Indira Gandhi University Meerpur Rewari
(A State University established under Haryana Act No.29 of 2013)

Examination Scheme & Syllabus for M.Sc. Chemistry (Semester-I to IV)

OUTCOME BASED EDUCATION SYSTEM /

LEARNING OUTCOME CURRICULUM FRAMEWORK

OBES / LOCF, CBCS CURRICULUM (2022-23)
(w.e.f. 2022-23)

VISION AND MISSION OF THE DEPARTMENT

VISION

To train students to be highly effective instructors, researchers, and contributors to chemical based industries and stakeholders globally. Be regarded as a prestigious centre of scholarly achievement worldwide.

MISSION

1. To advance chemical sciences research, science, and education.
2. To create skilled employees for businesses and industries based on chemistry's experimental methods and methodologies.
3. To offer learning environments that are centered on the needs of the students in order to help them develop as people as a whole.

Programme Outcomes (PO), M.Sc. Chemistry, Department of Chemistry, Indira Gandhi University, Meerpur, Rewari

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 Programme 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.

Programme Specific Outcomes (PSO's):

The Programme 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 Programme 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.	*Programme 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.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

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.

The Curriculum is so designed that it offers three specializations to the M.Sc. Chemistry students, which includes Physical, Organic, Inorganic 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 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.

The Aims of the Programme include

- To inculcate basic and advanced knowledge of chemical sciences among students.
- To provide higher education, disciplinary and inter/multi-disciplinary research- oriented knowledge to the students to make them lifelong learners.
- To provide a learned, skilled and creative pool of graduates who are ready to take up challenging assignments in different kinds of chemical industries, research institutions and academia.
- To mould responsible, proactive citizens who are equipped with scientific thinking and skills to address problems of their locality
- Adequate blend of theory, computation and hands-on experiments.
- Modernized lab courses – close to recent/current research.

M. Sc. Chemistry (Four Semesters) Programme
Under Choice Based Credit System
Outcome Based Education System /
Learning Outcome Curriculum Framework (LOCF) Pattern
(Effective from the Academic Session 2022-23)

PROGRAMME SCHEME

Credits requirement for completion of the Programme	**:**	**111**
Credits Core Courses	**:**	**88**
Credits Discipline Centric Elective Courses	**:**	**16**
Credits Open Elective Courses	**:**	**03**
Credits Foundation Elective Courses	**:**	**02**
Credits Summer Training	**:**	**02**
Total Marks	**:**	**2500**

Semester-wise distribution of Credits -

Semester I	**:**	**29 (CC-21, DCEC-8)**
Semester II	**:**	**33 (CC-21, DCEC-8, FC-2, Summer Training-2)**
Semester III	**:**	**28 (CC-25, OEC-3)**
Semester IV	**:**	**21 (CC-21)**

CC	**:**	**Core Course**
DCEC	**:**	**Discipline Centric Elective Course**
OEC	**:**	**Open Elective Course**
FC	**:**	**Foundation Elective Course**

Scheme of Examination for M.Sc. Chemistry

Semester-I **Credits= 29** **Marks =650**

Paper Code	Subjects	Type of Course	Contact Hours Per Week	Credits	Total Marks
CHE-101	Inorganic Chemistry-I (Chemistry of Transition Metals)	CC	04	04	100
CHE-102	Physical Chemistry-I (Principles of Physical Chemistry)	CC	04	04	100
CHE-103	Organic Chemistry-I (Conceptual Organic Chemistry & Stereochemistry)	CC	04	04	100
Discipline Centric Elective Course (Any Two)					
CHE-104(a) CHE-104(b)	Biology for Chemists/ Mathematics for Chemists	DCEC	04	04	100
CHE-105	Statistical Techniques & its Applications	DCEC	04	04	100
CHE-106	Sustainable and Green Chemistry	DCEC	04	04	100
CHE-107	Practical-I Inorganic Chemistry	CC	06	03	50
CHE-108	Practical-II Physical Chemistry	CC	06	03	50
CHE-109	Practical-III Organic Chemistry	CC	06	03	50
Total			**38**	**29**	**650**

CC =Core Course
DCEC = Discipline Centric Elective Course
FEC=Foundation Elective Course

