Kurukshetra University, Kurukshetra
(Established by the State Legislature Act XII of 1956)
('A^{+}' Grade, NAAC Accredited)

(Perform Actions while Steadfasting in the State of Yoga)

DEPARTMENT OF CHEMISTRY
(DOCHEM)

CBCS CURRICULUM (2020-21)
M.Sc. Chemistry

(For the Batches Admitted From 2020-2021)

OUTCOME BASED EDUCATION SYSTEM /
LEARNING OUTCOME CURRICULUM FRAMEWORK

OBES / LOCF, CBCS CURRICULUM (2020-21)

M. Sc. Chemistry
(For the Batches Admitted From 2020-2021)

VISION

Be globally acknowledged as a distinguished centre of academic excellence.

MISSION

To prepare a class of proficient students, scholars and professionals with human values and commitment to expand the frontiers of knowledge for the advancement of society.

DEPARTMENT VISION AND MISSION

VISION

To provide competitively trained young minds to contribute as efficient teachers, chemists, researchers and assist chemical based industries and stakeholders globally.

MISSION

1. To develop researchers, scientists and educators in chemical sciences
2. To develop competent manpower for industries and business houses which are based on experimental methodologies and practices of Chemistry.
3. To provide student centric learning facilities for the development of the overall personality of the learner.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as Modal Centre of Learning and Research by

University Vision and Mission	Department Vision and Mission
High quality knowledge delivery through state of art infrastructure and ethical values to the students	**Yes**
Students excellence will make them professionals and innovators emerging as global leaders	**Yes**
Research and development will help in furtherance of Faculty knowledge	**Yes**

Program Outcomes (PO) for Post Graduate Programmes (CBCS) in the Faculty of Sciences, Kurukshetra University, Kurukshetra

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PO2	Research Aptitude	Capability to ask relevant/ appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis.
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large.
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems.
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices.

PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

Programme Educational Objectives (PEOs):

The Department of Chemistry has formulated the Programme Educational Objectives (PEO's) with those in fields. The program educational objectives (PEO) are the statement that describes the career and professional achievement after receiving the degree. The PEO's of the Master's degree in Chemistry are as follows:

PEO1: To have fundamental as well as advanced knowledge of the chemistry domain.

PEO2: To provide the professional services to industries, Research organization, in the domain of super specialization.

PEO3: To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

Program Specific Outcomes (PSO's): The program outcomes (PSO) are the statement of competencies/ abilities. PSOs are the statement that describes the knowledge and the abilities the post-graduate will have by the end of program studies.

PSO1: The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry.

PSO2: To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.

PSO3: To understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.

PSO4: Provide opportunities to excel in academics, research or Industry.

Mapping of PEO's with PO's and PSO's

S. No.	*Program Educational Objectives*	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
1	To have fundamental as well as advanced knowledge in the domain of chemistry.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	To provide the professional services to industries, Research organization, in the domain of super specialization.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3	To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Structure and Syllabi of
M. Sc. Chemistry (Four Semesters) Course
Under Choice Based Credit System
Outcome Based Education System /
Learning Outcome Curriculum Framework (LOCF) Pattern
(Effective from the Academic Session 2020-21)

COURSE SCHEME M.Sc. Programme: Two-year (Four semesters) under Choice Based Credit System – OBES / LOCF Pattern

SYLLABUS M.Sc. (Chemistry) Programme

Credits requirement for completion of the Programme	**:**	**100**
Credits Compulsory Courses	**:**	**51**
Credits Elective Courses	**:**	**03**
Credits Open Elective Courses	**:**	**04**
Credits Specialisation Elective Courses	**:**	**40**
Credits Seminar	**:**	**02**
Credits Total	**:**	**100**

Semester-wise distribution of Credits -

Semester I	**:**	**24 (CT-12, ET-3, CP-9)**
Semester II	**:**	**23 (CT-12, OE-2, CP-9= 23)**
Semester III	**:**	**27 (CT-9, OE-2, SET-8, SEP-8)**
Semester IV	**:**	**26 (SET-16, SEP-8, SEMINAR-2)**

CT : Compulsory Theory
ET : Elective Theory
CP : Compulsory Practical
OE : Open Elective
SET : Specialisation Elective Theory
SEP : Specialisation Elective Practical

SEMESTER - I

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 101	Inorganic Chemistry-I	CT	4	4	20	60	80	**3 Hrs.**
CHEM 102	Physical Chemistry-I	CT	4	4	20	60	80	**3 Hrs.**
CHEM 103	Organic Chemistry-I	CT	4	4	20	60	80	**3 Hrs.**
CHEM 104a	Mathematics for Chemists	ET	3	3	15	45	60	**3 Hrs.**
CHEM 104b	Chemistry of Life Science	ET	3	3	15	45	60	**3 Hrs.**
CHEM 104c	Introduction to pharmacy and pharmacology	ET	3	3	15	45	60	**3 Hrs.**
CHEM 105	Inorganic Chemistry Practical-I	CP	3	6	15	45	60	**6 Hrs.**
CHEM 106	Physical Chemistry Practical-I	CP	3	6	15	45	60	**6 Hrs.**
CHEM 107	Organic Chemistry Practical-I	CP	3	6	15	45	60	**6 Hrs.**
Total Credits/Marks			**24**	**33 (T-15, P-18)**			**480**	

CT = Compulsory Theory, CP = Compulsory Practical, ET =Elective Theory, Student has to opt any one of the elective theory paper (ET) based upon the course in B.Sc.

SEMESTER - II

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 201	Inorganic Chemistry-II	CT	4	4	20	60	80	**3 Hrs.**
CHEM 202	Physical Chemistry-II	CT	4	4	20	60	80	**3 Hrs.**
CHEM 203	Organic Chemistry-II	CT	4	4	20	60	80	**3 Hrs.**
OE-201	OPEN ELECTIVE	OE	2	2	15	35	50	**2 Hrs.**
CHEM 204	Inorganic Chemistry Practical-II	CP	3	6	15	45	60	**6 Hrs.**
CHEM 205	Physical Chemistry Practical-II	CP	3	6	15	45	60	**6 Hrs.**
CHEM 206	Organic Chemistry Practical-II	CP	3	6	15	45	60	**6 Hrs.**
Total Credits/Marks			**23**	**32 (T-14, P-18)**			**470**	

OE = Open elective, Students of Chemistry department will study one open elective paper offered by other department from among the department of physical sciences and students of other department (s) of physical sciences may opt open elective paper (OE-201)offered by Chemistry department.

SEMESTER - III

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 301	Inorganic Chemistry General	CT	3	3	15	45	60	**3 Hrs.**
CHEM 302	Physical Chemistry General	CT	3	3	15	45	60	**3 Hrs.**
CHEM 303	Organic Chemistry General	CT	3	3	15	45	60	**3 Hrs.**
OE-301	OPEN ELECTIVE	OE	2	2	15	35	50	**2 Hrs.**
CHEM 304	Inorganic Chemistry Special-I	SET	4	4	20	60	80	**3 Hrs.**
CHEM 305	Inorganic Chemistry Special-II	SET	4	4	20	60	80	**3 Hrs.**
CHEM 304	Physical Chemistry Special-I	SET	4	4	20	60	80	**3 Hrs.**
CHEM 305	Physical Chemistry Special-II	SET	4	4	20	60	80	**3 Hrs.**
CHEM 304	Organic Chemistry Special-I	SET	4	4	20	60	80	**3 Hrs.**
CHEM 305	Organic Chemistry Special-II	SET	4	4	20	60	80	**3 Hrs.**
CHEM 304	Pharmaceutical Chemistry Special-I	SET	4	4	20	60	80	**3 Hrs.**
CHEM 305	Pharmaceutical Chemistry Special-II	SET	4	4	20	60	80	**3 Hrs.**
CHEM 306	Inorganic Chemistry Special Practical-I	SEP	4	8	20	60	80	**6 Hrs.**

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 307	Inorganic Chemistry Special Practical-II	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 306	Physical Chemistry Special Practical-I	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 307	Physical Chemistry Special Practical-II	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 306	Organic Chemistry Special Practical-I	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 307	Organic Chemistry Special Practical-II	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 306	Pharmaceutical Chemistry Special Practical-I	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 307	Pharmaceutical Chemistry Special Practical-II	SEP	4	8	20	60	80	**6 Hrs.**
Total Credits/Marks			**27**	**(83)T-35, P-48**			**550**	

SET=Specialization elective theory, SEP=Specialization elective theory (Student has to opt all three CT, One OE offered by other departments from among the physical sciences and any two SET and two SEP from the same specialization)

SEMESTER - IV

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 401	Inorganic Chemistry Special-III	SET	4	4	20	60	80	**3 Hrs.**
CHEM 402	Inorganic Chemistry Special-IV	SET	4	4	20	60	80	**3 Hrs.**
CHEM 403	Inorganic Chemistry Special-V	SET	4	4	20	60	80	**3 Hrs.**
CHEM 404	Inorganic Chemistry Special-VI	SET	4	4	20	60	80	**3 Hrs.**
CHEM 401	Physical Chemistry Special-III	SET	4	4	20	60	80	**3 Hrs.**
CHEM 402	Physical Chemistry Special-IV	SET	4	4	20	60	80	**3 Hrs.**
CHEM 403	Physical Chemistry Special-V	SET	4	4	20	60	80	**3 Hrs.**
CHEM 404	Physical Chemistry Special-VI	SET	4	4	20	60	80	**3 Hrs.**
CHEM 401	Organic Chemistry Special-III	SET	4	4	20	60	80	**3 Hrs.**
CHEM 402	Organic Chemistry Special-IV	SET	4	4	20	60	80	**3 Hrs.**
CHEM 403	Organic Chemistry Special-V	SET	4	4	20	60	80	**3 Hrs.**
CHEM 404	Organic Chemistry Special-VI	SET	4	4	20	60	80	**3 Hrs.**
CHEM 401	Pharmaceutical Chemistry Special-III	SET	4	4	20	60	80	**3 Hrs.**

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
CHEM 402	Pharmaceutical Chemistry Special-IV	SET	4	4	20	60	80	**3 Hrs.**
CHEM 403	Pharmaceutical Chemistry Special-V	SET	4	4	20	60	80	**3 Hrs.**
CHEM 404	Pharmaceutical Chemistry Special-VI	SET	4	4	20	60	80	**3 Hrs.**
CHEM 405	Inorganic Chemistry Special Practical-III	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 406	Inorganic Chemistry Special Practical-IV	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 405	Physical Chemistry Special Practical-III	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 406	Physical Chemistry Special Practical-IV	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 405	Organic Chemistry Special Practical-III	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 406	Organic Chemistry Special Practical-IV	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 405	Pharmaceutical Chemistry Special Practical-III	SEP	4	8	20	60	80	**6 Hrs.**
CHEM 406	Pharmaceutical Chemistry Special Practical-IV	SEP	4	8	20	60	80	**6 Hrs.**

Course Code	Course Title		Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
					Internal Assess-ment*	End-semester Exam-ination	Total	
	Seminar*	C	2				20	
Total Credits/Marks			**26**	**96 (T-48,P-48)**			**500**	

Student has to opt four SET and Two SEP from same specialization and every student has to deliver one seminar on the topic assigned by the seminar committee.

***2 credits per specialization, Student should prepare and submit a seminar report, typed by computer using chemistry software on the topic as assigned by seminar committee.**

Open Elective Papers

For the Students of M.Sc. Chemistry

A student will earn four credits by choosing any two papers out of the open elective papers offered by the departments in the faculty of sciences other than the department of Chemistry.

Course Code	Course Title	Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
				Internal Assess-ment*	End-semester Exam-ination	Total	
OE*	Open Elective Paper -01	2	2	15	35	50	**2 Hrs.**
OE*	Open Elective Paper -02	2	2	15	35	50	**2 Hrs.**
Total Credits/Marks		**04**				**100**	

For the Students of Other Departments in the Faculty of Science

The Department of Chemistry offers the following open elective papers to the students of second and third semesters of other departments in the faculty of sciences.

Course Code	Course Title	Credits	Teaching Hours per week	Maximum Marks			Duration of Exam.
				Internal Assess-ment*	End-semester Exam-ination	Total	
OE-201	Environmental & Analytical Chemistry	2	2	15	35	50	**2 Hrs.**
OE-301	Applied Chemistry	2	2	15	35	50	**2 Hrs.**
Total Credits/Marks		**04**				**100**	

***code will be provided by the respective department, opted by the student.**

Total Marks of all Four Semesters

Semester	Credits	Marks
Semester I	24	480
Semester II	23	470
Semester III	27	550
Semester IV	26	500
Grand Total	100	2000

Internal Assessment in theory papers will be made on the basis of sessional test (s) and other parameters as decided by the University from time to time, while in Laboratory papers it will be decided from continuous assessment in internal viva-voce examination of all the experiments performed. Current guidelines for determining Internal Assessment in theory papers are given as Annexure 1.

Each student will deliver one seminar of about 40 minutes duration on the topic to be allotted by the departmental seminar committee in the 4th Semester of the M.Sc. Chemistry Course as per the schedule given by the department. The marks will be awarded by the seminar committee on the basis of performance in the seminar and the seminar report submitted by the student.

The special papers will be allotted to students on the basis of their preference-cum-merit (percentage of marks in the First Semester examination of M.Sc. Chemistry) basis.

General objectives of the course

Chemistry is the science of matter; the branch of the natural sciences dealing with the composition of substances, their properties and reactions. Chemistry is involved in almost everything with which we come in contact. The life processes of all organisms involve chemical changes. Chemistry enables the development of drugs to cure and alleviate diseases and prolong life span. It also connects the fundamental principles of physics to the other natural sciences - biology, botany, medicine, geology, ecology- in short, to the life sciences and the earth sciences. It is an experimental science and students need to be trained in practicals to get expertise in doing fine experiments and handle sophisticated instruments and statistically analyse the experimental data.

Master of Science (M.Sc.) in Chemistry is the oldest **(1961)** post graduation course of University of Kurukshetra. The Curriculum is so designed that it offers four specializations to the M.Sc. Chemistry students, which includes Physical, Organic, Inorganic and Pharmaceutical Chemistry.

Through this curriculum, a choice based credit system (CBCS) is being implemented for all round development of the students, giving a fair weightage to their interest. It would allow the students to develop their abilities in the disciplines of their own interest. The students pursuing this course will develop in depth understanding of various aspects of the subject. The conceptual understanding of structure and behaviour of elements (atoms), energy changes associated with the reactions, principles and rules that unite these phenomenon in to comprehensive system, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, acquiring basic concepts for structural elucidation with hyphenated techniques, understanding the fundamental biological processes and rationale towards computer assisted drug designing are among such important aspects. This curriculum has an immense potential for chemistry and post graduate students to develop as a good chemistry teacher or as skilled chemists to undertake advanced research in laboratory or in Industry.

M.Sc. Chemistry Semester-I
Inorganic Chemistry-I (CHEM-101)

Credits-4 **Total Marks = 80**
Time: 3 Hrs **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Symmetry and Group Theory in Chemistry

Definitions of group, subgroup, relation between orders of a finite groups and its subgroups. Conjugacy relation and classes. Symmetry elements and symmetry operations, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations. The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C_{2v}, C_{3v} and D_{2h} Character tables and their use. Molecular asymmetry, dissymmetry and optical activity.

SECTION – B

Stereochemistry and Bonding in Main Group Compounds.

VSEPR Theory, Walsh diagrams (tri-atomic molecules), $d\pi$-$p\pi$ bonds, Bent rule and energetic of hybridization, Huckel theory with reference to ethylene and butadiene, Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen.

SECTION – C

Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes. Brief account of electron transfer reactions, inert and labile complexes.

SECTION – D

Metal-Ligand Bonding

Crystal field theory and its limitation , crystal field effects, John Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory

of octahedral, tetrahedral and square planar complexes (with and without π - bonding).

Course Outcomes:

CO1 Describe advanced symmetry concepts of chemical molecules and its applications.

CO2 To identify the axis, plane, center and point group, polarity, dipole moment, product of symmetry operation and character table of chemical compounds.

CO3 Describe the bonding and stereochemistry in covalent compounds, characterstics of bonding in covalent compounds viz. Bent's rule, walsh diagrams, dπ-pπ bonding.

CO4 To discuss the substitution reactions of covalently bonded molecules boron, silicon and nitrogen.

CO5 To know about the metal equilibria in solutions.

CO6 To describe the factors affecting stability of metal ligand complexes.

CO7 To use the various methods for the determination of stability constant.

CO8 To know about the substitution reactions in square planar complexes with special reference to trans effect.

CO9 Know about the limitations of crystal field theory and its effects in coordination complexes.

CO10 To apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.

Mapping of Paper No. CHEM 101

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	W	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	W	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	W	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	W	S	S	S	M	S
CO5	S	S	S	S	S	M	S	S	M	S	S	S	S	S	S
CO6	S	S	S	S	S	M	S	S	S	M	S	S	S	S	M
CO7	S	S	S	S	s	S	M	S	M	M	S	S	S	S	M
CO8	S	S	S	S	s	S	M	S	S	W	M	S	S	S	S
CO9	S	S	S	S	S	S	S	M	S	M	S	S	S	S	S
CO10	S	S	S	S	S	S	S	M	S	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond; J.N.Murrel, SFA Kettle and J.M. Tedder; Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H. J. Emeleus and Sharpe.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J. J. Alexander; John Wiley and Sons.
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

M.Sc. Chemistry Semester-I
Physical Chemistry-I (CHEM-102)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section – A

Partial Molar Properties

Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture(s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

Real Gases: Concept of Fugacity and Activity

Concept of fugacity, methods for determining the fugacity of a real gas, its variation with temperature and pressure, activity, choice of standard states, dependence of activity on temperature and pressure, determination of activity by (i) measurement of vapour pressure, (ii) distribution of solute between two immiscible solvents and (iii) emf measurement.

SECTION – B

Chemical Kinetics

Collision theory of reaction rates, the steric requirement, Arrhenius equation and activated complex theory (ACT), Equilibrium hypothesis, Statistical mechanics and Chemical Equilibrium, Comparison of Collision and Activation complex theory, Potential energy surfaces (Only basic Idea), Thermodynamic formulation of activated complex theory, Chain reactions (hydrogen-halogen reaction), Unimolecular reactions: Lindemann-Christiansen Hypothesis, Hishelwood treatment.

SECTION – C

Electrochemistry

Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect. D-H-O equation - its applicability and

limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

Metal/Electrolyte interface, Concept of electrical double layer and its structure: Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena, determination of zeta potential.

SECTION-D

Surface Chemistry and Catalysis

Gibbs adsorption equation, Langmuir adsorption isotherm and its derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its derivation and applications.

Study of surfaces by STM, SEM. Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. Comparison of uncatalyzed and catalyzed reaction rates.

Course Outcomes:

CO1 Recapitulation of thermodynamic laws, concept of fugacity and its determination.

CO2 Concept of activity and its determination using emf measurement, vapour pressure method and some other methods.

CO3 To know about Partial molar quantities, chemical potential and Gibbs-Duhem equation and its variation with temperature and pressure.

CO4 To explain thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

CO5 To describe the concept of potential energy surfaces.

CO6 To explain Collision theory of reaction rates, steric requirement, Arrhenius equation and activated complex theory (ACT).

CO7 To demonstrate thermodynamic formulations of activated complex theory.

CO8 To explain Lindemann-Christiansen and Hinshelwood mechanisms of unimolecular reactions.

CO9 To discuss Debye-Hückel theory of ion-ion interaction and activity coefficient, its applicability, limitations and its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient.

CO10 Able to derive D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment)and its modifications for ion-pair formation.

CO11 To know the Concept of electrical double layer and its structure.

CO12 To know about Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena and the determination of zeta potential.

CO13 To discuss the Langmuir adsorption isotherm and its kinetic derivation for non- dissociative and dissociative adsorption.

CO14 To know about surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons.

CO15 To carry out a comparison between homogeneous and heterogeneous reaction rates.

Mapping of Paper No. CHEM 102

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	M	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	M	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	M	S	M	W	M	S	S	M	M	S	M
CO6	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO7	S	S	S	S	M	M	S	M	S	S	S	M	M	M	M
CO8	S	M	S	M	S	M	M	W	M	S	M	S	M	M	M
CO9	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S
CO10	S	S	S	S	S	S	M	S	S	S	S	S	M	S	S
CO11	S	M	S	S	S	M	M	M	S	S	M	S	M	M	M
CO12	S	M	W	M	M	S	M	M	M	M	M	S	W	M	M
CO13	S	S	S	S	S	S	M	M	S	S	M	M	M	S	S
CO14	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO15	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.

6. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
7. Electrochemistry, S. Glasstone, Affiliated East-West Press.
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition edition (October 1, 2007).
10. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet.

M.Sc. Chemistry Semester I
Organic Chemistry-I (CHEM-103)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section – A

Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.

SECTION – B

Mechanism of Nucleophilic Aliphatic Substitution

The limiting cases SN^1 and SN^2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, competition between nucleophilicity and basicity, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution. SN^i, $SN^{1'}$, $SN^{2'}$ and $SN^{i'}$ mechanisms.

