the given solution using Nephelometric turbidimeter.
8. Estimation of the amount of nitrate present in the given solution using spectrophotometric method.
9. Heavy metal analysis in textiles and textile dyes by AAS.
10. Determination of caffeine in soft drinks by HPLC.
11. Analysis of water quality through COD, DO, BOD measurements.
12. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry.
13. Estimation of chromium in steel sample by spectrophotometry.
14. Determination of Stern-Volmer constant of Iodine quenching by fluorimetry.
15. Determination of ascorbic acid in real samples using Differential Pulse Voltammetry and comparing with specifications.
16. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography.
17. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.
18. Estimation of Fe(II) by 1,10 phenonthroline using spectrophotometry.

UNIT-III:

Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments

1. UV-Visible
2. IR
3. Raman
4. NMR
5. ESR
6. Mass etc.,

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Practical Physical Chemistry	B. Viswanathan P.S. Raghavan	Viva Books, New Delhi	2009
2	Practical Chemistry (Part II)	Sundaram, Krishnan, Raghavan	S. Viswanathan Co. Pvt.	1996
3	Inorganic Experiments	J.D. Woollins	VCH: Weinheim	1995
4	Vogel's Text book of Practical Organic Chemistry	Vogel	5th edn, ELBS / Longman, England	2003
5	Practical Chemistry (Part II)	Sundaram, Krishnan, Raghavan	S. Viswanathan Co. Pvt	1996

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Advanced Practical Physical Chemistry	J.B. Yadav	Goel Publishing House	2001
2	Organic Chemistry – Lab manual	N.S. Gnanapragasam and G. Ramamurthy	S. Viswanathan Co. Pvt. Ltd	2009
3	Advanced Experimental Chemistry	J. N. Gurthu and R. Kapoor	S. Chand and Co.	1987
4	Experiments in Physical Chemistry	G.W. Garland, J.W. Nibler, D.P. Shoemaker	8th edn, McGraw Hill	2009
5	Advanced Experimental Chemistry	J.N. Gurthu and R. Kapoor	S. Chand and Co.	1987

SEMESTER-IV

SEC-III	M.Sc. Chemistry	Credits: 2
Course Code: M23PCHS03	CHEMISTRY FOR ADVANCED RESEARCH STUDIES	Contact Hours Per Week: 4

OBJECTIVES

On completion of this course student shall know the importance of research, methodology of writing thesis, Journal articles and errors involved in chemical analysis.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the meaning of research.	K1
CO2	Acquire knowledge about errors involved in chemical analysis.	K2
CO3	Analyze about sampling techniques.	K3
CO4	Relate ideas regarding research and thesis writing.	K4
CO5	Develop knowledge about the use of tools and Softwares in research.	K5

UNIT-I: Meaning of Research [12 hours]

The search for knowledge, purpose of research, scientific method, role of theory, characteristics of research. Types of research: fundamental or pure research, applied research, action research, historical research, experimental research. Criteria of good research, Defining and formulating the research problem, selecting problem, necessity of defining the problem. Research ethics.

UNIT-II: Errors involved in Chemical Analysis [12 hours]

Classification, minimization of errors, determination of accuracy of results, reliability of results, rounding numbers - Significant figures - Mean standard deviation. Types of correlation, correlation coefficient, Regression analysis. Binomial, normal distribution – Hypothesis generation and testing of hypothesis.

UNIT-III: Sampling [12 hours]

Introduction - Definitions, theory of sampling - techniques of sampling – Statistical criteria of good sampling & required size - Stratified sampling Vs random sampling.

UNIT-IV: Thesis Writing **[12 hours]**

Nature and purpose, the components of dissertation, overview, title and title page, abstract, preface and table of contents, Introduction, results, discussion, conclusion, experimental section, references and miscellaneous components. Preparation of dissertation.