Scheme of Examination for M.Sc. Chemistry

Semester-II **Credits = 33** **Marks =750**

Paper Code	Subjects	Type of Course	Contact Hours Per Week	Credits	Total Marks
CHE-201	Inorganic Chemistry-II (Organometallic Chemistry & Molecular Clusters)	CC	04	04	100
CHE-202	Physical Chemistry-II (Physical Chemistry: Concepts & Applications)	CC	04	04	100
CHE-203	Organic Chemistry-II (Organic Reaction Mechanism & Rearrangement)	CC	04	04	100
Discipline Centric Elective Course (Any Two)					
CHE-204	Basic Pericyclic & Photochemistry	DCEC	04	04	100
CHE-205	Group Theory & Molecular Spectroscopy	DCEC	04	04	100
CHE-206	Polymer materials	DCEC	04	04	100
CHE-207	IT Skills	FEC	02	02	50
CHE-208	Practical-I Inorganic Chemistry	CC	06	03	50
CHE-209	Practical-II Physical Chemistry	CC	06	03	50
CHE-210	Practical-III Organic Chemistry	CC	06	03	50
CHE-211	Summer Training		--	02	50
Total			**40**	**33**	**750**

FEC = Foundation Elective Course

Scheme of Examination for M.Sc. Chemistry

Semester-III **Credits = 28** **Marks =650**

Paper Code	Subjects	Type of Course	Contact Hours Per Week	Credits	Total Marks
CHE-301	Organic Spectroscopy	CC	04	04	100
CHE-302	Inorganic Spectroscopy	CC	04	04	100
CHE-303	Analytical Chemistry	CC	04	04	100
CHE-304(a) CHE-304(b) CHE-304(c)	Inorganic Chemistry Special-I/ Physical Chemistry Special-I/ Organic Chemistry Special-I	CC	04	04	100
Open Elective Course					
CHE-305	To be chosen from the pools of open electives provided by the other departments of University	OEC	03	03	100
CHE-306 (a) CHE-306 (b) CHE-306 (c)	Practical-I Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry	CC	06	03	50
CHE-307(a) CHE-307 (b) CHE-307 (c)	Practical-II Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry	CC	06	03	50
CHE-308(a) CHE-308 (b) CHE-308 (c)	Practical-III Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry	CC	06	03	50
Total			**37**	**28**	**650**

OEC = Open Elective Course

Scheme of Examination for M.Sc. Chemistry

Semester-IV **Credits = 21** **Marks =450**

Paper Code	Subjects	Type of Course	Contact Hours Per Week	Credits	Total Marks
CHE-401(a) CHE-401(b) CHE-401(c)	Inorganic Chemistry Special-II/ Physical Chemistry Special-II/ Organic Chemistry Special-II	CC	04	04	100
CHE-402(a) CHE-402(b) CHE-402(c)	Inorganic Chemistry Special-III/ Physical Chemistry Special-III/ Organic Chemistry Special-III	CC	04	04	100
CHE-403(a) CHE- 403(b) CHE- 403(c)	Inorganic Chemistry Special-IV/ Physical Chemistry Special-IV/ Organic Chemistry Special-IV	CC	04	04	100
CHE-404(a) CHE-404 (b) CHE-404 (c)	Practical-IV Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry/ Project	CC	06	03	50
CHE-405(a) CHE-405 (b) CHE-405 (c)	Practical-V Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry/ Project	CC	06	03	50
CHE-406(a) CHE-406 (b) CHE-406 (c)	Practical-VI Inorganic Chemistry/ Physical Chemistry/ Organic Chemistry/ Project	CC	06	03	50
Total			**30**	**21**	**450**

Guidelines for Summer Training:-

Objective:

The objective of summer training is to render the students to work environment in the field of Chemistry at industry, academic institute and research institute. It helps them to learn the latest technologies, skills, methodologies and to build a strong foundation for their career growth. It will provide learning platform to students where they can enhance their ability, skills and become job ready. Particularly, Summer training Programme will:

i) Enable the students to get important tips from the professionals to gain valuable practical experience.

ii) Test the students' career interest.

iii) Provide the students with in depth knowledge about career field.

iv) Develop the students' job-related skills.

v) Enhance relationship between the chemistry department and public as well as private sectors.

Outcome:

i) Capability to acquire and apply fundamental principles of chemistry.

ii) Become master in one's specialization.

iii) Become updated with all latest changes occurring in particular field.

iv) Capability and enthusiasm for self-improvement through professional development and life long learning.

v) Awareness of the social, cultural, global and environmental responsibility as a chemist.