Mechanism of Elimination Reactions

The El, ElcB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Pyrolytic eliminations.

SECTION – C

Stereochemistry-I

Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes,

hemispiranes. Elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

SECTION - D

Stereochemistry –II

Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule. Stereochemistry of sugars- C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins,

Chemical correlation of configuration-determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.

Course Outcomes:

CO1 Describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understand effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.

CO2 Understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.

CO3 Know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these in prediction of product formation in various elimination reactions.

CO4 Master stereo-chemical terms, inter-convert stereo-structural formulae of organic molecules, analyze configurations, create stereo-structures and correlate configuration by applying the concept of chemical correlation.

CO5 Realize the concepts of prochirality, topicity related terms, asymmetric synthesis, its main categories vis-à-vis application of Cram's, Prelog and Horeaus rule.

CO6 Describe stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins.

Mapping of Paper No. CHEM 103

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	--	--	S	--	S	S	S	S	S
CO2	S	S	S	S	S	S	--	M	S	--	S	S	S	S	S
CO3	S	S	S	S	S	S	--	--	S	--	S	S	S	S	S
CO4	S	S	S	S	S	S	--	M	S	--	S	S	S	S	S
CO5	S	S	S	S	S	S	--	M	S	--	S	S	S	S	S
CO6	S	S	S	S	S	S	--	M	S	--	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
10. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International.
11. Stereochemistry of Organic compounds, E.L. Elien, Mc Graw Hills, 1962.

M.Sc. Chemistry Semester I
Mathematics for Chemists (CHEM 104A)

Credits-3 **Total Marks = 60**
Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION - A

Vectors

Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product, concept of normalization, orthogonality and complete set of unit vectors. Illustration of applications to spectroscopy and quantum chemistry.

Matrices and Determinants

Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition of determinant, properties of determinants, evaluation of determinants. Illustration or applications to group theory, problems in chemistry.

SECTION - B

Logarithm

Need for logarithm in chemistry. Theory and application of logarithms for solving general and chemical problems.

Graphical Representation of Equations

Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines, points of intersection, distance between two points, change of origin. Examples from problems in chemistry, curve fitting for least squares method.

Elements of Algebraic and Trigonometric Functions

The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities, polar coordinates in trigonometric functions.

SECTION-C

Differential Calculus

Theory, graphical significance of differentiation, rules of differentiation, Algebraic simplification, Partial differentiation, Exact and inexact differential with their application to thermodynamic principles.

Integral Calculus

Integral theory, methods of integration, viz. algebraic simplifications, integration by substitution, integration by parts, integration by partial fractions, integration between limits, curve sketching, integral as area, , Illustration of application in chemistry.

Differential Equation

Simple differential equations, separable variables, homogeneous equations, exact differential equations, linear differential equations, partial differential equations, application to physico-chemical problems.

Course Outcomes:

CO1 To explain definitions of vectors, representation and properties of vectors.

CO2 To perform vector mathematical operations.

CO3 To explain scalar and vector products of vectors.

CO4 To discuss definition and properties of matrices and determinants.

CO5 Be able to perform matrix mathematics.

CO6 To solve linear equations using matrices.

CO7 To discuss need, theory and applications of logarithms.

CO8 To execute the knowledge in solving general and chemical problems.

CO9 Be able to represent equations graphically and perform curve fitting for least squares method.

CO10 To perform binomial expansion.

CO11 To prove and apply trigometric identities and explain polar coordinates in trigonometric functions.

CO12 To explain rules of differentiation and be able to find out the derivative of a function by applying various methods of differentiation.

CO13 To perform partial differentiation.

CO14 To discuss exact and inexact differentials and their applications to chemistry.

CO15 To explain rules and methods of integration.

CO16 To perform integration between limits and its application in chemistry.

CO17 To discuss types of differential equations and their solutions with their application to physico-chemical problems.

Mapping of Paper No. CHEM-104A

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO12	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO13	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO14	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO15	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO16	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO17	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, C.E. Reid, Mc Graw Hills, College 0th Edition.

Or

M.Sc. Chemistry Semester I

Chemistry of Life Science (CHEM 104B)

Credits-3 **Total Marks = 60**

Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION - A

Carbohydrates

Structure and biological functions of important monosachharides (excluding detailed conformational analysis) and derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-N-acetylmuramic acid and sialic acid. Disaccharides- sucrose, lactose and maltose.

Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen) Heteropolysaccharides-glucosaminoglycans/mucopolysaccharides.

Glycoconjugates- glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances.

Cell Structure and Metabolism

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle.

SECTION – B

Lipids

Fatty acids, essential fatty acids, structure and functions of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids.

Lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure.

Lipid metabolism - β-oxidation of fatty acids.

Amino-acids, Peptides and Protein

Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides, Sanger method and Edman degradation method for amino acid sequencing. Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins. Denaturation of Proteins.

SECTION – C

Nucleic Acids and Genetic Code

Structure and functions of nucleotides, nucleosides, DNA (Watson-Crick model, Chargaff's rules) and RNA (m RNA, r-RNA and t-RNA).

Genetic code and its characteristics, codon-anticodon pairing (Wobble hypothesis).

Replication, Transcription and Translation (Prokaryotes only)

Replication of DNA: Maselson-Stahl experiment, mechanism of replication (Initiation, Elongation and Termination).

Transcription: Promoters site, Initiation, Elongation, Termination.

Translation: Activation of amino acids, Initiation, Elongation, Termination.

Course outcomes:

CO1 To describe the prokaryotic and eukaryotic cell Structure, metabolic processes occurring in cell. Able to discuss the Carbohydrate metabolism-glycolysis, Kreb's cycle, glycogenolysis, glycogenesis pentose phosphate pathway and gluconeogenesis.

CO2 To explain the Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, structural polysaccharides - cellulose and chitin. Storage polysaccharides-starch and glycogen.

CO3 To analyze the structure and functions of fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids. β-oxidation of fatty acid, Fluid mosaic mode of cell membrane.

CO4 To know the concept of the amino acids, peptides and proteins. Able to describe the primary, secondary structure of proteins and forces responsible for holding these structures.

CO5 To understand enzymatic and chemical cleavage of polypeptide chain, sequencing of amino acids in a polypeptide segment, Sanger method, Edman degradation method, concept of denaturation of proteins.

CO6 To explain the Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA and their conformation.

CO7 Able to explain the DNA replication, translation and transcription.

Mapping of Paper No. CHEM-104(B)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO 1	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 3	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 6	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 7	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2. Biochemistry, L.Stryer, W.H.Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.

Or

M.Sc. Chemistry Semester I

Introduction to Pharmacy and Pharmacology (CHEM 104C)

Credits-3 **Total Marks = 60**

Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION-A

Introduction

Introduction to Pharmaceutical sciences, its branches, naming of drugs, Generic drugs, routes of drug administration, drug development and its regulation.

Introduction of pharmacopeia (IP, BP, USP), introduction of national formularies, typical parts of monograph of Indian pharmacopeia, an introduction to content of IP.

Dosage Forms-1

Solid dosage forms: Tablets-Types, granulation, compression, additives used in formulations, coating, evaluation (including dissolution, disintegration, Hardness, Friability, weight variation).

Capsules-Soft and hard gelatin capsules, microencapsulation.

SECTION-B

Dosage Forms-II

Semi solid dosage forms: Introduction, types, brief description of ointments and creams. Biphasic liquid dosage forms: Emulsions and suspensions-types, formulation, methods of preparation, stability.

Monophasic liquid dosage forms: Types, brief description of mixtures and syrups.

Sterile dosage forms and ophthalmic products.

Toxicology

Introduction, acute and chronic toxicity, LD50 and ED50, therapeutic index, adverse drug effects, dose response relationship, therapeutic drug monitoring, General principles of management of poisoning, antidotes, Treatment of heavy metal poisoning and drugs (barbiturates, benzodiazepines, salicylates, morphine & morphine derivatives, alcohol).

SECTION-C

Pharmacokinetics

Physicochemical factors in transfer of drugs across membranes, ADME (Absorption, distribution, metabolism-Phase I and Phase II reactions, Excretion) of drugs, important pharmacokinetic parameters-apparent volume of distribution, bioavailability, clearance, Half life.

Pharmacodynamics

Mechanism of drug action, drug targets, neurotransmitters and hormones, the receptor role, Drug Receptor Interactions, types of receptors, structure and functioning of ion channel receptors, G-protein coupled receptors, kinase-linked receptors.

Course outcomes:

The paper is designed to provide basic knowledge about pharmacology, naming, routes to administer, pharmacopoeias, dosage forms, toxicology, pharmacokinetics and pharmacodynamics.]

CO1 To know the naming of drugs and various routes of drug administration.

CO2 To describe different pharmacopeias (IP, BP, USP).

CO3 To tell about the solid dosage forms, tablets and capsules (soft and hard gelatin capsules).

CO4 To give the idea of Semi solid dosage forms, ointments and creams.

CO5 To make to know biphasic liquid dosage forms, Emulsions and suspensions.

CO6 To deliver the information of monophasic liquid dosage forms, their types and brief description.

CO7 To learn the sterile dosage forms and ophthalmic products.

CO8 To inform about the adverse effects of drugs including details of LD50 and ED50 and therapeutic index.

CO9 To make aware about the management of poisoning, antidotes, treatment of heavy metal poisoning and drugs.

CO10 To familiarize with pharmacokinetics (ADME) and important pharmacokinetic parameters.

CO11 To understand about pharmacodynamics, neurotransmitters, drug targets.

CO12 To discuss structure and functioning of receptor types.

Mapping of CO with PO's and PSO's Paper No. CHEM 104C

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO9	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO11	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO12	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Foye's principles of medicinal chemistry. David A. Williams, Thomas L. Lemke, Fifth Edition. Lippincott Williams & Wilkins.
2. Essentials of medicinal Pharmacology, K.D.Tripathi, 4th Edition . Jaypee Brothers Medical Publishers Ltd.
3. Medicinal chemistry Vol. I & II. A. Burger, Willey interscience, 1970
4. Pharmacology & Pharmacotherapeutics, Vol. I & II. R.S. Satoskar & S.C. Bhandarkar, Popular Prakashan 1978.
5. A Textbook of medicinal chemistry. P. Parimoo.
6. The Pharmacological Basis of Therapeutics, L.L. Brunton, J.S. Lazo, K.L. Parker 11th ed., Magraw Hill, US, (2006).
7. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
8. Basic and Clinical Pharmacology, Lauge Medical Publication. 1995 B. G. Katzung.
9. Introduction to Pharmacology by P.C. Dandya and S.K. Kulkarni.
10. Cooper and Gunn's Dispensing for Pharmaceutical Students, Ed.S.J. Carter, CBS publishers & distributors.
11. Tutorial Pharmacy, Cooper and Gunn's.
12. "Theory and Practice of Industrial Pharmacy" Lea & Fabiger, L.Lachman.
13. "A textbook of Pharmaceutical Chemistry", Oxford Press, Bentley and Drivers.

M.Sc. Chemistry Semester I

Inorganic Chemistry Practical-I (CHEM 105)

Credits-3 **Total Marks = 60**

Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

1. Qualitative analysis:

Total five radicals to be given containing two less common metal ions, one insoluble and two acid radicals:, $CH_3COO^-, BO_3^{3-}, PO_4^{3-}, CO_3^{2-}, HCO_3^-, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, S_2O_3^{2-}, F^-, C_2O_4^{2-}$.

Less common metal ions – W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be (two metal ions in cationic and anionic forms).

Insoluble: Halides (AgCl, AgBr, AgI); Sulphates ($PbSO_4$, $BaSO_4$) and Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2)

2. Cerimetric / Iodometric/Oxidimetry titrations.

Experiment **Marks: 30**

Lab record & Viva-voce **Marks: 5+10**

Course outcomes:

CO1 To know the basic concept about the qualitative analysis.

CO2 To analyse the given mixture for the presence of two acidic radicals, two rare earth metal ions and one insoluble salt.

CO3 To know the cerimetric / Iodometric titrations.

CO4 To demonstrate the various cerimetric and iodometric titrations in laboratory.

CO5 To perform experimentation and evaluate the results.

CO6 To develop the ability to compile interpreted information in the form of lab record.

CO7 To face viva-voce.

Mapping of Paper No. CHEM-105

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	M	M	S	S	M	M	S	S	M	S
CO2	S	M	S	M	S	S	M	M	S	S	M	S	M	S	M
CO3	S	S	S	M	S	M	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	M	S	S	M	S	S	S	S	M	M
CO5	S	S	M	S	M	M	S	S	S	M	M	S	M	S	S
CO6	M	M	S	M	S	S	M	M	S	S	S	M	S	S	M
CO7	S	S	S	M	S	M	S	S	M	S	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.

2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

M.Sc. Chemistry Semester I
Physical Chemistry Practical-I (CHEM 106)

Credits-3 **Total Marks = 60**
Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

Experiments

Surface Tension

[1] Determine the surface tension of given organic solvents.

[2] Study the effect of soap concentration on the lowering of surface tension of water.

[3] Compare the cleansing powers of two cloth detergents provided to you.

Conductometry

[4] Determine the strength of strong acid by conductometric titration with strong base.

[5] Determine the strength of weak acid by conductometric titration with strong base.

[6] Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.

[7] Study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine the strength of given solution of $AgNO_3$.

[8] Determine solubility and solubility product of sparingly soluble salts like $PbSO_4$, $BaSO_4$.

[9] Determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements.

Potentiometry

[10] Determine the standard electrode potential of Cu and Zn.

[11] Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.

[12] Study the precipitation titration between KCl and $AgNO_3$ potentiometrically.

[13] Determine the standard free energy change and equilibrium constant for the reaction

$$Cu + 2Ag^{+} \longrightarrow Cu^{2+} + 2Ag$$

Chemical Kinetics

[14] Study the hydrolysis of methyl acetate in presence of hydrochloric acid.

[15] Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.

[16] Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

Adsorption

[17] Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/oxalic acid on activated charcoal.

Data Handling

[18] Wherever possible, error analysis in the experimental observations and results should be reported.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+10**

Course outcomes:

CO 1 To understand the concept of surface tension and its determination for various organic solvents.

CO 2 To examine surface active agents and their cleansing power.

CO 3 To understand and master the fundamentals of conductometric titrations in aqueous media.

CO 4 To study and conduct experiments related to chemical kinetics for the determination of the order and rate constant of the reaction.

CO 5 To understand and master the fundamentals of potentiometric experiments.

CO 6 To determine extent of adsorption and verify Freundlich and Langmuir adsorption isotherms.

CO 7 To learn data handling and analysis.

CO 8 To develop problem solving ability.

Mapping of Paper No. CHEM 106

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	-	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	-	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

M.Sc. Chemistry Semester I
Organic Chemistry Practical-I (CHEM 107)

Credits-3 **Total Marks = 60**
Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

Demonstrations of Laboratory & Purification techniques

Refluxing, Solvent extraction, Purification of solvents and reagents using various techniques like crystallization, distillation, steam distillation, vacuum distillation. Drying and storage of solvents, sublimation etc.

Two-step Preparation of some important organic compounds involving the reactions out of the followings representative reactions)

1. Esterification and saponification
2. Oxidation
3. Reduction or Hydrogenation
4. Partial Reduction
5. Nucleophilic substitution
6. Aromatic electrophilic substitution reaction
7. Condensation reactions
8. Hoffman's Bromamide reaction
9. Heterocyclic synthesis
10. Any other reaction as per requirement

All the students must submit the recrystallised product along with m.p. for all the stages of preparation.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+10**

Course outcomes:

CO1 To understand the basic laboratory & purification techniques in organic chemistry.

CO2 To know the concept of stepwise synthesis of the organic compounds.

CO3 To explore the practical applicability of different types of organic reactions.

CO4 To perform the experimentation and evaluate the results.

CO5 To develop the ability to compile interpreted information in the form of lab record.

CO6 To face viva-voce after completion of course.

Mapping of Paper No. CHEM-107

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO 1	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 3	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 6	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Hand book of Organic Analysis-Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al., Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, EX CBS Publishers and Distributors.
5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

M.Sc. Chemistry Semester II
Inorganic Chemistry-II (CHEM 201)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Electronic Spectra and Magnetic Properties of Transition Metal Complexes-I

Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicates coupling of orbital angular momenta in p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 metal ions, determining the ground state terms-Hund's rules, derivation of the term symbols for a closed subshell.

SECTION – B

Electronic Spectra and Magnetic Properties of Transition Metal Complexes-II

Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris-chelated complexes.

SECTION - C

Metal Δ-Complexes

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

SECTION - D

Metal Clusters

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Course outcomes:

CO1 To discuss the various possible arrangements of electrons in terms of term symbols.

CO2 Able to draw the vector diagrams of orbital coupling and spin orbital coupling in p2, p3, d2 configurations.

CO3 To calculate the spectral terms for d2 and d8 metal ions.

CO4 To derive the term symbol for closed subshell.

CO5 To interpret the Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states).

CO6 To apply the spectroscopic methods for assignment of absolute configuration in optically active metal chelates and their stereochemical information.

CO7 To know the concept of Circular Dichroism and Optical Rotatory Dispersion and its application to determine configuration of Tris-chelated complexes.

CO8 To discuss the synthesis, structure characterstic and chemical properties of metal carbonyls, metal nitrosyls.

CO9 To explain the synthesis and structural characterstics and important reactions of dinitrogen and dioxygen complexes.

CO10 To know the various classifications of metal cluster compounds.

CO11 To categories the metal boranes carboranes, metalloboranes and metallocarboranes and their various aspects.

CO12 To discuss the existence, stability and formation of metal-metal multiple bonds.

Mapping of Paper No. CHEM-201

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	M	M	S	M	S	S	M	S	S	S	M	S
CO2	S	S	S	S	M	M	M	S	S	S	M	S	S	M	S
CO3	S	M	S	M	S	M	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	M	S	S	M	S	S	M	M	S	S
CO5	S	S	M	S	M	M	S	S	S	M	M	S	S	S	M
CO6	M	M	S	M	S	S	M	M	S	S	S	M	S	S	S
CO7	S	S	S	M	S	M	S	S	M	S	S	S	S	M	S
CO8	S	S	S	S	M	M	S	M	M	M	M	S	S	S	M
CO9	M	M	S	M	S	S	M	M	S	S	S	S	M	S	M
CO10	S	M	S	S	S	S	M	S	S	S	M	S	M	M	M
CO11	M	S	S	M	S	M	S	S	S	S	S	S	S	S	S
CO12	S	S	M	S	M	M	S	S	S	M	M	S	S	M	M

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Introduction to Ligand Field Theory; C.J.Ballahyen, McGraw Hill, New York.
8. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J. Alexander; John Wiley.
10. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.

M.Sc. Chemistry Semester II
Physical Chemistry-II (CHEM 202)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION-A

Quantum Mechanics-I

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Eigen functions and Eigen values. Schrödinger equation, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Tunnelling Problem: Tunnelling through a rectangular barrier Schrödinger equation for linear harmonic oscillator and its solution, zero point energy.

SECTION – B

Quantum Mechanics-II

Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions. Angular momentum and its directional quantization, Angular momentum operators, commutation relations, Ladder operators, shapes of atomic orbitals upto d-level and their discussion.

SECTION – C

Polymers

Basic concepts, Kinetics of Polymerization: Mechanism and Kinetics of chain growth polymerization: free-radical, cationic, anionic and coordination polymerization. Mechanism and Kinetics of step-growth polymerization. Comparison between step-growth and chain polymerization. Molecular mass of polymers: Significance of average molecular mass. Poly-dispersity, Molecular mass distribution curves. Determination of molecular mass by viscosity method. Electrically conducting polymers, Flame retardant polymers, Liquid crystal polymers.

SECTION-D

Nuclear and Radiochemistry

Nuclear stability and binding energy. Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter, Detectors (Proportional, Geiger-Muller and Scintillation counters) and their principles. Units for measuring radiation absorbed, radiation dosimetry.

Radiotracer technique, Activation analysis, isotope dilution technique, Radiochromatography, radiometric titrations, Neutron absorptiometry. Some applications.

Course outcomes:

CO1 To discuss the various postulates of quantum mechanics.

CO2 To learn about operators and their properties.

CO3 To be able to perform operator mathematics including commutation of operators.

CO4 To discuss Heisenberg's Uncertainty Principle.

CO5 To understand and form Schrödinger equation for various systems.

CO6 To be able to setup and solve Schrödinger equation for a particle in a box and for a one-dimensional box with a finite barrier and its application to quantum mechanical tunnelling.

CO7 Able to setup and solve Schrödinger equation for linear harmonic oscillator and its solution.

CO8 To know about angular momentum operators their commutation relations and Ladder operators.

CO9 To explain the shapes of atomic orbitals upto d-level.

CO10 To explain the basic concepts of polymers and polymerization.

CO11 To discuss the Mechanism and Kinetics of chain growth and step growth polymerization.

CO12 To determine the molecular mass by osmometry and viscometry methods.

CO13 To know the basic concept of nuclear and radiochemistry.

CO14 To discuss the structure and functioning of various detectors use in radiochemistry.