UNIT-V: Writing techniques **[12 hours]**

Introduction, word processing and page layout, hardware and operating systems, word processing and page layout software, writing and formatting with computer, becoming accustomed to your system.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Research Methodology Methods & Techniques	C.R. Kothari	New Age International Publishers	2011
2.	Research Methodology	Y.K. Singh, R. Nath	APH Publishing Corporation	2005
3.	Methods in Social Research	W.J. Goode, P.K. Hatt	McGraw-Hill, New York	1982

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Basic research methods for librarians	L.S. Connaway R.R. Powell	Libraries unlimited California.	2010
2.	Research methodology in Library and information science	A. Glootenberg	Uxbridge: Koros	2013

Mapping with Programme Specific Outcomes

Cos/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

EXTRA DISCIPLINARY COURSE

SEMESTER – II

EDC-I	OTHER DEPARTMENT	Credits: 2
Course Code: M23PCHED1	FOOD PROCESSING AND PRESERVATION	Contact Hours Per Week: 4

OBJECTIVES

To this course explains about food processing and different methods of preparing food using additives.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain food science and know about cooking objectives.	K1
CO2	Classify the advantage and disadvantages of Microwave cooking & Solar cooking.	K2
CO3	Identify food adulterants and Changes in food constituents due to spoilage.	K3
CO4	Examine methods of food preservation.	K4
CO5	Analyze the functions and uses of food additives.	K5

UNIT-I: Introduction to food [12 Hours]

Source, functions of food – food groups – food guide – basic five food groups, usage of the food guide – food in relation to health. Cooking - Objectives, limitations, preliminary preparations - Cleaning, Peeling and Stringing, Cutting and Grating, Sieving, Soaking, Processing, Coating, Blanching, Marinating, Sprouting, Fermentation, Grinding, Filtering, Roasting.

UNIT-II: Cooking Methods [12 Hours]

Classification of cooking methods - Moist heat methods - Boiling, Simmering, Poaching, Stewing, Steaming, Pressure cooking. Dry heat methods - Air as medium of cooking - Grilling, Pan broiling, baking. Fat as medium of cooking - sautéing, shallow fat frying, deep fat frying. Microwave cooking - Advantages and disadvantages. Solar cooking - Advantages and disadvantages.

UNIT-III: Food Adulterants and Food spoilage [12 Hours]

Food Adulterants: Common adulterants in different foods – milk and milk products, vegetable oils, and fats, spices and condiments, cereals,

pulses, sweetening agents and beverages. Contamination with toxic chemicals – pesticides and insecticides. Principles involved in the analysis of detection and prevention of food adulteration. Food spoilage: Microbiological spoilage - Moulds, yeasts, pseudo yeasts, viruses, bacteria. Biochemical spoilage - spoilage by insects, Parasites and Rodents. Mechanical spoilage, Chemical spoilage. Changes in food constituents due to spoilage.

UNIT-IV: Food Preservation [12 Hours]

Principles of food preservation-Preservation by low temperature - Freezing, slow freezing, quick freezing process, dehydro freezing, freezing foods, effect of freezing and nutritive value. Preservation by high temperature - Pasteurization, Canning. Preservation by preservatives, Preservation by high Osmotic pressure, Preservation by dehydration and by irradiation.

UNIT-V: Food Additives [12 Hours]

Definition, need for additives, functions and uses of food additives. Classification of food additives - preservatives, antioxidants, sequestrants, surface active agents, bleaching and maturing agents, starch modifiers, flavoring agents and flavour enhancers, non - nutritive dietary sweetners, nutrient supplements, food colours, stabilizers and thickeners.

TEXT BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Food Science	B. Srilakshmi	New Age Internationl Pvt Ltd	2003
2.	Food Chemistry	Seema Yadav	Anmol publishing (P) Ltd, New Delhi	2002
3.	Foods: Facts and Principles	N. Shakuntala Manay, M. Shadaksharaswamy	New Age International Publishers	2008

REFERENCE BOOKS

S. No	Title of the Book	Author	Publishing Company	Year
1.	Text Book on Food storage and Preservation	Vijaya Khader	Kalyani Publishers	1999
2.	Food Chemistry	Alex V Ramani	MJP Publishers	2009
3.	Food Processing and Preservation	Sivasankar	PHI. (Eastern Economy Editions)	2004

4.	Advanced Text Book on Food and Nutrition Vol. I & II	M. Swaminathan	Bapcco Ltd	2015
5.	Food Science	Owen R. Fennema	Marcel Dekker Publishers	2007

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium

SEMESTER – II

EDC-I	OTHER DEPARTMENT	Credits: 2
Course Code: M23PCHED2	**CHEMISTRY OF CONSUMER PRODUCTS**	**Contact Hours Per Week: 4**