Duration of Summer Training:

The Summer/Industrial training will comprise of 3-4 weeks

Evaluation of Summer Training:

Sr. No.	Roll No.	Name of Students	Writing Report(20)	Attendance (15)	Viva-Voce (15)	Total (50)

Signature of Evaluation committee:

Guidelines for Project:-

Total number of students' project offered will be one per faculty member per year, and allotment will be made on the basis of merit cum preference of the students. Students opting for project will be exempted from the corresponding laboratory course.

The purpose of the Project in M.Sc. 4th semester is to introduce research methodology to the students. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. The students must submit their project report in the department as per the date announced for the submission. External assessment of the project work will be carried out by an external examiner (nominated by the Chairperson of the Department) through power-point presentation cum viva-voce given by candidates.

1. Project report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be 12 with Times New Roman.
- The text of the report may be typed in 1.5 (one and a half) space.
- The print out of the report shall be done on both sides of the paper (instead of single side printing)
- The total no. of written pages should be between 40 to 60 for report.

2. The candidate shall be required to submit two soft bound copies of report along with a CD in the department as per the date announced.

3. The candidate will defend her/his project work through presentation before the External examiner at the end of semester and will be awarded marks.

4. In case, a student is not able to score passing marks in the project exam, he/she will have to resubmit her/his report after making all corrections/improvements & this report shall be evaluated as above. The candidate is required to submit the corrected copy of the report in hard bound within two weeks after the viva -voce.

M.Sc. Chemistry
Semester-I

CHE-101: Inorganic Chemistry-I
(Chemistry of Transition Metals)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *To provide the students with basic understanding of structure, bonding, stability, electronic spectra, magnetic properties, and theories of transition metal ligand complexes. The course content also explains the mechanism of ligand substitution reaction in Octahedral and Square Planar Complexes.*

Unit-I

Transition Metal Chemistry: Structure, bonding and properties of transition metal ligand complexes– ligand, coordination, geometry, isomerism (recapitulation); thermodynamic stability, successive and overall stability constants and their interactions, trends in stepwise constants, factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Irving-William series, chelate and macrocyclic effect, thermodynamic origin of chelate effect.
Theories of Bonding- Crystal field theory and its limitation; d-orbital splitting in octahedral, square planar, square pyramidal and trigonal bipyramidal complexes, John-Teller distortion, Molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π -bonding).

Unit-II

Electronic spectra and magnetic properties: Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols and splitting of terms in free atoms, determining the ground state terms, correlation and spin-orbit coupling in free ions for Ist series of transition metals. Interpretation of electronic spectra; Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 – d^9 states), Spectrochemical and nephelauxetic series, calculation of Dq, B, β parameters, charge transfer spectra, magnetic properties**;** anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Unit-III

Reaction Mechanisms-I: Inert and labile complexes**,** kinetic application of valence bond and crystal field theories, substitution reactions in octahedral complexes- acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, water exchange, anation reactions, reactions without metal ligand bond cleavage, racemization of tris-chelate complexes, electrophilic attack on ligands.

Unit-IV

Reaction Mechanisms-II: Substitution reactions in square planar complexes, the trans effect, theories of trans effect, redox reactions, mechanism of electron transfer reactions – Inner and outer sphere electron transfer reactions, cross reactions and Marcus-Hush theory, electron exchange, mixed valence complexes and their electron transfer.

Course Outcomes:

CO1 To introduce the structure, bonding and properties of transition metal-ligand complexes.
CO2 To describe the factors affecting stability of metal ligand complexes.
CO3 To apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.
CO4 To impart knowledge of electronic spectra and to interpret the electronic spectra using Orgel and Tanabe-Sugano diagrams for T.M. complexes.
CO5 To know about the magnetic properties; anomalous magnetic moments, magnetic exchange coupling and spin crossover.
CO6 To instruct about inert and labile complexes.
CO7 To explain the mechanism of ligand substitution reaction in Octahedral and Square Planar Complexes.
CO8 To divulge the process of electron transfer reactions in octahedral complexes.

Mapping of Paper No. CHE - 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	S	S	S	S	S	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	S	M	S	S	S	S	S	M	S
CO4	S	S	S	S	M	S	S	S	S	S	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	S	S	S	S	S	M
CO7	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huhey, E.A. Keiter andR.L. Keiter, Pearson Education.