CO15 To explain the radiotracer technique, activation analysis and its applications in various aspects.

Mapping of Paper No. CHEM-202

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO12	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO13	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO14	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO15	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Essentials of Nuclear Chemistry, 4th Edition (1995), H.J. Arnikar, Wiley Eastern, New Delhi.
4. Nuclear & Radiochemistry, 3rd Edition (1981), G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
5. Introduction to Nuclear Chemistry, B. C. Harvey Prentice-Hall (1969).
6. Polymer Chemistry, Billmayer.
7. Polymer Chemistry, Gowarikar.
8. Principles of Polymerization, Geroge Odian.
9. Quantum Chemistry, B. K. Sen, Kalyani Publishers.
10. Quantum Chemistry, R. Prasad, New Age International.

M.Sc. Chemistry Semester II
Organic Chemistry-II (CHEM 203)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two questions from each of the sections A, B, C & D. The candidates are required to attempt five questions in all, selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Aromatic Electrophilic Substitution

Theoretical treatment of aromatic substitution reactions, structure-reactivity relationship in mono substituted benzene ring, orientation in other ring system, energy profile diagram, Vilsmeir-Haak reaction, Reimer-Tiemann reaction, Bischler-Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Fries rearrangement.

Nucleophilic Aromatic Substitution

Mechanism of Nucleophilic substitution in aromatic systems via diazonium ions, by addition-elimination and elimination-addition mechanism (involving arynes); von-Richter rearrangement, Sommelet-Hauser, Stevens and Smiles rearrangements.

General aspects of generation, structure, stability and reactivity of arynes.

SECTION-B

Aliphatic Electrophilic Substitution

Bimolecular mechanisms - S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Neighbouring Group Participation and Carbocation Rearrangements

Anchimeric assistance, neighbouring group participation by non-bonding electrons, sigma and □-bonds, classical and non-classical carbocations. Carbocations rearrangements: migratory aptitudes, Wagner Meerwein rearrangement, pinacol pinacolone rearrangement, Demjanove rearrangement, Tiffeneau-Demjanov ring expansion, aldehyde-ketone rearrangement, dienone-phenol rearrangement and trans-annular rearrangements.

SECTION – C

Free Radicals

General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic

halogenation (NBS), auto-oxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker reaction.

Addition to C-C Multiple Bond

General mechanistic considerations, Mechanism of addition of hydrogen halide, H_2O, halogens, HOX and mercuric salt to alkenes and alkynes. Hydroboration, formation of C-C bonds via organoboranes, hydroboration of acetylenes, nucleophilic addition to alkenes.

SECTION-D

Addition to Carbon-Hetero Atoms Multiple Bonds

General mechanistic considerations and reactivity, Hydration and Addition of Alcohols to Aldehydes, Ketones and Acids. Addition -Elimination Reactions of Ketones and Aldehydes, Reactivity of carbonyl compounds towards Addition.

Lithium aluminium hydride reduction- carbonyl compounds, acids, esters, nitriles. Additions of Grignard reagents. Reformatsky reaction, Wittig reaction, Claisen condensation, Dieckman reaction, Aldol condensation, Knoevenagal condensation, Perkin reaction, Cannizzaro reaction, Benzoin condensation, Mannich Reaction, Robinson-Mannich reaction, Ester hydrolysis, aminolysis of esters, amide hydrolysis.

Course outcomes:

CO1 To know the concept of Aromatic Electrophilic Substitution and their applications.

CO2 To understand the mechanisms of Aromatic Nucleophilic Substitution by diazonium salts, arynes.

CO3 To understand the concept of aliphatic electrophilic substitution reaction.

CO4 To know the Bimolecular aliphatic electrophilic substitutions mechanisms - SE2, SE1 and SEi.

CO5 To understand the neighbouring group participation, classical and non-classical carbocation.

CO6 Role of non-bonding electrons, sigma and π-bonds.

CO7 To understand the concept of carbocations rearrangements and migratory aptitudes.

CO8 To describe the generation, structure, stability and reactivity of free radicals.

CO9 To know the mechanisms of addition alkenes and alkynes.

CO10 To study addition to C=O group of aldehydes, ketones and acids.

CO11 To understand and reactivity of carbonyl compounds in various reactions.

CO12 To learn various name reactions related to ketones and aldehydes.

Mapping of Paper No. CHEM- 203

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO2	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO3	S	S	M	M	M	S	M	M	S	W	M	S	S	S	S
CO4	S	S	M	M	M	S	M	M	S	W	M	S	S	S	S
CO5	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO6	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO7	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO8	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO9	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO10	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO11	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO12	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
8. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.
9. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.

M.Sc. Chemistry Semester II
Inorganic Chemistry Practical-II (CHEM 204)

Credits-3 **Total Marks = 60**
Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

1. Quantitative analysis:

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.

Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe-Mg, Fe-Ni etc.

2. Preparations:

Preparation of the following inorganic compounds and their spectroscopic studies.

I. $Hg[Co(SCN)_4]$
II. $[Cu(NH_3)_4]SO_4.H_2O$
III. Prussian Blue and Turnbull's Blue
IV. $Na[Cr(NH_3)_2(SCN)_4]$
V. $Mn(acac)_3$
VI. $[Ni(NH_3)_6]Cl_2$
VII. $VO(acac)_2$

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+10**

Course outcomes:

CO1 To know the concept of quantitative analysis and its application.

CO2 To separate and quantify the presence of two metal ions in a solution.

CO3 To prepare a sample of various coordination complexes and their spectroscopic study.

CO4 To perform experimentation and evaluate the results.

CO5 To develop the ability to compile interpreted information in the form of lab record.

CO6 To face viva-voce.

Mapping of Paper No. CHEM-204

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	S	M	M	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	M	M	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO5	S	S	M	M	S	M	S	S	M	S	M	S	S	S	M
CO6	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

M.Sc. Chemistry Semester II
Physical Chemistry Practical-II (CHEM 205)

Credits-3 **Total Marks = 60**
Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

Viscosity

[1] Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.

[2] Determination of molar mass of a polymer.

pH-metry

1. Determine the strength of strong acid by pH-metric titration with strong base.
2. Determine the strength of weak acid by pH-metric titration with strong base.
3. Determine the dissociation constant of acetic acid using pH-meter.

Distribution Law

4. Determine the partition coefficient of iodine for distribution between chloroform and water.
5. Determine distribution coefficient of ammonia between chloroform and water.
6. Determine the formula of the complex formed between copper (II) ion and ammonia using distribution method.

Polarimetry

7. Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and thereafter determine the unknown concentration of the same substance in given solution.
8. Determine the specific and molecular rotation of sucrose or glucose at a number of concentrations.
9. Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid.

Refractometry

10. Determine the refractive index of simple organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
11. Determine the refractivity and molar refractivity of some organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
12. Determine the molar refractivities for CH_2, C, H and Cl.
13. Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

Note: Any experiment can be introduced in the practical class on the basis of availability of instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+10**

Course outcomes:

CO1 To know the concept of viscosity and its determination.

CO2 To determine the viscosity averaged molar mass of a polymer.

CO3 To study the pH metric titration for the determination of normality of acids.

CO4 To determine the partition coefficient of an solute between two immiscible solvents by using distribution law.

CO5 To study the specific and molecular rotation of sucrose or glucose by polarimetry.

CO6 Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid by polarimetry.

CO7 To determine the refractive index of various organic solvents and its variation with concentration.

CO8 To perform experimentation and evaluate the results.

CO9 To develop the ability to compile interpreted information in the form of lab record.

CO10 To face viva-voce.

Mapping of Paper No. CHEM 205

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	M	S	S	S	S	S	M	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO8	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO9	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

M.Sc. Chemistry Semester II
Organic Chemistry Practical-II (CHEM 206)

Credits-3 **Total Marks = 60**
Time: 6 Hrs. (Two sessions) **45 (EM) + 15 (IA)**

Organic Mixture Analysis

Demonstrations of separation of binary mixtures: using H_2O, HCl, NaOH, $NaHCO_3$, Ether or other reagent as may be necessary along with required conditions for their use.

Systematic identification of mixtures of pure organic compounds: separation and identification of simple binary mixtures having acidic, basic and neutral components. Preparation of their derivatives, determination of b.p./m.p. for components and their derivatives.

Any other experiment be added as per requirement

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+10**

Course outcomes

CO1 To introduce and demonstrate the basic principle and techniques of separation of binary organic mixture.

CO2 To analyse qualitatively the presence of extra elements and functional groups in the binary organic mixture along with understanding of chemical reaction involved.

CO3 To make them able to differentiate between aromatic/aliphatic, saturated/unsaturated, hydrocarbon/heterocycles.

CO4 To understand and develop the capabilities of preparing derivatives of different organic compounds bearing various organic functionalities.

CO5 To understand significance of melting point, mixed melting point, boiling point in identification of organic compounds.

CO6 To develop the skill of performing experiments and analysing data to evaluate results.

CO7 To develop the ability to compile interpreted information in the form of lab record.

CO8 To make them mentally and academically sound to face viva-voce.

Mapping of Paper No. CHEM-206

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	S	M	M	M	W	M	S	S	S	M
CO2	S	S	M	S	M	S	S	M	M	W	M	S	S	S	S
CO3	S	S	M	S	M	S	S	M	S	W	S	S	S	S	S
CO4	S	S	M	S	M	S	S	M	M	W	M	S	S	S	S
CO5	M	M	S	S	W	M	M	M	S	M	S	S	S	S	M
CO6	M	S	S	S	S	S	W	W	S	S	S	S	S	S	S
CO7	M	M	M	M	M	S	W	W	S	S	M	S	S	S	S
CO8	S	S	S	S	M	M	W	S	M	S	S	M	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.) Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY.
6. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
7. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
8. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

M.Sc. Chemistry Semester III
Inorganic Chemistry General (CHEM-301)

Credits-3 **Total Marks = 60**
Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION A

TRANSPORT AND STORAGE OF DIOXYGEN

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythin, model synthetic complexes of iron and cobalt.

Electron Transfer in Biological Systems

Structure and function of metalloproteins in electron transport processes- cytochromes and iron-sulphur proteins, synthetic models.

SECTION B

Polarography

General principles, diffusion controlled current, Dropping mercury electrode, Ilkovic equation (without proof), Half-wave potentials, over potential, Evaluation of Polarographic waves, Conditions for performing Polarographic determinations and applications of Polarography, theories of hydrogen overvoltage (Tafel's theory, Recombination theory and Volmer, Erdy and Gruss theory / theory of slow discharge of ions).

Vibrational Spectroscopy

Symmetry, shapes and number of IR modes AB_2, AB_3, AB_4, AB_5 and AB_6 (Group theoretical treatment) mode of bonding of ambidentate ligands and diketonato or complexes, application of resonance Raman spectroscopy particularly for the study of active- sites of metalloproteins.

SECTION C

Mossbauer Spectroscopy

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{2+} and Sn^{4+} compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

Photoelectron Spectroscopy

Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA.

Course outcomes:

CO1 To introduce various basic concepts of bioinorganic chemistry to the students.

CO2 To discuss the various dioxygen carriers proteins present in various organisms.

CO3 To explain the electron transfer processes in living organisms with reference to iron sulphur proteins and cytochromes. To know the fundamentals of polarography and its applications.

CO4 To discuss the various theories applicable in polarography.

CO5 To apply the symmetry and group theory in elucidation of structural features with the help of vibrational spectra.

CO6 To study the resonance Raman spectroscopy for the study of active sites of metalloproteins.

CO7 To discuss the basic principles, spectral parameters and display in Mossbauer spectroscopy to explain the oxidation states, coordination number and nature of metal ligand bond.

CO8 To apply the Mossbauer technique for the determination of structure and bonding in iron and tin complexes.

CO9 To know the basic principle of Photoelectron spectroscopy and study of simple molecules.

CO10 To study the chemical information from ESCA.

Mapping of Paper No. CHEM 301

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books.
2. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons.
3. Physical methods in Chemistry; R. S. Drago; Saunders, Philadelphia.
4. Fundamentals of Molecular Spectroscopy; C. N. Banwell; McGraw Hill.

M.Sc. Chemistry Semester III
Physical Chemistry General (CHEM-302)

Credits-3 **Total Marks = 60**
Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION – A

Microwave Spectroscopy

Basics of spectroscopy. The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules.

Infrared Spectroscopy

The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P,Q,R branches, vibration of polyatomic molecules, normal mode of vibrations.

Raman Spectroscopy

Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines.

SECTION – B

Nuclear Magnetic Resonance Spectroscopy

Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques chemical shift, the □-scale of chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling, the nuclear overhauser effect.

Nuclear Quadrupole Resonance Spectroscopy

Introduction, energies of quadroupole transitions, effect of magneticfield on the spectra, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra.

Electron Spin Resonance Spectroscopy

Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.

SECTION – C

X-ray Crystallography

Symmetry elements in crystals, stereographic projections, point groups (illustration of R, R-bar, Rm, R/m, (R-bar)m point groups only), miller indices for planes and directions, criteria for determining unit cell of lattice, space lattices, space groups P1, Pbar1, P2, $P2_1$, Pm, Pc, C2, Cm, Cc.

X-ray emission spectra, absorption edges, X-ray filters, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Equivalence of Bragg's and Laue condition, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded), Interpretation of powder photographs for cubic crystals, Data reduction, Phase problem – Patterson method and Heavy-atom method, refinement of structure by successive and difference fourier synthesis. Correctness of a structure (Discrepancy index).

Characteristic difference between X-ray, electron and neutron diffraction techniques.

Course outcomes:

CO1 To know the basic concept of microwave spectroscopy and able to interpret the rotational spectra of rigid diatomic and polyatomic linear molecules and symmetric top molecules.

CO2 To discuss the raman and infrared spectroscopy and its application in physical chemistry.

CO3 To explain the NMR spectroscopy and its significance in chemistry.

CO4 Know about NQR and ESR spectroscopy and their applications in chemistry.

CO5 To identify symmetry elements in crystals and know the classification of crystals under various point groups and space groups.

CO6 To understand the basic concept of reciprocal lattice related to X-ray crystallography and interpretation of powder X-ray diffraction patterns.

CO7 To determine interplanar spacing for different crystal systems and structure factors for different types of lattices.

CO8 To know about phase problem in crystallography and methods for phase determination.

CO9 To know about various crystal structure refinement procedures.

Mapping of Paper No. CHEM 302

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Elementary Crystallography, L. Azaroff.
7. Structure Determination by X-ray Crystallography, M. Ladd and R. Palmer.
8. X-Ray Structure Determination: A Practical Guide, 2nd Edition by George H. Stout and Lyle H. Jensen.
9. Essentials of Crystallography, McKie & McKie, Blackwell Scientific Publications, 1986.
10. Handbook of X-rays, Emmett and F. Kaelbse, McGraw Hill.

M.Sc. Chemistry Semester III
Organic Chemistry General (CHEM-303)

Credits-3 **Total Marks = 60**
Time: 3 Hrs. **45 (EM) + 15 (IA)**

Note: Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

SECTION – A

Ultraviolet and Visible Spectroscopy

Introduction and understanding of UV phenomenon, Various electronic transitions (185-800 nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds.

Mass Spectrometry

Introduction, ion production - EI, CI, FD and FAB, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination molecular formula from isotopic ratio data, isotope profile of halogen compounds, fragmentation pattern - simple cleavage, retro-Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

SECTION – B

Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, virtual coupling. Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve - variation of coupling constant with dihedral angle. Fourier transform technique and its advantages. Resonance of other nuclei-F, P.

Tools for simplification of complex NMR spectrum (chemical and instrumental)**:**-Deuteration, changing solvent, trifluoroacetylation, basification

and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe. Concept of 2D-NMR spectroscopy.

SECTION – C

Carbon-13 NMR Spectroscopy

General considerations, Comparison of ^{1}H-NMR and ^{13}C-NMR, Proton coupled and proton decoupled ^{13}C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect.

Infrared Spectroscopy

Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT-IR.

Composite Problems

Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.

Course outcomes:

CO1 To know the basic concept of Ultraviolet and Visible Spectroscopy.

CO2 To discuss the Beer-Lambert law, effect of solvent on electronic transitions.

CO3 To apply Fieser-Woodward rules for calculating λmax for conjugated dienes and carbonyl compounds.

CO4 To introduce mass spectrometry and difference with spectroscopy.

CO5 To discuss the methods of fragmentation of organic compounds - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance.

CO6 To apply the concept of mass spectrometry for the determination of structure of organic compounds based on fragmentation.

CO7 To explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.

CO8 To introduce and discuss the chemical shift and coupling constant in relation to stereochemical structure of the organic compound.

CO9 To explain the difference between First order and second order NMR spectra and Tools used for simplification of complex NMR spectrum (instrumental and chemical).

CO10 To know the difference between 1 H-NMR and 13 C-NMR and their applications in structure determination of organic compounds.

CO11 To introduce the concept of 2D-NMR.

CO12 To explain the principle of IR spectroscopy and its application in determining different functional groups present in organic compounds.

CO13 To apply various spectroscopic techniques discussed above for solving/determining the structure of organic compounds (composite problems).

Mapping of Paper No. CHEM-303

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	S	S	W	M	M	S	S	S	S	S
CO2	S	S	M	S	M	S	S	W	M	W	S	S	S	S	S
CO3	S	S	M	S	M	S	S	W	M	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	M	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	M	S	S	S	S	S
CO6	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S
CO7	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S
CO8	M	S	M	S	M	S	M	W	M	W	S	S	S	S	M
CO9	M	M	M	S	W	S	S	W	M	W	S	S	S	S	S
CO10	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S
CO11	S	S	S	S	S	S	S	M	M	M	S	S	S	S	S
CO12	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S
CO13	S	S	S	S	S	S	S	S	M	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.

3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P. S. Kalsi, Wiley Estern, New Delhi.
6. Organic Spectroscopy by William Kemp, John Wiley.
7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

M.Sc. Chemistry Semester III
Inorganic Chemistry Special-I (CHEM-304)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the Trans effect, mechanism of the substitution reactions.

SECTION – B

Electron Transfer Reactions

Redox reactions, electron transfer reactions, general discussion and kinetic rate laws., mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions, two electron transfer reactions, metal ion catalysed reactions, mixed valence complexes and their electron transfer.

SECTION – C

Reactions of metal complexes

Reactions of metal complexes having ligands as nitrile, phosphate and azide. Reactivity of coordinated hydrocarbons: a) Nucleophilic addition and substitution b) Rearrangement reactions, Redistribution reactions, Fluxional isomerism of organometallics.

SECTION – D

Inorganic Polymers

Classification, types of inorganic polymerization, comparison with organic polymers, boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.

Non-aqueous Solvents

Reaction in non-aqueous media with respect to H_2SO_4, BrF_3, N_2O_4 and phosphoryl chloride; Kinetics and mechanism of coordination reactions in non-aqueous media.

Course outcomes:

CO1 To discuss the Reaction Mechanism of Transition Metal Complexes.

CO2 To know the kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism.

CO3 To describe the Substitution reactions in square planar complexes, with reference to Trans effect and their mechanism.

CO4 To describe electron transfer reactions and mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions.

CO5 To study the Reactions of metal complexes having ligands as nitrile, phosphate and azide.

CO6 To know the concept of fluxionality and Fluxional isomerism of organometallics.

CO7 To classify inorganic polymers and their comparison with organic polymers.

CO8 To know about boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.

CO9 To study the Kinetics and mechanism of coordination reactions in non-aqueous media.

Mapping of Paper No. CHEM 304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	M	S	S	S	M	W	M	M	S	S	S	S
CO2	S	S	S	S	S	S	S	S	W	M	M	S	S	S	S
CO3	S	S	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S
CO5	S	S	S	M	M	S	S	S	S	S	S	S	M	S	M
CO6	S	S	M	M	M	S	S	M	M	M	S	S	M	S	S
CO7	S	S	S	M	S	M	M	S	M	M	S	S	S	M	S
CO8	S	S	S	W	W	S	M	S	M	S	M	S	S	S	S
CO9	S	S	S	W	M	M	S	M	S	W	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.

2. Inorganic Reaction Mechanism; M.L. Tobe; Nelson, Wlaton and Thames.

3. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia.
4. The Chemistry of Molten Salts; H. Bloom Benjamin, New York.
5. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
6. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
7. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
8. Coordination Chemistry; Banerjea; Tata McGraw Hill.
9. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
10. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.

M.Sc. Chemistry Semester III
Inorganic Chemistry Special-II (CHEM-305)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Alkyls and Aryls of Transition Metals

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Fluxional Organometallic compounds

Fluxionality and dynamic equilibria in compound such as η^2-olefin, η^3-allyl and dienyl complexes, Carbonyl scrambling.

SECTION – B

Compounds of Transition Metal-Carbon Multiple Bonds

Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

Transition Metal Compounds with Bonds to Hydrogen

SECTION – C

Transition Metal □-Complexes

Transition metal □-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

SECTION – D

Homogeneous Catalysis

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.

Course outcomes:

CO1 To explain the use of organocopper compounds in organic synthesis.

CO2 To know the concept of Fluxionality and its dynamic equilibria in compounds such as η^2-olefin, η^3-allyl and dienyl complexes.