OBJECTIVES

To this course focuses to provide basic knowledge in consumer product chemistry and modern trends in the cosmetic products.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify the kinds of consumer products.	K1
CO2	Relate the kind of chemicals used in the manufacturing of consumer product.	K2
CO3	Examine the basic formulation methods and mechanism of action of consumer product.	K3
CO4	Inspect the significance of consumer products, Hazards and ISI specifications.	K4
CO5	Evaluate the applications of inorganic consumer products. Soaps and detergents, shampoos, hairdye, candles, inks and dental care products.	K5

UNIT-I: Inorganic Consumer Products [12 Hours]

Ceramic materials: cement – Preparation, Properties and Uses. Glass - Preparation, Properties and Uses. Graphite - Preparation, Properties and Uses. Silica Aerogel - Preparation, Properties and Uses. Plastic - Preparation, Properties and Uses. Paint and Varnish: Paint – Definition – Components of Paints and their functions – Varnish – Definition – Preparation of Oil Varnish – Differences between Paint and Varnish.

UNIT-II: Soaps and Detergents [12 Hours]

Soaps: Saponification of oils and fats. Manufacture of soaps. Formulation of toilet soaps. Different ingredients used. Their functions. Mechanism of action of soap. ISI specifications. Testing procedures/limits.

Detergents: Classification of detergents - Anionic detergents, cationic detergents, non-ionic detergents with examples. Anionic detergents: Manufacture of LAB (linear alkyl benzene). Sulphonation of LAB. Preparation of acid slurry. Different ingredients in the formulation of detergent powders and soaps. Liquid detergents. Foam boosters. AOS (alpha olefin sulphonates. Comparison of soaps and detergents. Biodegradation – environmental effects. ISI specifications / limits.

UNIT-III: Shampoos, Hair dye and Hair colorants [12 Hours]

Shampoos: Manufacture of shampoos - Ingredients and Functions. Different kinds of shampoos – anti-dandruff, anti-lice, herbal and baby shampoos. Manufacture of conditioners. Coco betaines or coco diethanolamides – ISI specifications. Testing procedures and limits.

Hair dye and Hair colorants: Hair lighteners and bleaches -temporary colorants - semi and permanent colorants - vegetable dyes -oxidation dyes and modifiers.

UNIT-IV: Candles, Inks and Dental cares [12 Hours]

Candles: Types of candles – raw materials – machinery – method of candle making. Chalk – dust free chalk. Crayons – machines and method. Inks: Types - blue, red, black, green and rubber stamp ink – composition – preparation. Shoe polish – basic ingredients – preparation method.

Dental care preparations: Classifications - tooth paste – toothpowder - oral rinses. Mouth washes: Ingredients, their characteristics and functions.

UNIT-IV: Skin Preparations [12 Hours]

Face and skin powders: Ingredients, functions. Different types. Snows and face creams: Chemical ingredients used. Antiperspirants. Sun screen preparations. UV absorbers. Skin bleaching agents. Depilatories. Turmeric and Neem preparations. Vitamin oil.

Nail polishes: nail polish preparation, nail polish removers. Article removers. Lipsticks, roughes, eyebrow pencils. Ingredients and functions – hazards. ISI specifications.

TEXT BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Industrial Chemistry: including chemical – engineering	B.K. Sharma	Goel publishing house, Meerut. 16th Edition.	2011
2	Textbook of Cosmetics	R.K. Nema	CBS, Publisher	2017
3	Outlines of chemical technology	S. Gobala Rao	Affiliated East West press	1998

REFERENCE BOOKS

S. No.	Title	Author	Publishing Company	Year
1	Engineering chemistry fundamentals & Applications	Shikha, Agarwal	Cambridge University Press.	2016

2	Cosmetic Formulation: Principles and Practice	Heather A.E. Benson, Michael S. Roberts, Vania Rodrigues Leite-Silva, Kenneth Walters	CRC Press Publisher.	2021
3	Encyclopedia of Chemical Technology	Kirk Othmer	John Wiley and Sons, New York	1999

Mapping with Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	M
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	M	S	S	S	S
CO5	M	S	M	S	S

S – Strong, **M –** Medium