3. Shriver & Atkins: Inorganic Chemistry, P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford University Press.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond, J.N. Murrel, SFA Kettle and JM. 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 Moller, John Wiley and Sons.
9. Mechanism of Inorganic Reactions, F. Basolo and R.G. Pearson, John Wiley and Sons, New York.
10. Inorganic Reaction Mechanism, M.L. Tobe; Nelson, Wlaton and Thames

M.Sc.-Chemistry
Semester-I

CHE-102: Physical Chemistry-I
(Principles of Physical Chemistry)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide students with a basic understanding of thermodynamics, phase rule, essentials of chemical kinetics, and principle of quantum mechanics. The objective of the course is to strengthen the fundamentals of Physical Chemistry, especially thermodynamics and quantum chemistry.*

Unit-I

Thermodynamics: Brief resume of first and second Law of thermodynamics, entropy changes in reversible and irreversible processes, variation of entropy with temperature, pressure and volume, free energy functions and their significance, criteria for spontaneity of a process, partial molar quantities (free energy, volume, heat concept), Gibb's- Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential in ideal gas mixture, determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy).

Unit-II

Chemical Dynamics: Effect of temperature on reaction rates, Unimolecular reactions, Lindemann–Hinshelwood mechanism of unimolecular reactions, rate law for opposing reactions of I^{st} order and II^{nd} order, rate law for conjugated reactions, collision theory of reaction rates and its limitations, steric factor, arrhenius equation and activated complex theory, the comparison of collision and activated complex theory, chain reactions (hydrogen-halogen reaction).

Unit-III

Electrochemistry: Debye -Huckel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, applicability and limitations of Debye-Huckel limiting law, activity coefficient, physical significance of activity coefficients, mean activity coefficient of an electrolyte, Debye - Huckel-Onsager treatment for aqueous solutions and non-aqueous solutions, Debye - Falkenhagen effect, Wein effect.

Unit-IV

Quantum Mechanics: Postulates of Quantum Mechanics, Quantum mechanical operators and their commutations relation, hermitian operators (elementary ideas, quantum mechanical operator for linear momentum and angular momentum), average value of the square of hermitian operators, derivation of Schrodinger wave equation, eigen function and eigen values, Schrodinger wave equation for a particle in one dimensional box, evaluation

of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, Schrodinger wave equation for a particle in a three-dimensional box and the concept of degeneracy of energy levels.

Course Outcomes:

CO1 Recapitulation of thermodynamic laws, entropy changes in reversible and irreversible processes and thermodynamic functions of mixing
CO2 To know about Partial molar quantities, chemical potential and gibbs-duhem equation and its variation with temperature and pressure.
CO3 To explain Collision theory of reaction rates, steric requirement, arrhenius equation and activated complex theory (ACT).
CO4 To explain unimolecular reactions and Lindemann–Hinshelwood mechanism of unimolecular reactions.
CO5 To discuss Debye- Hückel theory of ion-ion interaction and activity coefficient, its applicability, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential.
CO6 Able to derive D-H-O equation - its applicability and limitations, Debye -Falkenhagen effect, Wein effect.
CO7 To discuss various Postulates of quantum mechanics, quantum mechanical operators and their commutations relation, hermitian operators.
CO8 To learn about quantum mechanical operators, Schrodinger wave equation for a particle in a three-dimensional box, eigen function, and eigen value.

Mapping of Paper No.CHE-I02

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	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	M	S	M	S	M	M	M	M	S	M	S	M	M	M
CO5	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S
CO6	S	S	S	S	S	S	M	S	S	S	S	S	M	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

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Quantum Chemistry, B. K. Sen, Kalyani Publishers
4. Quantum Chemistry, R. Prasad, New Age International.

5. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
6. Physical Chemistry, P.W. Atkins, Oxford University Press.
7. Thermodynamics for Chemists, S. Glasstone, Affiliated East -West Press.
8. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
9. Chemical Kinetics, K.J. Laidler, McGraw Hill.
10. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
11. Electrochemistry, S. Glasstone, Affiliated East -West Press.

M.Sc.- Chemistry
Semester-I

CHE-103: Organic Chemistry-I
(Conceptual Organic Chemistry & Stereochemistry)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide the basics in Organic Chemistry at the beginning of the semester. The objective of the course is to provide the knowledge about the nature of bonding in organic molecules, delocalized chemical bonding, aromaticity, stereochemistry, such as conformation and configuration, RS and EZ notations and mechanistic aspects of aliphatic and aromatic nucleophilic substitution and electrophilic aromatic substitutions and elimination reactions.*

Unit-I

Nature of Bonding in Organic molecules: Delocalized chemical bonding –conjugation, cross conjugation; Concept of aromaticity; Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity. Bonds weaker than covalent; addition compounds.
Reaction Mechanism: Structure and Reactivity: Types of mechanisms, types of reactions, Relationship between thermodynamic stability and rates of reactions - kinetic versus thermodynamic control of product formation – Hammond postulate. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, guidelines for proposing reaction mechanism. The Hammett equation, Curtin-Hammett principle, and linear free energy relationship, substituent and reaction constants. Taft equation.