CO3 To discuss the structural characteristics, nucleophilic and electrophilic reactions of transition metal – carbon multiple bonds.

CO4 To know the classification of transition metal pi complexes, their synthesis, structural characterstics and their important reactions.

CO5 To learn about various types of homogenous catalysis reactions and their utility in organic synthesis.

Mapping of Paper No. CHEM 305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. .
3. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
4. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
5. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
6. Coordination Chemistry; Banerjea; Tata McGraw Hill.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.

Or

M.Sc. Chemistry Semester III
Physical Chemistry Special-I (CHEM-304)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION - A

Quantum Mechanics-I

Problem of two electrons, exchange interactions. Approximate methods: First order time-independent perturbation theory for non-degenerate states. Variation theorem and variational methods. Ground and excited state of helium atom. Coupling of angular momentum for many electron system, spin-orbit coupling, Molecular Term symbols. Born-Oppenheimer approximation, the hydrogen molecule ion, the hydrogen molecule, their symmetric and antisymmetric solution (without actual evaluation of various integrals). Self-consistent field method.

SECTION - B

Quantum Mechanics-II

Valence bond and MO (LCAO) treatment of hydrogen molecule. Comparison of the MO and VB treatments and their equivalence limit. Configuration Interaction. Extension of MO theory to other systems- Homonuclear and heteronuclear diatomics, simple polyatomic molecules.

The pi-electron approximation, Huckel theory of conjugated systems. Applications to ethylene, butadiene, cyclobutadiene and cyclopropenyl molecules. Calculation of properties- Delocalization energy, electron density, bond order. Ab initio and Semi-empirical Methods for Closed Shell Systems.

SECTION-C

Quantum Photochemistry

Types of Photophysical Pathways, Radiative and Non-Radiative transitions, Einstein Treatment of Absorption and Emission Phenomena, Probability of Induced Emission and Its Application to Lasers, Time-dependent Schrödinger equation, Time-dependent perturbation theory for photochemical systems, Transition moment integral, Theoretical Absorption Intensity, Oscillator Strength, Rules governing the transition between two energy states.

SECTION-D

Micelles

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting

the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, emulsions, micro emulsion.

General Properties of Liquids

Liquids as dense gases, liquids as disordered solids, some thermodynamics relations, internal pressure and its significance in liquids, equation of state, critical constants, Different types of intermolecular forces in liquids.

Course outcomes:

CO1 To explain time-independent perturbation theory and variational methods.

CO2 To describe Born-Oppenheimer approximation.

CO3 To obtain symmetric and antisymmetric solution of hydrogen molecule and its ion.

CO4 To compare MO and VB treatment of hydrogen molecule.

CO5 To explain Self Consistent Field method.

CO6 To discuss Hückel theory of conjugated systems and apply it to various organic molecules.

CO7 To describe Ab initio and Semiempirical methods for closed shell systems.

CO8 To discuss photophysical pathways, radiative and non-radiative transitions and Einstein's treatment of absorption and emission phenomena.

CO9 To understand the probability of induced emission and its application to lasers.

CO10 To know about Time-dependent Schrödinger equation.

CO11 To describe time-dependent perturbation theory applicable to photochemical systems.

CO12 To know about theoretical absorption intensity and oscillator strength.

CO13 To explain rules governing the transition between two energy states.

CO14 To express the knowledge about various terms associated with micelles.

CO15 To explain the thermodynamics of micellization.

CO16 To discuss various terms about general properties of liquids.

CO17 To describe different types of intermolecular forces in liquids.

Mapping of Paper No. CHEM-304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO12	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO13	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO14	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO15	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO16	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO17	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.
2. Quantum Mechanics, H.L. Strauss, Prentice Hall.
3. Quantum Chemistry, B.K. Sen, Kalyani Publishers
4. Quantum Chemistry, R.K. Prasad, New Age International.
5. A Textbook of Physical Chemistry, Vol. 4, K.L. Kapoor, MacMillan India Ltd.
6. Introduction to Quantum Chemistry, C. R. Gatz, Charles E. Merrill Pub. Co.
7. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedman, 3rd Edition (1997), Oxford University Press, New York.
8. Quantum Chemistry, H. Eyring, J. Walter and G.E. Kimball (1944) John Wiley, New York.
9. Quantum Chemistry, I.N. Levine, 5th edition (2000), Pearson Educ., Inc., New Delhi.

10. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherjee, 3rd Edition, New Age.
11. Micelles, Theoretical and Applied Aspects, Y. Moroi, Plenum Press.
12. Significance of liquid structures, H. Eyring.

M.Sc. Chemistry Semester III
Physical Chemistry Special-II (CHEM-305)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Statistical Mechanics

Ensemble averaging, postulates of ensemble averaging. Micro canonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermind multipliers). Maxwell- Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression.

SECTION – B

Quantum Statistics

The Bose-Einstein statistics, statistics of a photon gas, the Fermi-Dirac statistics, Fermi-Dirac systems, extreme gas degeneration, slight gas degeneration, electron gas in metals, thermionic emission and comparison of two statistics, non degenerate and degenerate systems.

SECTION – C

Statistical Thermodynamics – I

Partition function and thermodynamic properties, partition function and factorization of partition function, translational partition function, translational thermodynamic function, atoms and monoatomic molecules, Sackur-Tetrode equation, diatomic molecules, separation of internal partition function. Rotational and vibrational energies, entropy due to internal degrees of freedom. Rotational partition function, rotational partition function for polyatomic molecules, vibrational partition function.

SECTION-D

Statistical Thermodynamics – II

Determination and calculation of thermodynamic properties i.e. internal energy, entropy, Helmholtz and Gibbs free energy, ortho and para hydrogen states, free energy functions. Partition function and equilibrium constant, effect of nuclear spin, isomolecular reaction, isotopic exchange reactions. Einstein theory and Debye theory of heat capacities of monatomic solids.

Non-equilibrium Thermodynamics

Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-liner laws, Gibb's equation, Onsager's reciprocal relation, Entropy production-specific laws of entropy production, Non-equilibrium stationary states, Prigogine's principle of entropy production, Coupled phenomena. Some important applications.

Course outcomes:

CO1 To describe types of ensembles.

CO2 To be able to discuss corresponding distribution laws.

CO3 To explain Maxwell-Boltzmann statistics.

CO4 To discuss Maxwell distribution law of velocities.

CO5 To describe Bose-Einstein and Fermi-Dirac statistics and their comparison.

CO6 To explain extreme and slight gas degeneration.

CO7 To know about partition function and its factorization.

CO8 To discuss translational thermodynamic function.

CO9 To describe separation of internal partition function.

CO10 To explain rotational and vibrational partition functions.

CO11 To be able to evaluate thermodynamics properties.

CO12 To describe free energy functions.

CO13 To discuss isotopic exchange reactions.

CO14 To know about Einstein theory and Debye theory of heat capacities of monoatomic solids.

CO15 To discuss scope of irreversible thermodynamics.

CO16 To explain phenomenological laws.

CO17 To describe specific laws of entropy production.

CO18 To discuss coupled phenomenon.

Mapping of Paper No. CHEM-305

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO12	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO13	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO14	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO15	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO16	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO17	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO18	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Introduction to Statistical Thermodynamics, H. Dole.
2. Theoretical Chemistry, S.Glasstone, Affiliated East-West Press.
3. Thermodynamics, Lewis and Randall.
4. Chemical Physics, J.C. Slater.
5. Non-equilibrium Thermodynamics, C. Kalidas.

Or

M.Sc. Chemistry Semester III
Organic Chemistry Special-I (CHEM-304)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Organometallic Reagents I

Principle, preparations, properties and applications of the reagents of the following metals/non-metals in organic synthesis with mechanistic details:

Li, Mg, Cd, Zn, Cu, S, Si, B and I.

SECTION - B

Organometallic Reagents II

Principle, preparations, properties and applications of the reagents of the following metals in organic synthesis with mechanistic details Pd, Ni, Fe, Co, Rh, Cr and Ti compounds.

SECTION –C

Oxidation

Introduction, Different oxidative processes, Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, and thallium (III) nitrate.

SECTION –D

Reduction

Introduction. Different reductive processes. Hydrocarbons– alkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides.Nitro, nitroso, azo and oxime groups. Hydrogenolysis.

Course outcomes:

CO1 To understand the principle of Organometallic Reagents and their applications in organic synthesis.

CO2 To know about the role of various Organometallic Reagents of Li, Mg, Cd, Zn,Cu, S, Si, B, I, Pd, Ni, Fe, Co, Rh, Cr and Ti compounds in organic synthesis along with their preparations, properties and applications of these reagents with mechanistic details.

CO3 To understand the principle of oxidation, oxidative processes related to Hydrocarbons- alkenes,aromatic rings, activated and unactivated saturated C-H groups, alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides

CO4 To learn about applications of ruthenium tetraoxide and thallium (III) nitrate in oxidation of various types of compounds.

CO5 To understand the general pathways of reduction reactions. Reduction of Hydrocarbons – alkanes, alkenes, alkynes, substituted and unsubstituted aromatic rings.

CO6 To be able to understand the reduction of carbonyl compounds – aldehydes, ketones, acids and their derivatives, Epoxides. reduction of compounds containing nitro, nitroso, azo and oxime groups.

Mapping of Paper No. CHEM-304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO 1	S	S	S	S	S	M	M	S	S	S	S	S	S	S	S
CO 2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 3	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 6	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Modern Synthetic Reactions, H.O. House, W.A. Benzamin.
2. Some Modern Method of Organic Synthesis, W. Carruther, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
6. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.
7. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.

M.Sc. Chemistry Semester III
Organic Chemistry Special-II (CHEM-305)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all, selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Pericyclic Reactions

Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5 hexatriene and allyl system classification of pericyclic reactions, Woodward - Hoffmann correlation diagram. FMO & PMO approach, Electrocyclic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic Reactions.

SECTION – B

Pericyclic Reactions

Sigmatropic Rearrangements-suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements introduction to ene reactions. Simple problems on Pericyclic reactions, Group transfers and eliminations.

SECTION – C

Photochemistry

Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photosensitization, quenching, quantum efficiency and quantum yield.

Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreducation. Photochemistry of olefins and 1, 3-Butadiene (cis-trans isomerisation, dimerisation and cycloadditions).

SECTION – D

Photochemistry

Di-π-methane rearrangement, enone and dienone rearrangements, photochemistry of aromatic compounds (substitution, isomerization, cyclization and cycloaddition reactions), Photo-Fries rearrangement, photolysis of nitrile

esters and Barton reaction, Hoffman-Loefller-Freytag reaction, synthesis of vitamin-D.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Appreciate the role of Molecular Orbitals in analysing Pericyclic Reactions.

CO2 Interpret the stereochemical course of a Pericyclic Reaction and identify the product.

CO3 Predict the course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule.

Mapping of Paper No. CHEM-305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	M	M	S	W	S	S	S	S	S
CO2	S	S	S	S	S	S	M	M	S	W	S	S	S	S	S
CO3	S	S	S	S	S	S	M	M	S	W	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Pericyclic Reactions, S.M. Mukherji Macmilan India.
2. Organic Photochemistry, J Coxan & B. Halton, Cambridge University Press.
3. Introductory Photochemistry, A. Cox and T. Camp McGraw Hill.
4. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" Verlag Chemie Academic Press.
5. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand.
6. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2nd Edn. 1979.

Or

M.Sc. Chemistry Semester III

Pharmaceutical Chemistry Special-I (CHEM-304)

Credits-4 **Total Marks = 80**

Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Synthon approach-I

Definition of terms- Disconnection, synthons, functional group interconversions (FGI), synthetic equivalents. General principles of the disconnection approach, the importance of order of events in organic synthesis, one group C-X and two group C-X, One group C-C disconnections-alcohols and carbonyl compounds, chemoselectivity, reversal of polarity, amine synthesis.

SECTION – B

Synthon approach-II

Two group C-C disconnections-1, 3 & 1,5-difunctionalized compounds, Stereochemistry in organic synthesis-stereoselectivity, stereospecificity, regioselectivity and regiospecificity.

Synthon approach in the synthesis of the following drugs: Salbutamol, Propanolol, moxnidazole, nafimidone, drildone, belfosih. Ocfentanil, afornine Principle of protection of alcoholic, amino, carbonyl and carboxylic groups.

SECTION – C

Heterocyclic Compounds - I

Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

Methods of synthesis and Reactions including mechanism of the following five-membered 1,2- and 1,3-heterocycles: pyrazole, imidazole, oxazole, isooxazole, thiazole, isothiazole; their basic character.

SECTION – D

Heterocyclic Compounds - II

Methods of synthesis and Reactions including mechanism of the following six-membered heterocycles: purines and pyrimidines. Caffeine, xanthine, theobromine, theophylline.

Methods of synthesis and Reactions including mechanism of-Indoles, quinolines and isoquinolines.

Flavanoids: Occurrence, nomenclature and general methods of structure determination, isolation, importance and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.

Course outcomes:

The purpose of the paper is to make students able to know the concepts of synthetic chemistry like synthon approach, protection, heterocyclic chemistry and their application in drugs.

CO1 To be familiar with basic concepts of synthon approach explaining one- & two-group C-X and C-C disconnections, chemoselectivity, reversal of polarity, amine synthesis, stereoselectivity, stereospecificity, regioselectivity and regiospecificity.

CO2 To apply the concept of disconnection approach for the synthesis of drug molecules.

CO3 To apprise of protection of important functional groups namely alcoholic, amino, carbonyl and carboxylic groups.

CO4 To be acquainted with mechanistic details of the methods of preparation and reactions of five-membered diheteroatomic molecules, 1,2- and 1,3-azoles.

CO5 To make to know about the synthesis and reaction of purines and pyrimidines and the mechanistic pathways.

CO6 To inform about xanthines, indole, quinoline, isoquinoline

CO7 To offer details of flavonoids including Cyanin, Quercetin, Daidzein and Chrysin.

Mapping of Paper No. CHEM 304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	M	S	S	M	S	S	S	S	S	S	S	M	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Modern Synthetic Reactions, H. O. House, W.A. Benzamin.
4. Advanced Organic Chemistry Reactions, Mechanisms a Structures, J. March, Wiley.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Organic Chemistry, Vol. 2, I. L. Finar, ELBS.

M.Sc. Chemistry Semester III
Pharmaceutical Chemistry Special-II (CHEM-305)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

General mode of action, Medicinal Uses and Synthesis of Important Drugs in the Following Categories.

Antineoplastic Agents: Metastasis, classification, mode of action of alkylating agents (synthesis of mephalan, thiotepa, busulfan, lomustine) and antimetabolites (synthesis of methotrexate, 5-fluorouracil, 6-mercaptopurine), hormone based therapies, plant products, radiotherapeutic agents. Taxol realated compounds.

Antiviral agents: RNA and DNA viruses, An introduction to AIDS, how HIV infects the system, mode of action of nucleoside reverse transcriptase inhibitors- AZT, ddI, ddC, d4T & 3TC and HIV-protease inhibitors-Ritonavir. Synthesis of AZT.

An overview of HIV entry inhibitors, Integrase inhibitors, Chemokine receptor binders, Inhibitors of gp41 fusion activity.

Antimalarials: Cinchona alkaloids, 4-aminoquinolines, 8-aminoquinolines, Mefloquine, 9-aminoacridines. Synthesis of Mefloquine, chloroquine, primaquine.

SECTION – B

Antibiotics

Penicillins: Discovery, mode of action, SAR, Penicillins and semi-synthetic penicillins, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity; solving these problems leading to the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxycillin, carbenicillin and carfecillin; β-lactamase inhibitors-Clavulanic acid, Olivanic acids.

Cephalosporins: Classification, SAR, synthesis of cephalosporin-C, recent advances of fourth generation cephalosporins

Sulfonamides-SAR, mode of action. Sulfanilamide analogs- synthesis of Sulfathiazole, sulfadiazine, sulfacetamide.

Tetracyclins and aminoglycosides: Structure, mode of action, SAR, streptomycin, neomycin, gentamycin; Macrolides- mode of action, erythromycin, azithromycin; Synthesis of chloramphenicol.

Quinolones, fluoroquinolones: Structure, mode of action, synthesis of nalidixic acid and ciprofloxacin Lincomycins.

SECTION – C

Prostaglandins: General Introduction, nomenclature of prostaglandins and eicosanoid biosynthesis.

Non-Steroidal anti-inflammatory agents: Classification, mode of action, COX-2 inhibitors, salol principle.

Synthesis of celecoxib, valdecoxib, aspirin, phenbutazone, mefanamic acid, indomethacin, piroxicam, diclofenac, Naproxen.

Antipyretic-Analgesics: opoid antagonists and agonists-codeine and heroin), synthesis of meperidine, methadone, dextropropoxyphen.

SECTION – D

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives- norethindrone, norethynodrel, estradiol and mestranol. Recent Advances.

Antihypertensive agents: Classification, Hypertension, Renin-Angiotensin system, mode of action, Calcium channel blockers, ACE inhibitors and α-blockers, β-blockers, centrally acting adrenergic drugs, Synthesis of atenolol, clonidine, methyldopa, guanabenz, diltiazem, captopril, enalapril.

Course outcome: The purpose of the paper to put forward the description of major classes of pharmaceutical agents especially the mode of action and synthesis.

CO1 To discuss antineoplastic agents including alkylating agents, antimetabolites, radiotherapeutic agents, hormone based therapies, plant products.

CO2 To explore antiviral agents like reverse transcriptase inhibitors, protease inhibitors, integrase inhibitors, chemokine receptor binders, Inhibitors of gp41 fusion activity, HIV entry inhibitors.

CO3 To enrich the knowledge about antimalarials (cinchona alkaloids, aminoquinolines, 9-aminoacridines.

CO4 To understand penicillins in detail, lactamase inhibitors, cephalosporins, sulfonamides, tetracyclins, aminoglycosides, macrolides, quinolones, lincomycins.

CO5 To inform about prostaglandins, NSAIDS, antipyretic-analgesics.

CO6 To know about the antifertility agents, ovulation inhibitors and related hormonal contraceptives.

CO7 To aware about antihypertensive agents, calcium channel blockers, ACE inhibitors and alpha-blockers, beta-blockers, centrally acting adrenergic drugs.

Mapping of Paper No. CHEM 305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
2. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
4. Organic Chemistry Vol.-2 I.L. Finar, ELBS.

M.Sc. Chemistry Semester III
Inorganic Chemistry Special Practical I & II
(CHEM 306 & CHEM 307)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Inorganic Chemistry Special Practical I (CHEM-306)

Preparations:

Preparation of selected Inorganic Compounds and their Characterization by elemental analysis and spectroscopic methods (IR, NMR, EPR, Magnetic moment etc.).

I Choloropentaamminecobalt (III) Chloride.

II Nitro/Nitritopentaamminecobalt (III) Chloride (Distinction between nitro and nitrito by IR).

III Potassium trioxalatoferrate (III).

IV Chromous acetate.

V Cis and trans $[Co(en)_2Cl_2]$.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To demonstrate the synthesis of selected inorganic compounds.

CO2 Able to interpret the structure of synthesized inorganic complexes by various spectroscopic techniques.

CO3 To perform experimentation and evaluate the results.

CO4 To develop the ability to compile interpreted information in the form of lab record.

CO5 To face viva-voce.

Mapping of Paper No. CHEM-306

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	M	S	S	M	S	S	M	S	S	S	S	S
CO2	M	S	S	S	S	M	S	S	S	S	M	S	S	M	M
CO3	S	S	S	M	S	M	S	S	S	S	S	S	M	S	S
CO4	M	S	S	S	S	M	S	S	M	S	S	S	S	S	M
CO5	S	S	M	S	M	M	S	S	S	M	M	S	S	M	M

S = Strong, M = Medium, W = Weak

Inorganic Chemistry Special Practicals II (CHEM-307)

Instrumentation:

I Spectrophotometric Determinations.

II Conductometric Titrations.

III Flame Photometry.

IV Potentiometric/pH-analysis.

V Electrogravimetric analysis.

VI Polarographic analysis.

VII Any other techniques introduced.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To introduce various instrumental techniques present in inorganic laboratories.

CO2 Develop the ability to demonstrate the qualitative and quantitative application of spectrophotometric technique.

CO3 Develop the ability to learn potentiometric, polarographic and conductometric titrations.

CO4 Learn to perform experimentation and evaluation of the results.

CO5 Develop the ability to compile interpreted information in the form of lab record.

CO6 Develop the ability to express during Viva -Voce.

Mapping of Paper No. CHEM-307

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

Or

M.Sc. Chemistry Semester III
Physical Chemistry Special Practical I & II
(CHEM 306 & CHEM 307)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Physical Chemistry Special Practical I (CHEM-306)

Potentiometry

1. Determination of activity coefficient of Ag^+ in a solution of silver nitrate and to study the effect of potassium nitrate on the activity coefficient of silver nitrate.
2. Determination of the cell Pt, $H_2|HCl\ AgCl|Ag$ with various concentrations of HCl and to obtain the activity coefficient of HCl.
3. Determination of solubility of silver halides in water.
4. Determination of first and second ionization constant of phosphoric acid.
5. Study of silver-ammonia complex and determination of the stability constant.
6. Determination of strength of ferrous ammonium sulphate using potassium dichromate or ceric sulphate and determination of redox potential.
7. Determination of strength of HCl and CH_3COOH in a mixture using NaOH.
8. Titration of weak/strong acid with strong base using quinhydrone and determination of dissociation constant of the acid.
9. Study of equilibrium constant of the reaction $Fe^{+++} + Ag \rightarrow Fe^{++} + Ag^+$.
10. To determine the degree of hydrolysis of aniline hydrochloride.
11. Titration of halides with $AgNO_3$ individually and in the mixture of two halides.

Polarimetry

1. Determine the percentage of two optically active substances in a mixture polarimetrically.
2. Determination of relative strength of acids by the study of inversion of sucrose.
3. Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono-, di- and tri-chloroacetic acids as catalysts.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To apply the technique of potentiometry for :

- ❖ determining activity coefficients of different electrolytes.
- ❖ determining stability constants of the complexes.
- ❖ finding solubility of sparingly soluble salts.
- ❖ performing acid-base titrations.
- ❖ studying the equilibrium constant for redox reactions.
- ❖ determining liquid junction potential.

CO2 To apply the technique of polarimetry for:

- ❖ Determining the percentage of optically active substance in a mixture.
- ❖ Finding out the relative strength of acids.
- ❖ Studying the effect of substituents on rate constant of inversion kinetics.

CO3 To develop the ability to compile interpreted information in the form of lab record.

CO4 To face viva-voce.

Mapping of Paper No. CHEM-306

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Physical Chemistry Special Practical II (CHEM-307)

Conductometry

1. Determination of the equivalent conductance of weak acid (benzoic and acetic acid) at several concentrations and the dissociation constant of the acid.
2. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO_3 and NaCl and the validity of Onsagar equation.
3. Determination of solubility of silver halides.
4. Study of degree of hydrolysis of aniline hydrochloride.
5. Conductometric titration of: (i) Strong acid vs. strong base, (ii) Strong acid vs. weak base, (iii) Weak acid vs. strong base, (iv) Weak acid vs. weak base, (v) CH_3COOH + HCl vs. NaOH, (vi) $CuSO_4$ vs. NaOH.

6. Determine the critical micelle concentration (CMC) of a surfactant (sodium lauryl sulphate) by conductivity method.

Colorimetry/Spectrophotometry

7. Verification of the Lambert-Beer's law using solutions such as $K_2Cr_2O_7$, $CuSO_4$, $KMnO_4$ in water and I_2 in CCl_4.
8. Study of iron-tiron and iron-salicylic acid complexes.
9. Determination of the composition of various mixtures spectrophotometrically:
   (i) Potassium dichromate and potassium permanganate.
   (ii) Crystal violet and aurine.
10. Determine the dissociation constant of an indicator spectrophotometrically.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To apply the conductometry method for :

- Determining equivalent conductance of weak and strong electrolytes.
- Determining solubility of sparingly soluble silver salts.
- Performing conductometric acid base titrations.
- Determining CMC of surfactants.

CO2 To apply the technique of spectrophotometry for :

- Verifying Lambert-Beer's law.
- Determining composition of various mixtures.

CO3 To develop the ability to compile interpreted information in the form of lab record.

CO4 To face viva-voce.

Mapping of Paper No. CHEM-307

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
2. Experimental Physical Chemistry, R.C. Das and B. Behera,McGraw Hill.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.

Or

M.Sc. Chemistry Semester III
Organic Chemistry Special Practical I & II
(CHEM 306 & CHEM 307)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Organic Chemistry Special Practical I (CHEM-306)

1. **Preparations of Organic compounds involving two and three stages**: Typical preparations from which the two and three stage preparations can be chosen are:
   1. Toluene — p-nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid
   2. Hydroquinone — Benzoquinone — 5- Hydroxy benzoxathiole-2-one —5-Acetoxy benzoxathiol-2-one
   3. Benzene — Acetopheneone — Acetophenone oxime — Acetanilide
   4. Benzaldehyde — Benzoin — Benzil — Benzillic acid
   5. Acetylacetone — 4,6-dimethylpyridine-2-mercaptopyrimidine — 4,6-dimethyl-2- hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl) 3,5-dimethylpyrazole
   6. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol
   7. Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid
   8. Acetophenone — Benzalacetophenone — epoxide
   9. Cyclohexanone —Cyclohexanone oxime—caprolactam
   10. Phthalic anhydride—o-benzolylbenzoic acid—anthraquinone.
   11. O-Cholobenzoinc acid —N-phenylanthranilic acid —acridone.
   12. Cholrobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol
   13. Bromobenzene—triphenylcarbinol-tritylchloride
   14. Resorcinol—resacetophenone — 4-ethyl resorcinol
   15. Resorcinol — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-hydroxycoumarin
   16. Phenol — salicylaldehyde —coumarin
   17. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene
   18. Resorcinol—resacetophenone — Chalcone
   19. Any other multi step reaction as per requirement

All the students must check the progress of reaction and purity of Final products for all the stages of preparation by Thin layer Chromatography.

2. Demonstration of different software useful in Chemistry for drawing the structure of Organic compounds as well as for the computational studies of small organic molecules.

Draw the Scheme used for a multi step preparation (two or three) using any structural drawing tool & get the IUPAC name and predicted ^{1}H-NMR spectrum for each compound involved in multi step preparation.

Brief idea of given terms: Molecular graphics, Molecular minimization, Molecular Docking, Pharmacophore, QSAR, Optimization, Single point energy and Spectral analysis.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO 1 To understand the concept of stepwise synthesis of a product and their purification.

CO 2 To explore various combinations of reactions that can be exploited to form a product.

CO 3 To have a knowledge of multistep reactions the possibilities.

CO 4 Able to understand the application of structural drawing tools such as ChemAxon, ChemDraw etc. for sketching the organic compounds, finding IUPAC nomenclature, 1H NMR prediction and some useful physical properties of small organic compounds.

CO 5 To perform experimentation and evaluate the results.

CO 6 To develop the ability to compile interpreted information in the form of lab record.

CO 7 To face viva-voce.

Mapping of Paper No. CHEM- 306

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	M	S	W	M	S	S	S	S
CO2	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO3	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO4	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO5	S	S	M	S	M	S	M	M	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Organic Chemistry Special Practical II (CHEM-307)

1. **Quantitative estimation of the followings:** Amino group, hydroxyl group, acetoxy group, carbonyl group, unsaturation, reducing and non-reducing sugars.
2. Saponification value and iodine value of fats and oils, formalin and glycine, Determination of the molecular weight of an acid by titration and by the silver salt method.
3. Enzyme assays: Isolation and estimation of salivary Amylase and urease.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

At the end of the course the student will be able to –

CO 1 Understand the basics of quantitative analysis and application in analysis of functional groups in organic compounds.

CO 2 Analyze and estimate sugars, fats, amino acids in samples.

CO 3 Isolate, and determine enzyme activity.

CO 4 Evaluate, compile and present and explain the results.

Mapping of Paper No. CHEM-307

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	S	S	M	M	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. “Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.

Or

M.Sc. Chemistry Semester III
Pharmaceutical Chemistry Special Practical I & II
(CHEM 306 & CHEM 307)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Pharmaceutical Chemistry Special Practical I (CHEM-306)

Preparations:

1) Preparations of organic compounds of medicinal interest.
2) Techniques in isolation and extraction of crude drugs, purification of various active principles having medicinal, industrial and chemical importance.
3) Quantitative estimation of drugs in biological samples.
4) Identification of microbes on the basis of Gram staining, sterility testing, microbial assays.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To understand the concept of stepwise synthesis, to be acquainted with various combinations of reactions that can be exploited to form a product and to have experience to work under different reaction conditions.

CO2 To have practical knowledge of the isolation of active component from natural sources.

CO3 To be able to work with biological samples.

CO4 To have understanding of the microbial assays.

CO5 To perform experiments and evaluate the results.

CO6 To develop the ability to compile interpreted information in the form of lab record.

CO7 To face viva-voce.

Mapping Paper No. CHEM 306 (Practical)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Pharmaceutical Chemistry Special Practical I (CHEM-307)

Preparation and evaluation of the following : Emulsion, simple syrup, aqueous idodine solution, strong iodine solution, calamine lotion, boroglycerine, tannic acid glycerine, phenol glycerine, pipermint water, rose water, camphor water, formulation of simple and medicated ointments, magnesium hydroxide mixture (milk of magnesium), simple and complex powders, cough mixture, cold cream, vanishing cream and lotions.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To have a practical knowledge about the preparation of different dosage forms.

CO2 To prepare semi solid dosage forms-cold cream, vanishing cream and lotions.

CO3 To understand the know-how of the preparation of biphasic liquid dosage form, emulsions, by dry-gum and wet-gum method.

CO4 To prepare various Monophasic liquid dosage forms.

CO5 To perform experimentation and evaluate the results.

CO6 To develop the ability to compile interpreted information in the form of lab record.

CO7 To face viva-voce.

Mapping of Paper No. CHEM 307 (Practical)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY
6. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
7. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
8. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
9. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special-III (CHEM-401)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Errors and Evaluation

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data-determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. Significance of the F test, the student 't' test and the Chi-test.

Nephelometry and Turbidimetry

Theory - light scattering, choice and comparison between nephelometry and turbidimetry, factors affecting measurement, instrumentation, applications

SECTION – B

Sewage and fertilizers

Sewage treatment, Biochemistry of sewage, fertilizers - Nitrogen; ammonification, nitrification, denitrification, fixation of nitrogen, biochemistry and ecology of nitrogen fixation, nitrogen and phosphorus fertilizers in agriculture, eutrophication, surfactants - cationic, anionic and non ionic, specific properties, degradation.

Analysis of air pollutants

Biochemical effect of As and Heavy metals such as Cd, Pb and Hg.

Molecular luminescence

Fluorimetry and Phosphorimetry: Introduction, principles of fluorescence and phosphorescence, interpretation of fluorescence spectra, factors, fluorescence intensity and concentration, instrumentation for fluorimetry, applications of fluorimetry.

Phosphorimetry, instrumentation, applications, comparison between fluorimetry and phosphorimetry.

SECTION – C

Chromatography

General principles, types of chromatography, absorption chromatography, partition chromatography, vapour phase chromatography, paper and thin layer

chromatography, retardation factor, retention volume, mechanism and efficiency of separations.

Ion-Exchange

General principles, ion exchangers-natural and synthetic, ion-exchange capacity, purification of water and other applications.

Solvent Extraction

General Principles, extraction coefficients, Batch, continuous, and counter current extractions, applications.

SECTION -D

Ion selective electrodes

Fundamental types of electrodes, gas sensors, ion sensors and enzyme electrodes, principle involved in measurements with ion selective electrodes with special reference to halide, sulphide and oxygen electrodes.

Thermal Techniques

Thermogravimetry, differential thermal analysis (DTA) and differential scanning calorimetry (DSC) principles and applications.

Course outcomes:

CO 1 To study the various statistical parameters used in the treatment of analytical data like types of errors, their sources and minimization along with Statistical evaluation of analytical data.

CO 2 To know the concept of naphelometry and turbidimetry and also its used in the quantitative inorganic analysis.

CO 3 To explain the sewage and its process of treatment, biochemistry and ecology of nitrogen fixation and effects of various pollutants in the air on living organisms.

CO 4 To learn about the instrumentation and phenomenon of phosphorescence and fluorescence along with various factors related with these processes.

CO 5 To discuss about the various types of chromatographic techniques and its applications.

CO 6 To learn about the ion selective electrodes and their utilization in inorganic analysis.

CO 7 To discuss about Thermogravimetry, differential thermal analysis (DTA) and differential scanning calorimetry (DSC), their principles and applications.

Mapping of Paper No. CHEM-401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO2	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO3	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO4	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO5	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO6	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S
CO7	S	S	M	S	M	S	W	M	S	M	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Environmental Solution Analysis; S.M. Khopkar, Wiley Eastern.
3. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
4. Instrumental methods of Analysis; L.L. Merits, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
5. Physical methods in Chemistry; R.S. Drago; Saunders.
6. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.
7. Environmental Chemistry; S.K. Banerji, Prentice - Hall.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special-IV (CHEM-402)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Electro analytical methods of Analysis

Electrogravimetry: Current-voltage relationship during an electrolysis, decomposition potential, constant current electrolysis, constant cathode potential electrolysis, apparatus, electrodes, mercury cathode, applications physical properties of electrolytic precipitates, chemical factors of importance in electrodeposition.

Electrolytical methods without cathode potential control.

Coulometric analysis: Coulometric methods of constant electrode potential and coulometric titrations. Apparatus and applications.

Amperometric titrations, anodic stripping voltammetry, and cyclic voltammetry.

SECTION – B

Atomic Absorption Spectroscopy

General principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.

Flame photometry

Theory of flame photometry, flame temperature, Emission Flame photometry - intensity of spectral lines, selection of optimum working conditions, application of flame photometry in trace metal analysis.

SECTION –C

Spectrophotometry and Colorimetry

Fundamental concepts, instrumentation for absorption measurements, interferences, application of absorption spectroscopy and Colorimetry to analysis of inogganic substance.

Nuclear magnetic Resonance

Basic Principle of NMR, Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum and evaluation of reaction

rate of fast reactions, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on ^{31}P, ^{19}F, ^{195}Pt and ^{119}Sn NMR. Application in Inorganic Chemistry.

SECTION –D

Electron Spin Resonance Spectroscopy

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as PH_4, F_2^- and $[BH_3]^-$. Double resonance in EPR.

Circular Dichroism and Optical Rotatory Dispersion

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris-chelated complexes.
Course outcome.

Course outcomes:

CO 1 To discuss the various electroanalytical methods of analysis viz. electrogravimetry, coulometric, cyclic voltammetry, amperometric analysis and their application in metal ions determination.

CO 2 To know the basic concept of atomic absorption spectroscopy and its application to alkali and alkaline earth metals.

CO 3 To discuss about principles of flame photometry and application of flame photometry in trace metal analysis.

CO 4 To learn about Fundamental concepts, instrumentation application of absorption spectroscopy to analysis of inorganic substances.

CO 5 To know about basic concept of NMR and its utilization in the structural determination of inorganic compounds.

CO 6 To know the concept of Circular Dichroism and Optical Rotatory Dispersion and its application to determine configuration of Tris-chelated complexes.

CO 7 To learn about ESR spectroscopy and its application in inorganic analysis.

Mapping of Paper No. CHEM- 402

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
3. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
4. Physical methods in Chemistry; R.S. Drago; Saunders.
5. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.
6. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.
7. Modern Optical Methods of Analysis; E.D. Olgen; McGraw Hill.
8. Introduction to Magnetic Resonance; McLachan and Carrington; Chapman and Hall.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special-V (CHEM-403)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Metal Storage Transport and Biomineralization

Ferritin, transferrin, and siderophores.

Calcium in Biology

Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extra cellular binding proteins, Coenzyme vitamin B12, vitamin B6.

SECTION - B

Metalloenzymes

Zinc enzymes – carboxypeptidase and carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Copper enzymes – superoxide dismutase. Molybdenum oxatransferase enzymes – xanthine oxidase.

SECTION - C

Supramolecular Chemistry

Concepts and language.

a) Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition.

b) Supramolecular reactivity and catalysis.

c) Transport processes and carrier design.

d) Supramolecular devices. Some example of self-assembly in supramolecular Chemistry.

SECTION-D

Principles of Bio-Inorganic Medicine

Evaluation of modern therapeutical, means of administering chemicals to humans, concentration effects, and dose-response relationship, future developments and trends in bio-inorganic therapy.

Metals in Medicine

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

Course outcomes:

CO1 To discuss about Metal Storage, their Transportations in living organisms and Biomineralization.

CO2 To learn about role of calcium in biological systems.

CO3 To explain structural characterstics and role of vitamin B6 and vitamin B12 in living systems.

CO4 To describe the types of zinc containing metllalloenzymes, their structure and mechanistic approach in involving various reactions occurring in living organisms.

CO5 To explain the structure and role of copper and molybdenum enzymes in biological systems.

CO6 To learn about the concept and language of supramolecular Chemistry.

CO7 To describe the various supramolecules and their role in catalysis.

CO8 To discuss the principles of bioinorganic medicines.

CO9 Describe the role of various metal in medicines with special role in anticancer drugs.

Mapping of Paper No. CHEM-403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	M	S	S	S	S	M	S	S	S	M	S	S	S	M
CO2	M	S	S	M	S	M	S	S	S	S	S	M	M	S	M
CO3	S	S	M	S	M	M	S	S	S	M	S	S	S	S	S
CO4	M	S	S	S	S	M	S	S	M	S	S	S	S	M	M
CO5	S	S	M	S	M	M	S	S	S	M	M	S	S	S	M
CO6	M	M	S	M	S	S	M	M	S	S	S	S	S	M	M
CO7	S	S	S	M	S	M	S	S	M	S	S	S	M	M	M
CO8	S	S	S	S	M	M	S	M	M	M	M	S	S	S	S
CO9	M	M	S	M	S	S	M	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
3. Supramolecular Chemistry, J.M. Lehn, VCH.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special-VI (CHEM-404)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Photochemistry

Absorption, excitation, photochemical laws, quantum yield, electronically excited states- life times-measurements of the times. Energy dissipation by radiative and non radiative processes, bimolecular quenching, absorption spectra, Franck condon principle, photochemical kinetics, photochemical stages-primary and secondary.

SECTION – B

Excited States of Metal Complexes

Electronically excited states of metal complexes: charge-transfer spectra, charge transfer transition, photosubstitution reactions, photorearrangements, photoisomerisation, photoredox processes conditions of excited states to be useful redox reactant Illustration of some reducing and oxidising character of Ru(2+) tris-bipyramidal complex. Transformation of chemical energy into light energy.

Metal Complex Sensitizers

Metal complex sensitizer, photosensitised reactions in metal complexes, water photolysis, nitrogen fixation and carbon dioxide reduction.

SECTION – C

Solid State-I

Crystalline and non-crystalline materials, glass transition temperature Tg and melting temperature Tm, classes of compounds of the type A_2 B_3 and AB_3 Glass-ceramics, structures of polymers, glass and ceramics inorganic chains and rings.

Alloys-interstitial, substitutional and superconducting, Meissner effect, Hume-Rothery rules.

SECTION – D

Solid State-II

Perfect and imperfect crystals, intrinsic and extrinsic defects, point defects, line and plane defects, vacancies- schottky defects and Frankel defects, colour centers, non-stiochiometry and defects.

Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors. Intrinsic and

extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors, Optical and Magnetic properties.

Course outcomes:

CO1 To know about basic concepts of photochemistry viz photochemical laws, quantum yield, electronically excited states, life time – measurements.

CO2 To learn about the Energy dissipation by radiative and non radiative processes along with Franck condon principle, photochemical kinetics and photochemical stages.

CO3 To explain about Electronically excited states of metal complexes and about the transformation of chemical energy into light energy.

CO4 To discuss about Metal complex sensitizer and photosensitized reactions in metal complexes.

CO5 To discuss about the Crystalline and non-crystalline materials and their properties, different type of Alloys, Meissner effect and Hume-Rothery rules for alloys.

CO6 To discuss about the various defects present in solids and to discuss about the Metals, insulators and semiconductors.

Mapping of Paper No. CHEM-404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S
CO2	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S
CO3	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S
CO4	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S
CO5	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S
CO6	S	S	W	S	M	S	S	S	S	M	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
2. Photochemistry of coordination compounds, K.Balzani and V.Carassti, Academic press.
3. Elements of Inorganic Photochemistry; G.J. Ferraudi, Wiley.
4. An Introduction to Crystal Chemistry; R.C. Evans, Cambridge University Press.
5. Introduction to solid state Physics; C.Kittel, Wiley New York.
6. Solid State Chemistry; N.B. Hannay; Prentic.

Or

M.Sc. Chemistry Semester IV
Physical Chemistry Special-III (CHEM-401)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section – A

Polymers

Recapitulation and basics of polymers and polymerization. Biodegradable polymers: Types of degradable polymers, Chemical and biodegradation. Applications of biodegradable polymers, Hyperbranched–star polymers, Dendrimers, Plasticizers, Polymer composites. Properties of commercial polymers: Polyethylene, polyvinylchloride, polyamides, polyesters, phenolic resins, epoxy resins and silicon polymers.

Glass transition temperature (Tg), factors influencing the glass transition temperature, effect of molecular weight and melting point on glass transition temperature, importance of glass transition temperature.

Section – B

Thermodynamics of Polymer Solutions

Average end-to-end distance, average radius of gyration of polymer chains, statistical distribution of end-to-end dimensions, freely jointed chain in three dimensions, influence of bond angle restrictions.

Entropy of mixing and enthalpy of mixing by lattice model, Flory Huggins lattice theory, limitations of lattice model, entropy of mixing by free volume theory, heat and free energy of mixing, partial molar quantities i.e., chemical potential, heat of dilution and partial molar entropy of mixing, excluded volume, thermodynamic relations for dilute polymer solutions.