Unit-II

Generation, structure, stability and reactivity of reactive intermediates, carbocations, carbonanions, Free Radicals, Carbenes, Nitrenes.
Aliphatic Nucleophilic and Electrophilic Substitution: The S_N1, S_N2, mixed S_N1 and S_N2, S_Ni and SET mechanisms. Neighboring group participation by π and σ bonds, anchimeric assistance. Classical and non-classical carbocations, phenonium ions, common carbocation rearrangements. Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity. Phase transfer catalysis; The S_E1 mechanism, Bimolecular mechanisms S_E2 and S_Ei. Electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Unit-III

Stereochemistry-I: Introduction to molecular symmetry and chirality; D-L, R-S, E-Z and threo-erythro nomenclature, inter conversion of Fischer, Newman, Sawhorse and flying wedge formulae. Conformational analysis of simple acyclic, cyclic system (chair and boat configuration), fused and bridged bicyclic systems (decalins) and sugars. Conformation and reactivity (some examples); Optical activity in the absence of chiral carbon (biphenyls, allenes, ANSA compounds, cyclophanes, hemispiranes and spiranes); Stereochemistry of the compounds containing nitrogen, Sulphur and Phosphorus.

Unit-IV

Stereochemistry-II: Topicity of ligands and faces, their nomenclature; Brief account of Prostereoisomerism, stereogenecity, chirogenicity, pseudo asymmetry and prochiral center. Stereospecific and Stereoselective reaction. Asymmetric synthesis: Enantiomer excess, % enantio selectivity, optical purity, % diastereomeric excess and % diastereo selectivity. Asymmetric synthesis (basic principle, auxiliary, substrate, reagent and catalyst controlled).

Basic heterocyclic chemistry: Synthesis and reactivity of five membered heterocycles with one hetero atom.

Course Outcomes:

CO1 To describe the nature of bonding, concept of aromaticity.

CO2 To describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understanding effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.

CO3 To understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.

CO4 To understand mechanistic details of different types of and factors affecting aliphatic electrophilic substitution reactions and the terminology involved therein.

CO5 To know mechanistic details of NGP reaction and application of this in prediction of product formation in various reactions.

CO6 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.

CO7 To realize the concepts of prochirality, topicity related terms, asymmetric synthesis, its main categories vis-à-vis application of Cram’s and Prelog rule.

CO8 To describe stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins and introduce students with the basic heterocyclic chemistry.

Mapping of Paper CHE-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	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	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
CO6	S	S	S	S	S	S	S	S	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

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. March, J., *Advanced Organic Chemistry Reactions, Mechanism and Structure,* John Wiley 6th ed. (2007).
2. Carey, F.A. & Sundberg, R. J., *Advanced Organic Chemistry*, Plenum 5th ed. (1977)
3. Sykes, P.,*A Guide Book to Mechanism in Organic Chemistry*, Pearson 6th ed. (2003)
4. Ingold, C.K., *Structure and Mechanism in Organic Chemistry,* Cornell University Press (1957)
5. Morrison, R.T.& Boyd, R.N. *Organic Chemistry*, Prentice–Hall 6th ed. (2001)
6. House, H.O., *Modern Synthetic Reactions,* Benjamin (1965)
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional 3rd ed. (1993)
8. Prakash, O. & Singh, S.P., *Reaction Mechanism in Organic Chemistry*, Trinity (2017)
9. Eliel, E.L. & Wilen, S. H., *Stereochemistry of Organic Compounds*, John Wiley (1994)
10. Nasipuri, D., *Stereochemistry of Organic Compounds*, New Age International 3rd ed. (2018)
11. Kalsi, P.S., *Stereochemistry of Organic Compounds,* New Age International 10th ed. (2019)
12. Carruthers, W. & Coldham, I., *Modern methods of Organic Synthesis*, Cambridge University Press 1sted. (2005)
13. Robinson, M.J. T., *Organic Stereochemistry*, Oxford University Press (2005)
14. Issacs, N. S., *Reactive Intermediates in Organic chemistry*, John Wiley (1974)
15. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.