Section – C

Determination of Molecular Weight of Polymers

Molecular weight determination of polymers. Osmotic pressure: Membrane osmometer, high speed osmometer and vapour pressure osmometer. Sedimentation or ultracentrifugation: Sedimentation velocity method, sedimentation equilibrium method. Light scattering: Scattering of light by small molecules and polymer solutions, asymmetric scattering, Debye method, Zimm plot method, comparison of Zimm and Debye methods, Determination of molecular weight by Gel Permeation Chromatography.

Section – D

Advanced Statistical Mechanics

Real gases, intermolecular potential and virial coefficients.

Structure of liquids-definition of distribution and correlation functions, Thermodynamic functions of a fluid and radial distribution function, Spectroscopic techniques for liquid dynamic structure studies.

Random walk problem in 1D. Theory of Brownian motion, Langevin theory, Fokker-Planck equation.

Course outcomes:

CO1 To understand biodegradable polymers, their types and applications.

CO2 To know about the properties of commercial polymers.

CO3 To explain glass transition temperature and its importance.

CO4 To discuss about parameters of polymer chains.

CO5 To describe thermodynamic properties of mixing.

CO6 To know about thermodynamic relations for dilute polymer solutions.

CO7 To be able to explain molecular weight determination of polymers using osmotic pressure, ultracentrifugation, light scattering, Debye method, Zimm plot method and gel permeation chromatography.

CO8 To explain intermolecular potential and virial coefficients of real gases.

CO9 To discuss structure of liquids using spectroscopic techniques.

CO10 To know about thermodynamic functions of fluids.

CO11 To understand fluid dynamics from theory of Brownian motion, Langevin and Fokker-Planck equations.

Mapping Paper No. CHEM-401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Polymer Chemistry, P.J. Flory, Cornell University Press.
2. Physical Chemistry of Polymers, A.Tager, Mir Publishers.
3. Physical Chemistry of Macromolecules, C. Tanford, Wiley Publisher.
4. Polymer Chemistry by Gowarikar, New Age International.
5. Scaling Concepts in Polymer Physics, Pierre-Gilles Gennes, Cornell University Press.
6. Introduction to Polymers, Third Edition, Robert J. Young and Peter A. Lovell, CRC Press.
7. Polymer Physics (Chemistry), M. Rubinstein, Ralph H. Colby, OUP Oxford.
8. Statistical Mechanics by Donald A Mc Quarrie, University Science Books.

M.Sc. Chemistry Semester IV
Physical Chemistry Special-IV (CHEM-402)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION-A

Solid State Chemistry

Free electron theory of metals, Quantum mechanical treatment explaining the origin of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective mass of charge carriers, Semiconductors: Direct and indirect band gap semiconductors, hole concept, temperature dependence of mobility and electrical conductivity, free carrier concentration in intrinsic and extrinsic semiconductors, mass active law, Generation of carriers and their recombination in semiconductors. Types of junctions (metal-semiconductor, semiconductor-semiconductor, junctions in organic materials), Analysis of p-n junction including I-V characteristics.

SECTION-B

Renewable energy sources

Renewable energy resources: Biomass-Biofuels, Hydrogen, Solar energy. Related environmental and economical issues.

Introduction to Photovoltaics. Basic PV system design. Design and physics of solar cells, I-V characteristics, external and internal quantum efficiency. Thermodynamics of light conversion. Solar radiation and conversion efficiency. Factors influencing solar cell efficiency. Future trends in PV energy conversion. Silicon solar cells, alternatives to silicon, III-V materials for solar cells, thin film solar cells and third generation solar cells. Concentrator photovoltaics. Thermodynamic limit of light concentrators, Photovoltaics storage system.

SECTION –C

Advanced Electrochemistry

Advanced concepts: Overpotential concept, Exchange current density, Butler-Volmer equation, Polarizable and non-polarizable interfaces. Tafel equations. Electrochemical Processes: Difference between kinetically and mass transport controlled electrochemical processes. Difference between single step and multiple step electrode reactions. Brief introduction and applications of various electrochemical methods: Principle of electrochemical methods such as chronoamperometry, cyclic voltammetry, chronopotentiometry, coulometry, ac-impedance, spectroelectrochemistry and hydrodynamic methods.

Electrocatalysis: Introduction to electrocatalysis. Homogeneous and heterogeneous electrocatalysis.

SECTION-D

Applied Electrochemistry

Corrosion: Forms of corrosion, Corrosion monitoring and prevention methods. Batteries and Fuel cells: Introduction. Nanostructured and surface modified electrodes: Introduction and their applications. Environmentally oriented electrochemistry: Electrochemistry of water splitting, electrolysis of sea water, electrochemical reduction of CO_2, Electrochemical sewage disposal, electrochemical decontamination of soil.

Ion Selective Electrodes

Electrical Properties of membrane, glass electrode with special reference to H^+, Na^+, K^+ ions, operation of solid membrane electrode, operation of liquid membrane electrode, coated type ion electrode, Applications of ion selective electrode in determination of some toxic metals and some anions (F^-, Cl^-, Br^-, I^- and NO_3^-).

Course outcomes:

CO1 To grasp the procedure of scientific development/understanding through various theories proposed to explain the properties of solids.

CO2 To understand quantum mechanical treatment explaining the origin of band gaps in solids.

CO3 To know about Bloch theorem, Brillouin zones, effective mass of charge carriers, hole concept.

CO4 To classify semiconductors as direct and indirect band gap materials.

CO5 To discuss free carrier concentration in different types of semiconductors and effect of temperature on electrical conductivity of semiconductors.

CO6 To describe types of junctions - ohmic and rectifying and their current-voltage characteristics.

CO7 To introduce the basics of renewable energy source.

CO8 To understand the basics of photovoltaics, thermodynamics of light conversion and factors affecting solar cell efficiency.

CO9 To follow the development of different types of solar cells and understand solar cell design.

CO10 To know about concentrator photovoltaics and photovoltaics storage system.

CO11 To introduce advanced concepts of electrochemistry including overpotential, exchange current density and Butler-Volmer equation.

CO12 To distinguish between kinetically and mass transport controlled electrochemical processes and know about principles of various electrochemical methods.

CO13 To understand electro catalysis.

CO14 To be able to understand forms, monitoring and prevention of corrosion.

CO15 To discuss electrochemical energy sources.

CO16 To introduce nano structured and surface modified electrodes.

CO17 To discuss environmentally oriented electrochemistry with examples.

CO18 To introduce, explain and discuss the applications of ion-selective electrodes.

CO19 To explain the electrical properties of glass electrode and operation of solid membrane electrode.

Mapping of Paper No. CHEM- 402

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	-	-	S	M	S	S	S	S	S
CO2	S	S	S	S	M	S	-	-	S	M	S	S	S	S	S
CO3	S	S	S	S	M	S	-	-	S	M	S	S	S	S	S
CO4	S	S	S	S	M	S	-	M	S	M	S	S	S	S	S
CO5	S	S	S	S	M	S	-	M	S	M	S	S	S	S	S
CO6	S	S	S	S	M	S	-	-	S	M	S	S	S	S	S
CO7	S	S	S	S	M	S	M	S	S	M	S	S	S	S	S
CO8	S	S	S	S	M	S	M	S	S	-	S	S	S	S	S
CO9	S	S	S	S	M	S	M	S	S	-	S	S	S	S	S
CO10	S	S	S	S	M	S	M	S	S	-	S	S	S	S	S
CO11	S	S	S	S	M	S	-	-	S	-	S	S	S	S	S
CO12	S	S	S	S	M	S	S	-	S	-	S	S	S	S	S
CO13	S	S	S	S	M	M	M	-	S	-	S	S	S	S	S
CO14	S	S	S	S	M	S	-	-	S	-	S	S	S	S	S
CO15	S	S	S	S	M	W	-	M	S	-	S	S	S	S	S
CO16	S	S	S	S	M	-	M	M	S	-	S	S	S	S	S
CO17	S	S	S	S	M	-	M	M	S	-	S	S	S	S	S
CO18	S	S	S	S	M	M	S	S	S	-	S	S	S	S	S
CO19	S	S	S	S	M	-	S	S	S	-	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Principles of the Solid State, H.V. Keer, Wiley Eastern.
2. Solid State Physics, C.Kittel, John Wiley.
3. Solid State Physics by Neil W. Ashcroft and N. David Mermin.
4. The Physics of Solar Cells (Properties of Semiconductor Materials) by Jenny Nelson.
5. Physics of Solar Cells: From Basic Principles to Advanced Concepts (Physics Textbook) by Peter Würfel.
6. Optoelectronics of Solar Cells (SPIE Press Monograph Vol. PM115), Greg P. Smestad.
7. Electrochemical Methods: Fundamentals and Applications, 2nd Ed., A. J. Bard and L. R. Faulkner John Wiley & Sons: New York, 2002.
8. Modern Electrochemistry 1: Ionics 2nd Ed., Springer (1998), J. O' M. Bockris & A. K. N. Reddy.
9. Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science 2nd Ed., Springer (2001), J. O' M. Bockris & A. K. N. Reddy.
10. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O' M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.
11. Instrumental methods of analysis:Willard, Merritt & Dean.
12. Advanced Analytical Chemistry: Meiter and Thomas.
13. Instrumental methods of chemical analysis: Braun.
14. Principles of Instrumental analysis, 5th edition, D. A. Skoog, F. J. Holler, T. A. Nieman, Brooks Cole.

M.Sc. Chemistry Semester IV
Physical Chemistry Special-V (CHEM-403)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION - A

Thermal Methods of Analysis-I

Introduction to thermal analysis, TG and DTG, static, quasistatic and dynamic thermogravimetry, Instrumentation, thermogram, factors affecting thermograms, application of thermogravimetry. Reaction Kinetics–kinetics by single and multiple heating rates. Differential thermal analysis, DTA theories, DTA curves, factors affecting DTA curves, Instrumentation, applications of DTA, simultaneous determination in thermal analysis.

Differential Scanning Calorimetry (DSC)

Introduction, Instrumentation, Power compensated DSC, Heat Flux DSC, DSC-curves, factors affecting DSC curves, applications.

SECTION – B

Material Chemistry

Definition of nanomaterials, various techniques for the preparation of nanomaterials,Thermodynamics and Kinetics of Nucleation, Thin Films and Langmuir-Blodgett films - Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, sol-gel. Langmuir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films.

Electronic structure and properties of nanomaterials, optical, electrical and magnetic properties, diffusion and chemical behaviour, applications of nanomaterials.

SECTION – C

Photochemistry

Revision of basic concepts of photochemistry, Life times of excited electronic states of atoms and molecules. Charge transfer transitions.

The Frank-Condon principle, emission spectra, environment effect on absorption and emission spectra, Wigner's spin conservation rule.Modes of decay of excited states, quenching of fluorescence, delayed fluorescence, collisional quenching, Stern–Volmer equation. Excimer and exciplex formation and decay.

Techniques for the study of transient species in photochemical reactions. Applications of Lasers in photochemical kinetics.

SECTION – D

Biophysical Chemistry

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. Introduction to protein folding problem.Cell Membrane and Transport of Ions: Structure and functions of cell membrane. Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

Optical methods and applications: Optical techniques in biological systems: Absorption spectroscopy, Fluorescence spectroscopy, Linear and Circular Dichroism.

Course outcomes:

CO1 To know about details of Thermogravimetry (TG) technique and its applications.

CO2 To discuss Differential thermal analysis (DTA), its theory, instrumentation and applications.

CO3 To explain Differential scanning calorimetry and its applications.

CO4 To discuss preparation of nanomaterial through various techniques.

CO5 To be able to explain thermodynamics and kinetics of nucleation.

CO6 To know about preparation of thin films and Langmuir-Blodgett films and their applications.

CO7 To explain photolithography.

CO8 To discuss electronic structure and properties of nanomaterials and applications of nanomaterials.

CO9 To know about the fundamentals of photochemistry.

CO10 To explain absorption and emission spectra and environmental effects.

CO11 To discuss modes of decay of excited states.

CO12 To describe formation and decay of excimer and exciplex

CO13 To discuss the techniques for studying transient species in photochemical reactions.

CO14 To be able to discuss applications of Lasers in photochemical kinetics.

CO15 To discuss about thermodynamics principles in biological systems.

CO16 To know about muscular contraction and energy generation in mechanochemical system.

CO17 To discuss protein folding problem.

CO18 To explain structure and functions of cell membranes and treatment of membrane transport using irreversible thermodynamics.

CO19 To describe optical techniques in biological systems.

Mapping of Paper No. CHEM -403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	M	S	M	S	S	S	M	S
CO6	S	S	S	S	S	S	S	M	S	M	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	M	S	S	S	S	S
CO9	S	S	S	S	S	S	M	S	S	S	S	S	S	M	S
CO10	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO11	S	S	S	S	S	M	M	M	S	S	M	S	M	M	S
CO12	S	S	S	S	S	S	S	M	S	S	M	S	M	M	S
CO13	S	S	S	S	M	S	S	M	S	S	S	S	S	S	S
CO14	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO15	S	M	S	S	S	S	M	M	S	S	M	M	S	M	S
CO16	S	M	S	S	S	S	S	S	S	S	M	S	S	M	S
CO17	S	M	S	S	S	S	S	M	S	S	M	M	S	M	S
CO18	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO19	S	S	S	S	S	S	S	M	S	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Handbook of Thermal Analysis and Calorimetry; M. E. Brown.
2. Fundamentals of Photochemistry, K.K. Rohtagi & Mukherjee, Wiley Eastern.
3. Photochemistry, J.G. Calvert and J.N. Pitts, Wiley.
4. Photochemistry and Spectroscopy, J.P. Simons, Wiley Interscience.
5. Principles and Applications of Photochemistry by Brian Wardle.

6. Instrumental methods of analysis:Willard, Merritt & dean.
7. Advanced Analytical Chemistry: Meiter and Thomas.
8. Instrumental methods of chemical analysis: Braun.
9. Principles of Biochemistry, A.L.Lehninger, Worth Publishers.
10. Biochemistry, L.Stryer, W.H.Freeman.
11. Biochemistry, J.David Rawn, Neil Patterson.
12. Biochemistry, Voet and Voet, John Wiley.
13. Outlines of Biochemistry, E.E.Conn and P.K.Stumpf, John Wiley.
14. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H.Dugas and C. Penny, Springer-Verlag.
15. Macromolecules: Structure and Function, F.Wold, Prentice Hall.
16. Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel.
17. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by D. M. Freifelder.
18. Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalaya Publishing House.

M.Sc. Chemistry Semester IV
Physical Chemistry Special-VI (CHEM-404)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION-A

Advanced Chemical Kinetics

London-Eyring-Polanyi method of calculation of energy of activation. Sato Method and Bond-Energy-Bond-Order (BEBO) Method, Application of activated complex theory of reaction rates. Temperature dependence of pre-exponential factor. Statistical distribution of molecular energies, Kassel's theory (RRK), Rice-Ramsperger-Kassel-Marcus (RRKM) theory, unimolecular reactions and its validity.

SECTION-B

Reaction Dynamics

Molecular beams, principle of crossed-molecular beams. Molecular encounters and principal parameters, e.g. Impact parameter, Collision cross-section, Reaction cross-section and relation between reaction cross-section and reaction rate (single velocity). Dependence of collisional cross-section on translational energy.

Solution Kinetics

Ion-ion reaction, ion-dipole reaction and enzyme kinetics (effect of pH and temperature). Lineweaner-Burk plot for the analysis of enzymolysis. Reactions between polar molecules, kinetic salt, salt effect.

SECTION-C

Kinetics of Fast Reactions

General treatment of chain reaction, apparent activation energy of chain reactions, chain lengths, theories of branching chain and explosion (hydrogen-oxygen reaction). Modern techniques in gas phase and in solution, flash photolysis, flow methods, relaxation techniques (temperature jump, pressure jump) and shock tube technique.

SECTION-D

Liquid Crystals

Mesmorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic – nematic transition and clearing temperature – homeotropic, planar and schlieren textures, twisted nematics, chirals nematics, molecular arrangement in smectic

A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

Course outcomes:

CO1 Be able to explain London-Eyring-Polanyi method of calculation of energy of activation.

CO2 To describe Sato method and BEBO method to determine activation energy.

CO3 To know about applications of activated complex theory of reaction rates.

CO4 To discuss dependence of pre-exponential factors on temperature.

CO5 To explain validity of unimolecular reaction.

CO6 To know about Rice-Ramsperger-Kassel (RRK) theory of unimolecular reactions and Marcus extention (RRKM) of RRK theory.

CO7 To discuss principle of crossed-molecular beams, molecular encounters and principal parameters.

CO8 To explain dependence of collisional cross-section on translational energy.

CO9 To be able to discuss ion-ion and ion-dipole reactions in solutions.

CO10 To describe enzyme kinetics.

CO11 To discuss fundamental concepts of chain reactions.

CO12 To explain theories of branching chain and explosion reactions.

CO13 To know about the techniques of studying fast reactions in gas phase and in solution i.e., flash photolysis, flow methods, relaxation techniques and shock tube technique.

CO14 To discuss the mesomorphic behaviour of substances and to know the meaning of thermotropic liquid crystals.

CO15 To describe types of liquid crystals including nematic, smectic, chiral nematics and lyotropic phases.

CO16 To know about the homeotropic and schlieren textures of liquid crystals.

CO17 To explain optical and dielectric properties of liquid crystals.

Mapping of Paper No. CHEM-404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO9	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO10	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO11	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO12	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO13	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO14	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO15	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO16	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO17	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.
2. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
3. Material Science Engineering, W.D. Callisler, Jr.
4. Chemical Kinetics, K.J. Laidler, McGraw Hill
5. Theories of Chemical Reaction Rates, K.J. Laidler, McGraw Hill.
6. Theory of Rate Processes, S. Glasstone, K.J. Laidler and H. Eyring, McGraw Hill.
7. Reaction Kinetics Oxford Press (1997), M. J. Pilling and P. W. Seakins.
8. Thermotropic Liquid Crystals, G.W. Gray, John Wiley.
9. Handbook of Liquid Crystals, Kelkar and Hatz, Chemie Verlag.
10. Significance of liquid structures, H. Eyring.

Or

M.Sc. Chemistry Semester IV

Organic Chemistry Special-III (CHEM-401)

Credits-4 **Total Marks = 80**

Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all, selecting at least one question from each section. All questions carry equal marks.

SECTION - A

Disconnection Approach-I

An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, one group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.

SECTION - B

Disconnection Approach-II

Reversal of polarity, amine synthesis, use of Wittig reagents, use of acetylene and aliphatic nitro compounds in organic synthesis, synthesis of three membered rings, photochemistry in organic synthesis-synthesis of four membered rings, uses of ketenes in organic synthesis, synthesis of five and six membered rings.

SECTION - C

Disconnection Approach-III

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups, Two group C-C disconnection- Diels Alder reactions, 1,3-difunctionalized compounds and α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalized compounds-Michael addition and Robinson Annelation.

SECTION – D

Application of Disconnection

A brief survey of various approaches used towards the synthesis of Juvabione and their relative merits and demerits, Sarette's stereospecific synthesis of Cortisone.

Principle of Green chemistry and its applications

Basic Principle and need of green chemistry, Different tools for green synthesis (Elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted) atom economy, synthesis involving basic principle of green chemistry-synthesis of adipic acid and BHC synthesis of Ibuprofen.

Aromaticity

Concept of aromaticity, non-aromaticity, anti-aromaticity, homoaromaticity, and psuedo-aromaticity. Aromaticity in charged rings, HMO and PMO for determining aromatic, non-aromatic and anti-aromatic character of annulenes having various π-electron systems, application of ^{1}H-NMR in determining aromatic character of annulenes.

Course Outcomes:

CO1 After completion of course the students will be able to apply the concepts of Disconnection approach and Green chemistry for the synthesis of different target molecules in organic chemistry.

CO2 To have knowledge about various terms used in disconnection approach like synthons, synthetic equivalents, functional group interconversions and importance of order of events.

CO3 To know about one group C-X and two group C-X disconnections, one group C-C disconnection.

CO4 To understand the practical aspects of chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.

CO5 To understand the concept of reversal of polarity and amine synthesis.

CO6 To know the application of wittig reagents and acetylene for the synthesis of alkenes.

CO7 To understand application of aliphatic nitro compounds in organic synthesis.

CO8 To learn about different strategies for the synthesis of three, four, five and six membered rings.

CO9 To explore the use of ketenes in organic synthesis.

CO10 To explore two group C-C disconnection utilizing Diels Alder reactions, 1,3-difunctionalized compounds, unsaturated carbonyl compounds, 1,5-difunctionalized compounds, Michael addition and Robinson Annelation.

CO11 To know the strategy about control in carbonyl condensations.

CO12 To understand the principles of protection and deprotection approach in synthetic organic chemistry with special reference of alcoholic, amino, carbonyl and carboxylic groups.

CO13 To apply the tools of retero-synthesis for the synthesis of natural products like Juvabione and Cortisone.

CO14 To understand the need of green chemistry and its principles.

CO15 To have an elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted.

CO16 To know the concept of atom economy for different types of reactions.

CO17 To apply concepts of green chemistry for the synthesis of Adipic acid and Ibuprofen.

CO18 To understand the concept of aromaticity and various criteria of aromaticity.

Mapping of Paper No. CHEM-401 Organic Chemistry Special-III

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO2	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO3	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO4	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO5	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO6	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO7	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO8	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO9	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO10	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO11	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO12	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO13	S	S	M	S	S	S	M	S	M	M	S	S	S	S	S
CO14	S	S	S	S	S	S	M	S	M	M	S	S	S	S	S
CO15	S	S	S	S	S	S	M	S	M	M	S	S	S	S	S
CO16	S	S	S	S	S	S	M	S	M	M	S	S	S	S	S
CO17	S	S	S	S	S	S	M	S	M	M	S	S	S	S	S
CO18	S	W	M	S	S	S	M	M	M	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH.

4. Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley.
5. Polycyclic Aromatic Hydrocarbons, E. Clar, Academic Press.
6. Advanced Organic Chemistry Reactions, Mechanisms and Structures, J. March, Wiley.
7. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.

M.Sc. Chemistry Semester IV
Organic Chemistry Special-IV (CHEM-402)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Reactions

A detailed study including mechanism or Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzilbenzillic acid rearrangements.

SECTION – B

Reactions

A detailed study including mechanism of Darzens synthesis, stroke enamine synthesis, Shapiro reaction, Sharplcss asymmetric epoxidation, Prevost and Woodward hydroxylation.

Flavonoids

Occurrence, nomenclature, general methods (chemical and spectroscopic) of structure determination of flavonoids. Isolation, structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin. Biosynthesis of Flavonoids: Acetate and Shikimic acid pathway, biosynthesis of catechin.

SECTION – C

Heterocyclic compounds

Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

General synthesis and reactions (including mechanism) of the followings:

Three-membered heterocycles: oxirane, azirene, oxazirane, diaziridines

Four-memebered heterocycles: Oxetane and azetidine.

SECTION – D

Heterocyclic compounds

General synthesis and reactions (including mechanism) of the followings:

Five-membered heterocycles: pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole; Comparison of their basic character.

General synthesis and reactivity of purines and pyrimidines.

Course Outcomes:

CO 1 After completing this course, the student will know various name reactions, aspects of heterocyclic chemistry and flavonoids.

CO 2 Get to know mechanistic details of Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzilbenzillic acid rearrangements.

CO 3 To understand mechanistic details of Darzens synthesis, stroke enamine synthesis, Shapiro reaction; Sharplcss asymmetric epoxidation, Prevost and Woodward hydroxylation.

CO 4 To understand general aspects of isolation and degradative and synthetic aspects of structure elucidation of flavonoids.

CO 5 To apply this knowledge for structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.

CO 6 To understand Biosynthetic Acetate and Shikimic acid pathway leading to production of Flavonoids and catechin.

CO 7 To be familiar with systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

CO 8 To understand the method of synthesis and the chemical reactions of three and four membered heterocyclic compounds such as oxirane, azirene, oxazirane, diaziridines, Oxetane and azetidine.

CO 9 To understand basic character, methods of synthesis and Reactions with mechanistic details of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole.

CO 10 To understand the general method of synthesis and chemical reactions of purines and pyrimidines.

Mapping of Paper No. CHEM-402

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	M	M	S	W	M	S	S	S	S
CO2	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO3	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO4	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO5	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO6	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO7	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO8	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO9	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S
CO10	S	S	M	S	M	S	M	M	S	W	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Modern Synthetic Reactions, H.O. House, W. A. Benzamin.
4. Advanced Organic Chemistry Reactions, Mechanisms and Structures, J. March, Wiley.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
7. Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
8. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press.
9. Handbook of Heterocyclic Chemistry, Alan Katritzky, Christopher Ramsden, John A. Joule and Viktor Zhdankin, 3rd Edition, Elsevier.

M.Sc. Chemistry Semester IV
Organic Chemistry Special-V (CHEM-403)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion

SECTION – B

Mechanism of action of chymotrypsin, papain and carboxypeptidase A.

Co-enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate (PLP), NAD^+, $NADP^+$, FMN, FAD. Mechanisms of reactions catalyzed by the above cofactors.

Prostaglandins: General Introduction, nomenclature and biological roles of prostaglandins. Synthesis of PGE_2 and $PGF_{2\alpha}$.

SECTION - C

Terpenoids

General aspects of structure determination of terpenoids. Structure elucidation and synthesis of Geraniol, α-terpineol, α-pinene, camphor, farnesol and squalene. Biogenetic isoprene rule and biogenesis of terpenoids.

SECTION – D

Steroids

Isolation and nomenclature of steroids. Structure elucidation, synthesis (Woodward) and stereochemistry of cholesterol.

Methods for the following conversions.

i) Cholesterol → Testosterone

ii) Cholesterol → Progesterone

iii) Cholesterol → 5-α and 5-β cholanic acids.

Johnson's hydrochrysene approach towards the synthesis of Androsterone.

Course outcomes:

After completing this course the student will get to know about enzymes, coenzymes, terpenoids and cholesterol. The course outcomes are -

CO1 To understand chemical and biological catalysis, nomenclature and classification, of enzymes, extraction and purification of enzymes, Fischer's lock and key and Koshland's induced fit hypothesis.

CO2 To understand kinetics of Enzyme catalyzed reactions, Michaelis-Menten and Lineweaver-Burk plots and kinetics of reversible and irreversible inhibition.

CO3 To be familiar with mechanisms of enzyme catalyzed reactions, Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. To understand mechanism of action of chymotrypsin, carboxypeptidase A and papain

CO4 To get knowledge about Cofactors as derivatives of vitamins. knowledge of coenzymes, prosthetic groups, apoenzymes. structure and biological functions and mechanisms of reactions catalyzed by coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+,$NADP^+$, FMN, FAD, by the above cofactors. Nomenclature and biological roles of prostaglandins, synthesis PGE_2 and $PGF_{2\alpha}$.

CO5 To understand definition and classification of terpenoids, isoprene and special isoprene rule, general methods of structure elucidation of terpenoids.

CO6 To apply the acquainted knowledge for structure elucidation and synthesis of Geraniol,α-terpineol, α-pinene, camphor, farnesol and squalene, biogenetic isoprene rule and biosynthesis of terpenoids.

CO7 To know about steroids and their classification, Isolation and nomenclature, structure elucidation, synthesis and stereochemistry of cholesterol.

CO8 To the understand synthetic pathways of testosterone, progesterone, 5α- and 5β-cholanic acids from Cholesterol. Johnson's hydrochrysene approach for the synthesis of androsterone.

Mapping of Paper No. CHEM-403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO 1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 2	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 3	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 6	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 7	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO 8	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
3. Biochemistry, A.L. Lehninger.
4. Outlines of Biochemistry, Cohn & Stumpf.

M.Sc. Chemistry Semester IV
Organic Chemistry Special-VI (CHEM-404)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Drug Design

Classification and discovery of new drugs, history and development of chemotherapeutic agents, therapeutic index, LD50 and ED50, naming of (new) drugs.

Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. Chemical basis of messenger induced change of shape by the receptor. Design of agonists, antagonists and partial agonists.

Drug development: Screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds.

Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrug and synergism.

SECTION – B

Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories.

Antineoplastic Agents: Mechlorethamine, Chlorambucil, cyclophosphamide, carmustine, aminopterin, 6-mercaptopurine, paclitaxel (synthesis of paclitaxel excluded).

Antimalarials: Chloroquine, primaquine, chloroguanide, pyrimethamine.

Analgesics, Antipyretics and Antiinflammatory agents: Morphine and related compounds (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin, phenylbutazone, mefenamic acid, ibuprofen, diclofenac, naproxen, celecoxib.

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives - norethindrone, norethynodrel, estradiol, mestranol, non hormonal contraceptive- centchroman (synthesis of all the drugs excluded).

Cardiovascular Drugs: Calcium channel blockers and □-blockers: sorbitrate, diltiazem, atenolol and verapamil.

AIDS and drugs against HIV: HIV infection to the system, structure and mode of action of important drugs against HIV (nucleoside reverse transcriptase inhibitors) - AZT, ddI, ddC, d4T and 3TC (synthesis only of AZT).

SECTION – C

Antibiotics

Cell wall biosynthesis and protein synthesis inhibitors: Penicillins and semi-synthetic penicillins. synthesis, structure elucidation and medicinal uses of penicillin G, problems of sensitivity to acids, □-lactamases and narrow spectrum of activity, solving these problems leading to the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxicillin, carbenicillin and carfecillin.

Cephalosporins - Discovery, structure elucidation and synthesis of cephalosporin-C.

SECTION – D

Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, (+)-Coniine, Nicotine, Quinine and Reserpine.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Demonstrate understanding of the basic principles of drug action, design and the terminology involved therein.

CO2 Apply the knowledge of drug design in developing new drugs using rational approach to drug design.

CO3 Explain synthesis, general mode of action and medicinal uses of listed classes of drugs.

CO4 Describe synthesis, structure elucidation and medicinal uses of penicillins and cephalosporins as cell wall biosynthesis and protein synthesis inhibitors.

CO5 Relate physiological action of alkaloids and their classification based on nitrogen heterocyclic ring.

CO6 Appreciate general aspects of isolation and structure elucidation of alkaloids for application in structure elucidation, synthesis and biosynthesis of listed alkaloids.

Mapping of Paper CHEM-404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	W	S	S	S	S	M	M	S	S	S	S
CO2	S	S	S	S	W	S	S	S	S	M	S	S	S	S	S
CO3	S	S	S	S	W	S	M	S	S	M	M	S	S	S	S
CO4	S	S	S	S	W	S	M	S	S	m	M	S	S	S	S
CO5	S	S	S	S	W	S	M	M	S	W	M	S	S	S	S
CO6	S	S	S	M	W	S	M	M	S	W	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
2. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
4. Organic Chemistry Vol.-2 I.L. Finar, ELBS.
5. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.

Or

M.Sc. Chemistry Semester IV

Pharmaceutical Chemistry Special-III (CHEM-401)

Credits-4 **Total Marks = 80**

Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Mechanistic and biosynthetic approach to plant secondary metabolites: Acetate-malonate pathway: Biosynthesis of plant fatty acids, biosynthesis and oxidation of ricinoleic acid). Polyketides: Biosynthesis of 6-methylsalicyclic acid, pencillic acid, griseofulvin.

Acetate- mevalonate pathway: Biosynthesis of psoralen, gibberellic acid, cholesterol, conessine.

Shikimic-acid pathway: Biosynthesis of chlorogenic acid and cichoriin, Cyanin, Quercetin, Biosynthesis of Porphyrins.

SECTION – B

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, synthesis, biosynthesis and biological importance of the following: Ephedrine, (+)-Coniine, Nicotine, Quinine and Reserpine.

Carotenoids; Structure, synthesis and biogenesis of β-carotene and Vitamin-A.

SECTION – C

Carbohydrates: Introduction, stereoisomerism, mutarotation of monosaccharides, ring structure of glucose, structure elucidation, of disaccharides, sucrose, maltose, lactose, polysaccharides, starch, glycosides, general structure elucidation.

Terpene: General introduction, isoprene rule, isolation of terpenes, General methods of structure determination of terpenes, structure elucidation of citral, menthol and camphor.

SECTION – D

Steroids: Isolation, nomenclature, structural elucidation with special reference to Cholesterol, ergosterol and cardiac glycosides

Methods for the following conversions:

i) Cholesterol → Testosterone

ii) Cholesterol → Progesterone

Porphyrins

Structures elucidation of chlorophyll, General structural features of haemoglobin (not structure elucidation).

Course outcomes:

The course will provide details of biosynthetic and synthetic pathways for natural products -

CO1 To know the details of the biosynthetic pathways for plant secondary metabolism, acetate-malonate pathway, Acetate-mevalonate pathway, shikimic acid pathway.

CO2 To elaborate importance of alkaloids including general methods of structure elucidation, role of alkaloids in plants, synthesis, biosynthesis and biological importance of ephedrine, (+)-coniine, nicotine, quinine and reserpine.

CO3 To discuss carotenoids- β-carotene and vitamin-A.

CO4 To have knowledge of carbohydrate chemistry- stereoisomerism, monosaccharides (glucose), disaccharides (sucrose, maltose, lactose), polysaccharides (starch), glycosides.

CO5 To understand terpenoids- isoprene rule, General structure determination of acyclic (citral), monocyclic (menthol) and bicyclic (camphor) members.

CO6 To learn about steroids discussing nomenclature, structural elucidation (Cholesterol), ergosterol and cardiac glycosides.

CO7 To inform about porphyrin compounds-chlorophyll, haemoglobin.

Mapping of Paper No. CHEM-401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	M	S	S	S		S	S	S	S	S	M	S	W	S
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.

M.Sc. Chemistry Semester IV
Pharmaceutical Chemistry Special-IV (CHEM-402)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Drug Design

Introduction, Procedure followed in drug design-Screening of natural compounds, isolation, purification, structure determination, Search for lead Compounds, Molecular Modification of Lead Compound, prodrugs- utility, drug latentiation, carrier linked and bioprecursor prodrugs, Prodrugs of compounds containing alcohols, carboxylic acids, amines and carbonyl groups, drug synergism, hard and soft drugs. Structure-Activity Relationship (SAR), isosterism, Bioisosterism, Factors affecting Bioactivity, Theories of Drug Activity; Occupancy theory, Rate theory, Induced Fit theory

SECTION – B

Quantitative structure-activity relationships (QSAR)

Development of QSAR, Physicochemical parameters- Lipophilicity parameter, Polarizability, Electronic parameter, Ionization Constants, steric Parameters- Taft's steric factor, molar refractivity, Verloop steric parameter, chelation parameters, Surface activity parameter, redox potential, hansch analysis, Craig plot, Topliss Scheme, Free-Wilson Approach.

Co-Enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, Mechanisms of reactions catalyzed by the above cofactors.

SECTION – C

Combinatorial Chemistry

Introduction to Combinatorial chemistry, Combinatorial approaches, solid phase techniques, liquid phase synthesis, Chemical Peptide and small molecular libraries, split synthesis and parallel synthesis- applications and methodology, deconvolution, Combinatorial Organic Synthesis.

High throughtput screening (HTS), Planning and designing a combinatorial synthesis-scaffolds, X-ray crystallography, docking procedures.

SECTION – D

Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots. Enzyme inhibitors- reversible, irreversible, suicide inhibitors.

Mechanism of Enzyme Action.

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion.

Course outcomes:

The content of the paper is designed to enrich the knowledge of the students about designing of drugs, enzymes, co-enzymes and important concepts necessary to know for drug design like SAR, QSAR, combinatorial chemistry, HTS, X-Ray and docking -

CO1 To know about the procedure followed in drug design.

CO2 To have in-depth knowledge of lead compounds and their modification.

CO3 To inform concepts of prodrugs-drug latentiation, carrier linked- & bioprecursor prodrugs, Prodrugs of molecules containing alcohols, carboxylic acids, amines and carbonyl groups.

CO4 To educate about importance of drug synergism.

CO5 To grip hard and soft drug concept.

CO6 To enlighten about structure-activity relationship.

CO7 To make understand significance of isosterism & bioisosterism.

CO8 To be acquainted with important theories of drug activity-occupancy, rate, induced-fit.

CO9 To offer details of quantitative structure-activity relationship and its parameters- lipophilicity, polarizability, electronic, ionization, steric chelation, surface activity.

CO10 To be familiar with redox potential, hansch analysis, craig plot, topliss scheme, free-wilson approach.

CO11 To be informed about co-enzymes and related terms- Cofactors, prosthetic groups, apoenzymes, coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD (mechanisms of reactions catalyzed by the cofactors).

CO12 To explain combinatorial approaches, molecular libraries, solid- & liquid-phase procedures, split & parallel synthesis.

CO13 To gain the idea of the following techniques- high throughput screening, X-ray, docking.

CO14 To elaborate the basics of enzymes-nomenclature and classification, extraction, purification. chemical & biological catalysis, catalytic power, specificity, regulation, acid-base & covalent catalysis.

CO15 Fischer's lock and key & Koshland's induced fit hypothesis.

CO16 Enzyme kinetics-Michaelis-Menten and Lineweaver-Burk plots.

CO17 Enzyme inhibitors- reversible, irreversible, suicide inhibitors.

CO18 Mechanism of enzyme Action-Transition-state theory.

Mapping of CO Paper No. CHEM 402

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO4	S	S	S	S	S	M	M	S	S	S	S	M	S	M	S
CO5	S	S	S	S	S	M	M	S	S	S	S	M	S	M	S
CO6	S	S	S	S	S	W	M	S	S	S	S	M	S	M	S
CO7	S	S	S	S	S	S	W	S	S	S	S	M	S	M	S
CO8	S	S	S	S	S	S	W	S	S	S	S	M	S	M	S
CO9	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO11	S	S	S	S	S	S	W	S	S	S	S	M	S	M	S
CO12	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO13	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO14	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO15	S	S	S	S	S	S	S	S	S	S	S	M	S	M	S
CO16	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO17	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S
CO18	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. An Introduction to Medicinal Chemistry, G. L. Patrick, Oxford University Press.
2. Medicinal Chemistry, An Introduction, G. Thomas, John Wiley.
3. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
4. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
5. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, T. Palmer, Woodhead Publishers.

M.Sc. Chemistry Semester IV
Pharmaceutical Chemistry Special-V (CHEM-403)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Intellectual Property Rights - I

Introduction - IPR, GATT, WTO.

TRIPs – Its scope and options, the changing R & D processes and IPR, The IPR tool kit.

Patents – Definition, types, the patenting process, patent cooperation treaty, conditions to be satisfied by an invention to be patentable, features.

Intellectual Property Protections of Living Species – Compatibility between conventions, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, some case studies.

SECTION – B

Intellectual Property Rights - II

Exercising and Enforcing of Intellectual Property Rights - Rights of an IPR owner, licensing agreements, criteria for patent infringement, case studies of patent infringement, IPR – a contract, unfair competitions and control, provisions in TRIPs, some case studies.

Patent Laws - Introduction, Salient features of "The Patents Act 1970" , "The Patent Rules 2003" and "The Patent Rules 2005"

Role of Patents in the Pharmaceutical Industry - Recent changes in IPR laws impacting pharmaceutical industry, intellectual cooperation in the pharmaceutical industry, some case studies

SECTION – C

Drug & Cosmetic Act with special reference to schedule Y and M.

Clinical trials & Good clinical practices (GCP), guidelines and related management- GCP guidelines, principles of ICH GCP, ethical principles related to GCP, clinical trials, SOPs, regulation: obtaining clinical trial permission, application for permission, report: clinical trial report, trial management: data monitoring committee (DMC).

SECTION – D

Quality control and Quality Assurance: Requirements of GMP, cGMP, GLP, ISO-9000, regulatory requirements of drugs and pharmaceutical (USFD-NDA/ANDA), total quality management (TQM) Concept.

Stability testing of new drug substances and products: Drug substance – criteria, storage conditions, long term testing, accelerated testing, frequency, evaluation, labelling; Drug product – Selection of batches criteria, specification, conditions of storage and testing, Calculation of shelf life and expiry date of products.

Course outcomes:

The course is planned to understand the existing intellectual property rights, schedules, regulations, quality control and stability testing procedures to be followed in the area of pharmaceuticals -

CO1 To offer details of IPR- IPR tool kit, IP protections of Living Species, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, case studies.

CO2 To understand Exercising and Enforcing IPR- Rights of an IPR owner, licensing agreements, criteria for patent infringement, case studies of patent infringement.

CO3 To make aware of IPR concepts – a contract, unfair competitions and control, some case studies.

CO4 To be versed with GATT, WTO, TRIPs (provisions in TRIPs).

CO5 To study characteristics of Patents- patenting process, patent cooperation treaty, conditions to be satisfied by an invention to be patentable.

CO6 To have knowledge of Patent Laws - The Patents Act 1970, The Patent Rules 2003, The Patent Rules 2005.

CO7 To be aware of role of patents in pharmaceutical industry-Recent changes in IPR laws impacting pharmaceutical industry, intellectual cooperation in the pharmaceutical industry, case studies.

CO8 To be acquainted with Drug & Cosmetic Act (w.r.t. schedule Y & M).

CO9 To learn about Clinical trials & Good clinical practices (GCP)-guidelines, (ethical) principles of ICH GCP, SOPs, clinical trial permission, application for permission, report: clinical trial report, trial management: data monitoring committee (DMC).

CO10 To know about Quality control and Quality Assurance: Requirements of GMP, CGMP, GLP, ISO-9000, regulatory requirements of drugs and pharmaceutical (USFD-NDA/ANDA), total quality management (TQM) Concept.

CO11 To be familiar with stability testing of new drug substances- long term testing, accelerated testing, frequency.

CO12 To have an idea of conditions of storage and calculation of shelf life & expiry date of products.

Mapping of Paper No. CHEM-403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO2	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO3	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO4	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO5	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO6	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO7	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO8	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO9	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO10	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO11	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S
CO12	S	S	S	S	S	S	M	S	S	S	S	M	S	M	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. P.B. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata Mc Graw Hill (2001)
2. Steve Smith, The Quality Revolution, 1st ed., Jaico Publishing House (2002).
3. Lippincott Williams & Wilkins, The Science and Practice of Pharmacy, Vol. I & II, 21st edition, Remington, Wolters Kluwer Health (India) Pvt. Ltd., New Delhi (2005).
4. Arun Bhatt, Clinical Trials and Good Clinical Practice in India, 1st edition, D. K. Publications, Mumbai (2006).

M.Sc. Chemistry Semester IV
Pharmaceutical Chemistry Special-VI (CHEM-404)

Credits-4 **Total Marks = 80**
Time: 3 Hrs. **60 (EM) + 20 (IA)**

Note: Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

SECTION – A

Heat Transfer: Introduction, modes of heat transfer, Fourier's law of heat flow, thermal conductivity, steady state conduction. Equipments: Finned tube (extended surface) heat exchanger, plate heat exchanger, spiral heat exchanger, scraped heat exchanger and air cooled heat exchanger.

Distillation: Introduction, vapour – liquid equilibrium, partial vaporization, partial condensation, volatility, relative volatility, methods of distillation for two component systems–fractional distillation, azeotropic distillation, steam distillation, extractive distillation.

Filtration: Introduction, classification of filters, plate & frame filter presses, candle filter, filter media, filter aids, washing of filter cakes, filtration theory – constant pressure filtration, constant rate filtration, filtration cycle, centrifuges, batch top driven centrifuge, batch under driven centrifuge, disk type centrifuge.

SECTION – B

Drying: Introduction, rate of drying, constant rate period, critical moisture content, falling rate period, equilibrium moisture, free moisture, bound and unbound moisture, drying equipments – tray dryers, drum dryers, rotary dryers, spray dryers, flash dryers.

Crystallization: Introduction, supersaturation, modes of generation of supersaturation, nucleation, primary nucleation, secondary nucleation, crystal growth, Δ L law of cyrstal growth, growth rate and growth coefficients, crystallisation equipments – Tank crystallizers, circulating magma – vacuum crystallizers, circulating liquid evaporator crystallizers.

Fluid Flow: Introduction, Newtonian and non-Newtonian fluids, viscosity, effect of temeprature on viscosity, kinematic viscosity, laminar and turbulent flows, Reynolds number, Bernoullis equation without friction, orificemeter, venturimeter, pumps, types of pumps.

SECTION – C

Reactors: Introduction to reactor design, ideal batch reactor, space time, space velocity, steady state mixed flow reactor, steady state plug flow reactor.

Chemical process development: Process design development, types of design process development, plant location, plant layout, plant operation and control, material handling.

Safety and loss prevention: Health and safety hazards, source of exposure, exposure evaluation, exposure hazard control, fire and explosion hazard, safety regulation, loss prevention.

SECTION – D

Chromatographic techniques: Principles of separation, applications and recent trends in chromatography:

Column, Paper, Thin layer and gas chromatography, HPLC, HPTLC, Size exclusion chromatography, Affinity chromatography, Ion-exchange chromatography.

Biological Standardization: Bioassay and Radioimmunoassay: ELISA, radioimmunoassay of drugs like Digitalis & insulin.

Course outcome:

The present course is designed to impart knowledge about various techniques used in large scale production of pharmaceuticals-

CO1 To discuss modes and Fourier's Law of heat transfer, thermal conductivity, steady state conduction.

CO2 To confer details of heat exchangers- Finned tube, plate, spiral & air cooled.

CO3 To make understand vapour-liquid equilibrium, partial vaporization & condensation, volatility, relative volatility.

CO4 To tell about methods of distillation- fractional, azeotropic, steam, extractive.

CO5 To know about types of filters (plate & frame filter presses, candle filter), filter media, filter aids, washing of filter cakes, filtration theory-constant pressure & constant rate filtration.

CO6 To familiarize with types of centrifuges- batch top-driven, batch under-driven, disk type.

CO7 To understand concepts of drying-rate of drying, constant rate period, critical moisture content, falling rate period, equilibrium moisture, free moisture, bound & unbound moisture.

CO8 To inform about dryers- tray, drum, rotary, spray, flash.

CO9 To apprise of crystallization- supersaturation, modes of generation of supersaturation, nucleation, crystal growth, law of cyrstal growth, growth rate and growth coefficients.

CO10 To be acquainted with crystallizers- Tank, circulating magma-vaccum, circulating liquid evaporator.

CO11 To offer details of fluid flow, viscosity and pumps, Newtonian and non-Newtonian fluids, kinematic viscosity, laminar and turbulent flows, Reynolds number, Bernoullis equation without friction, orificemeter, venturimeter, pumps, types of pumps.

CO12 To study reactor design and various types of reactors-ideal batch reactor, steady state mixed flow reactor, steady state plug flow reactor.

CO13 To present information about chemical process development-Process design development, plant location, plant layout, plant operation and control, material handling.

CO14 To be aware about safety and loss prevention- health and safety hazards, source of exposure, exposure evaluation, exposure hazard control, fire and explosion hazard, safety regulation.

CO15 To know about various chromatographic techniques, their principles of separation and applications- Column, Paper, Thin layer and gas chromatography, HPLC, HPTLC, Size exclusion, affinity, ion-exchange chromatography.

CO16 To offer details of Biological Standardization- ELISA, radioimmunoassay of drugs like Digitalis & insulin.

Mapping of Paper No. CHEM 404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO9	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO10	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO11	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO12	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO13	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO14	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO15	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO16	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Cooper and Gunn's Dispensing for Pharmaceutical Students, Ed.S.J. Carter, CBS publishers & Distributors.
2. Cooper and Gunn's, Tutorial Pharmacy.
3. "Theory and Practice of Industrial Pharmacy" L.Lachman, Lea & Fabiger.
4. "A textbook of Pharmaceutical Chemistry" Bentley and Drivers, Oxford Press.
5. ISO Reports.
6. Indian Pharmacopoeia, Govt. of India, Ministry of Health and Family Welfare.
7. British Pharmacopoeia.
8. Indian Patent Act.
9. Sharma P.P., GMP, Vallabh prakashan.
10. "Remington's Pharmaceutical science". A.Osol Mack Publishing company.
11. Introduction to Chemical Engineering, Bedger et al., McGraw Hill.
12. Unit Operations of Chemical Engineering, Mc. Cable & Smith.
13. Handbook of Chemical Engineering by parry.
14. Principles and methods of Pharmacy management, Harrg, A.; smith Loa & Febiger, Philadelphia.
15. Materials management by Gopalkrishna, Prentice Hall, India.
16. Unit Operations of Chemical Reactor Design and Operation. W.d. Mc Cabe. J.C. Smith & P. Harriott.
17. "Chemical Reactor Design and Operation" K.R. Westreterp, W.P. M. Swaaij, AACM, Beanackers.
18. Introduction to chemical Engineering, Mc Graw Hill W.L.Badger and J.T. Benchard,.
19. Max peters, "Elementary chemical Engineering".
20. "Chemical Process Development"-Pt.I. D.G. Joreden,
21. "Plant Design and Economics for chemical Engineers" M.S. Peters & K.D. Timmerhans.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special Practical III & IV
(CHEM 405 & CHEM 406)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Inorganic Chemistry Special Practical III (CHEM-405)

Quantitative analysis:

Determination of triple elements in the mixtures, ores, alloys etc. by available analytical techniques.

I Volumetrically.
II Gravimetrically.
III Instrumentation methods.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To demonstrate the separation and quantitation of three metal ions present in a given solution.

CO2 To quantify the presence of an analyte a given pharmaceutical sample.

CO3 To know the basic concept of EDTA titrations and its utilization in quantitative analysis.

Mapping of Paper No. CHEM-405

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	M	M	S	S	S	M	M	S	S	S	S
CO2	S	S	S	M	S	M	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Inorganic Chemistry Special Practical IV (CHEM-406)

1. Determination of any one metal ion by volumetric method (Complexometric titration).

   Ca^{2+}, Mg^{2+}, Zn^{2+} , Cu^{2+} etc.

2. Preparation of some inorganic compounds and their spectral studies.

   Tris(acetyl-acetonato) manganese (III)

   Tris(acetyl-acetonato) cobaltate (III)

Preparation of Ferrocene

Tris thioureacopper(I) sulfate

Tris(acetylacetonato)chromium(III)

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To know about the basic concept of titrations and its utilization in the quantitative analysis of metal ions.

CO2 To prepare samples of various metal ligand complexes and also their spectroscopic characterstics.

Mapping of Paper No. CHEM-406

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	W	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	W	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.

2. Inorganic Preparations: W. G. Palmer.

Or

M.Sc. Chemistry Semester IV
Physical Chemistry Special Practical III & IV
(CHEM 405 & CHEM 406)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Physical Chemistry Special Practical – III (CHEM 405)

pH-metry

1. Preparation of buffer solution of various pH and the determination of their pH values.
2. pH-titratioins of: (i) Acetic acid vs. NaOH, (ii) hydrochloric acid vs. NaOH, (iii) acetic acid vs. ammonium hydroxide and (iv) HCl vs. NH_4OH.
3. Determination of the degree of hydrolysis of aniline hydrochloride.
4. To find dissociation constants of weak acids.
5. Determine the Hammett constant of a given substituted benzoic acid by pH measurements.

Chemical Kinetics

6. Determination of velocity constant of the reaction of ethyl acetate with NaOH and activation energy and temperature coefficient of the reaction.
7. Determination of the velocity constant and energy of activation of the reactions between H_2O_2 and HI.
8. Investigation of the reaction between acetone and iodine (with respect to H^+, I_2 and acetone).
9. Determination of the order and velocity of the reaction between potassium persulphate and potassium iodide.
10. Study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To apply pH-metry in

- ❖ Determining buffer solutions and determining their pH values.
- ❖ Performing acid-base titrations.
- ❖ Determining degree of hydrolysis and dissociation constants.

CO2 To study the chemical kinetics of reactions between.

- ❖ Ethyl acetate and NaOH, acetone and iodine, potassium persulphate and potassium iodide, ethylbromoacetate and sodium thiosulphate.

CO3 To be able to use Origin-Lab software in drawing graphs of different styles.

CO4 To use excel worksheet in linear curve fitting, calculation of regression coefficient, standard deviation and variance.

CO5 To use excel worksheet to calculate activation energy using thermal analysis data.

CO6 To develop the ability to compile interpreted information in the form of lab record.

CO7 To face viva-voce.

Mapping of Paper No. CHEM-405

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Physical Chemistry Special Practical – IV (CHEM 406)

Polarography

1. To determine dissolved oxygen in aqueous solution of organic solvent.
2. Determination of half wave potentials of some cations in aqueous and in non-aqueous solutions.
3. Determination of half wave potentials of ions in mixtures.
4. Amperometirc titrations involving: (i) $Pb(NO_3)_2$ vs. $K_2Cr_2O_7$ and (ii) $Pb(NO_3)_2$ vs. K_2SO_4.

Interferrometry

5. Determination of speed of sound of pure liquids/mixtures using interferrometer.

Flame Photometry

6. Determination of Na^+, K^+ Ca^{2+} and Mg^{2+} in tap water, juice, electrical etc.

Dielectric Constant and Dipole Moment

7. Determination of dielectric constants of some organic liquids and composition of unknown mixtures.
8. Determination of dipole moments of some organic liquids.

Data-Handling/Representation

1. Using origin-Lab draw data in different styles of graphs.
2. Linear Curve fitting and calculation of regression coefficient using EXCEL worksheet.
3. Calculate activation energy using /thermal analysis data by single/multiple heating rate methods using EXCEL worksheet.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO 1 To apply the technique of polarography to :
- ❖ Determine dissolved oxygen in aqueous solution of organic solvent.
- ❖ Determine half-wave potential of cations in solutions and of ions in mixtures.
- ❖ Perform amperometric titrations.

CO 2 To determine speed of sound of liquids using interferometer.

CO 3 To apply flame photometry technique in determining concentration of various ions in liquids.

CO 4 To determine dielectric constants and dipole moments of some organic liquids.

CO 5 To be able to perform GAMESS calculations on molecules.

CO 6 To develop the ability to compile interpreted information in the form of lab record.

CO 7 To face viva-voce.

Mapping of Paper No. CHEM-406

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO9	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.
6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj
7. Experimental Physical Chemistry, V.D.Athawale and Parul Mathur, New Age International.

Or

M.Sc. Chemistry Semester IV
Organic Chemistry Special Practical III & IV
(CHEM 405 & CHEM 406)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Organic Chemistry Special Practical – III (CHEM 405)

1. Qualitative Analysis: Separation of components of a binary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical method. Characterization of these components with the help of chemical analysis and derivative formation.
2. Spectroscopic confirmation of the components of binary mixtures using IR and NMR tools (IR & NMR spectra will be provided).

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To understand the methods of separations of binary (liquid-liquid, liquid-solid or solid-solid) organic mixtures.

CO2 Identification of different functional groups using qualitative analysis.

CO3 To understand significance of melting point and boiling point in structure elucidation of organic compounds.

CO4 To prepare derivatives of different organic functionalities.

CO5 To characterize given organic compounds by interpreting their ^{1}H NMR and FT-IR spectra.

CO6 To perform experimentation and evaluation the results.

CO7 To develop the ability to compile information in the form of lab records.

CO8 To defend Viva-voce examination.

Mapping of Paper No. CHEM-405 Organic Special Practical III

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO2	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO6	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO7	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S
CO8	S	S	M	S	S	S	S	S	M	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Organic Chemistry Special Practical – IV (CHEM 406)

1. **Colorimetric determination of the following:** Carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea.
2. **Extraction of organic compound from natural products:** Any one of the followings:–
   Caffeine from tea leaves.

   Isolation of β-carotene from carrot.

   Isolation of limonene from citrus rind.

   Isolation of nicotine from tobacco.

   Isolation of lactose from milk.

   Isolation of Casein from milk.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To quantitatively estimate carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea colorimetrically.

CO2 To purify natural products from raw material.

CO3 To perform experimentation, evaluation, compilation and presentation of results.

CO4 Skill development to explain the results.

Mapping of Paper No. CHEM-406

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	--	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. An Introduction to Practical Biochemistry, by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. Organic Synthesis" Collective Vol. I.
7. Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.

15. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.

16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).

17. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

Or

M.Sc. Chemistry Semester IV
Pharmaceutical Chemistry Special Practical III & IV
(CHEM 405 & CHEM 406)

Credits-4+4 **Total Marks = 80 (Each)**
Time: 12 Hrs. **Max. Marks: 60(EA)+20(IA) & 60(EA)+20(IA)**
(Four sessions, spread over 2 days to all papers)

Pharmaceutical Chemistry Special Practical III (CHEM 405)

1) Separations and identification of components of binary organic mixture using chemical methods and spectral data.

2) Applications of IR, UV, ^{1}HNMR, ^{13}C NMR, Mass spectroscopy in drug analysis.

3) Chromatographic separations: TLC, paper and column.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 To have practical knowledge of separation of binary mixtures: liquid-liquid, liquid - solid or solid-solid, containing acidic/basic/water-soluble components.

CO2 To identify extra elements by making Lassaigne's extract.

CO3 To perform chemical tests for the identification of functional groups.

CO4 To prepare derivatives of organic functionalities.

CO5 To characterize compounds by spectral techniques.

CO6 To carry out chromatographic separations.

CO7 To perform various experiments and evaluate the results.

CO8 To develop the ability to compile interpreted information in the form of lab record.

CO9 To face viva-voce.

Mapping of Paper No. CHEM 405 (Practical)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO9	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Pharmaceutical Chemistry Special Practical IV (CHEM 406)

1) Determination of specific rotation of ibuprofen and determination of its percentage in the unknown sample.
2) Volumetric determination of ibuprofen in the given tablet.
3) Spectrophotometer determination of aspirin content in the soluble aspirin table.
4) Spectrophotometer determination of Paracetamol in the tablet.
5) Determination of Vitamin C in given formulation.
6) Determination of phenobarbilone in the given cough syrup.
7) To perform I.P. monograph of tablet
8) To perform I.P. monograph of hard gelatine capsule.
9) Determination of Chloramphenicol in given capsule.

Experiment **Marks: 40**
Lab record & Viva-voce **Marks: 10+10**

Course outcomes:

CO1 The practicals are designed to study assay of drugs, their volumetric and spectrophotometric analysis.

CO2 To have practical knowledge of friability test of a tablet to know percentage weight loss.

CO3 To carry out disintegration test.

CO4 To perform experiments and evaluate the results.

CO5 To develop the ability to compile interpreted information in the form of lab record.

CO6 To face Viva-voce.

Mapping of Paper No. CHEM-406

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY
6. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
7. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
8. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
9. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

OPEN ELECTIVE PAPERS OFFERED BY CHEMISTRY DEPARTMENT FOR M.Sc. STUDENTS OF DEPARTMENT OF PHYSICAL SCIENCES OTHER THAN CHEMISTRY DEPARTEMENT

M.Sc. Physical Sciences.
Open elective paper-01 (OE-201, 2nd Semester)
Environmental and Analytical Chemistry

Credits-2 **Total Marks = 50**
Time: 2 Hrs. **Max. Marks: 35(EA)+15(IA)**

Note: Eight questions will be set, four from each of the sections. The candidates are required to attempt five questions in all selecting two question from each section. All questions carry equal marks.

SECTION – A

Hydrosphere

Hydrological cycle of water, Water pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards.

Atmosphere

Chemical composition of atmosphere – particles, ions and radicals and their formation, Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect, air pollution controls and their chemistry.

SECTION – B

Thermoanalytical methods:

Introduction, Thermogravimetric analysis (TGA), Derivative Thermogravimetric analysis (DTGA), factors affecting TGA and applications, Differential thermal analysis (DTA): theory, factors affecting DTA and applications.

Chromatography

Introduction, Classification of chromatographic methods; Adsorption and Partition Chromatography (Column, Paper and Thin Layer Chromatography), ion exchange chromatography: Principles and Applications.

Analysis of Food

Importance of Food analysis, Determination of approximate composition: Moisture, Fat, Protein, Fiber, Carbohydrate etc.

Course outcomes:

CO1 To discuss the hydrological cycle of water, water pollution, water quality parameter and standards.

CO2 To know about chemical composition of atmosphere and chemistry of air pollution and control.

CO3 To study the Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), factors affecting these techniques and their applications.

CO4 To discuss the principle and applications of chromatographic methods.

CO5 To describe the importance of food analysis and their approximate composition.

Mapping of Paper No. CHEM OE-201

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentic– Hall.
4. Handbook of Thermal Analysis and Calorimetry; M. E. Brown.
5. Dynamics of Chromatography Part I; J. C. Gidding; Dekker, New York.
6. Instrumental methods of Analysis; L. L. Merits, R. H. Willard and J. A. Dean; Van Nostrand-Reinhold.

M.Sc. Chemistry
Open elective paper-02 (OE-301, 3rd Semester)
Applied Chemistry

Credits-2 **Total Marks = 50**
Time: 2 Hrs. **Max. Marks: 35(EA)+15(IA)**

Note: Eight questions will be set, four from each of the sections. The candidates are required to attempt five questions in all selecting two question from each section. All questions carry equal marks.

SECTION A

Polymer Chemistry

Polymer basic concepts: monomers, degree of polymerization, classification of polymers, types of polymerization, Concept of no. average molecular weight and mass average molecular weight, Methods of determining molecular weights, concept of kinetic chain length Polydispersity index, kinetics of polymerization (addition and chain polymerization) Thermal properties of polymers, Flame retardant polymers, Flame retarding Thermoplastics and Thermosets, physical properties of polymers (glass transition temperature, crystalline melting point), factors affecting T_g and T_m Polymer composites, its classification, polymer composites using filler reinforcement, Biocomposites, application of biocomposites in automobiles and in construction materials. Polymer nanocomposites, Properties of polymer nanocomposites, application of polymer nanocomposites

SECTION B

Medicinal Chemistry

Concept of drug and drug development, lead compound and lead modification, prodrugs and soft drugs, an elementary idea of structure reactivity relationship (SAR), Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control, membrane bound enzymes-activation/deactivation, chemical basis of messenger induced change of shape by the receptor.

Definition, uses and side effects of the following categories of drugs:

Antipyretics, analgesics & anti-inflammatory agents (paracetamol, asprin, mefenamic acid, ibuprofen and diclofenac), antimalarial (Chloroquine, chloroguanide), Anticancer (Chlorambucil, cyclophosphamide), Cardiovascular drugs (sorbitrate, diltiazem), Antifertility agents (introduction to hormonal and nonhormonal contraception only).

Mapping of Paper No. OE-301

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO2	S	S	S	S	M	S	S	W	S	S	M	S	S	S	S
CO3	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO6	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Books Suggested:

1. Polymer Chemistry, Billmayer
2. Polymer Chemistry, Gowarikar
3. Principles of Polymerization, Geroge Odian
4. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
5. Burger's Medicinal Chemistry and Drug Discovery, Vol-I, Ed. M.E. Wolf, John Wiley.
6. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.