M.Sc.- Chemistry
Semester-I

CHE-104(a)
Biology for Chemists

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide the basic knowledge of cell, its metabolic processes and the macromolecules, proteins, carbohydrates, lipids, nucleotides, oxygen carriers.*

Unit-I

Cell Biology: Discovery of cell, Structure of Prokaryotic and Eukaryotic cells, classification of cell types, comparison of plant and animal cells, Cell cycle: mitosis & meiosis, Cellular organization: Biomembranes, Fluid mosaic model of membrane structure, cytoplasmic organelles and their functions. Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency.

Unit-II

Cellular macromolecules: Essential Amino acids and Isoelectric pH, chemical and enzymatic hydrolysis of proteins to peptides, Secondary structure of proteins, α -helix, β-sheets, triple helix structure of collagen, Quaternary structure, denaturation of proteins. Carbohydrates; Structure and biological functions of monosaccharides-- glucose, fructose and galactose, disaccharides- sucrose, lactose and maltose. Structural polysaccharides - cellulose and chitin. Storage polysaccharides - starch and glycogen. Lipids; Fatty acids, essential fatty acids, β-oxidation of fatty acids.

Unit-III

Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA structure & conformation, Replication of DNA (semi-conservative, conservative and dispersive replication Maselson-Stahl experiment), transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA, protein biosynthesis (initiation, elongation, termination and processing of the peptide chain).

Unit-IV

Oxygen carriers: Porphyrins, Metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, Photosynthesis and chlorophyll.
Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth‘s radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog, depletion of ozone.

Course Outcomes:

CO1 To describe the prokaryotic and eukaryotic cell Structure, metabolic processesoccurring 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.

CO8 To explain the Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, Photosynthesis and chlorophyll.

Mapping of Paper No. CHE-104

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	S	S	S	S	S	S	S	S	S
CO 4	S	S	M	S	S	S	M	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S	M	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

Suggested Readings:

1. Essential Cell Biology by Bruce Alberts, Dennis Bray, Karen Hopkin, and Alexander D Johnson (Hardcover - Mar. 27, 2009).

2. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, and Martin Raff.
3. Molecular Biology of the Gene (6th Edition) by James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann.
4. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson (Author), Michael M. Cox.
5. Fundamentals of General Organic and Biological Chemistry (Study Guide) by John Mc Murry (Paperback - Jan. 1999).
6. Environment, Problems and Solutions, D.K. Asthana and Meera Asthana, S. Chand and Co.(2006)
7. Text Book on Environmental Chemistry, Balaram Pani, I.K. International Publishing House(2007)

M.Sc.- Chemistry
Semester-I

CHE-104(b)
Mathematics for Chemists

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide the basic information about various parameters of mathematics used in chemistry like vector, matrix, Differential Calculus etc. The purpose of the course is to provide the knowledge about the logarithm in chemistry, integral calculus theory, rules of integration.*

Unit-I

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.

Unit-II

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. Elements of Algebraic and Trigonometric Functions: The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities, polar coordinates in trigonometric functions.

Unit-III

Differential Calculus: Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, and parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation. Examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell‘s distribution. Exact and inexact differential with their application to thermodynamic principles. Partial Differentiation: Partial differentiation, successive partial differentiation. Integral transforms (Fourier and Laplace). Reduction formulae, application to chemical problems. Methods of Lagrangian multipliers, Sterling‘s approximation, probability theory.

Unit-IV

Integral Calculus: Integral theory, rules of integration between limits, significance of ‗e' exponential equations, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, coordinate transformation (e.g., cartesian to spherical polar). Illustration of application in chemistry. Evaluation of standard integrals used in chemistry. Differential Equation: Simple differential equations, separable variables, homogeneous equations, exact equations, linear equations, equation of the first and second order, partial differential equation, application to physico-chemical problems.

Course Outcomes:

CO1 To explain definitions of vectors, representation and properties of vectors.
CO2 To discuss definition and properties of matrices and determinants.
CO3 Be able to perform matrix mathematics, linear equations using matrices.
CO4 To discuss need, theory and applications of logarithms, represent equations graphically and perform curve fitting for least squares method.
CO5 To prove and apply trigometric identities and explain polar coordinates in trigonometric functions.
CO6 To explain rules of differentiation and be able to find out the derivative of a functionby applying various methods of differentiation.
CO7 To discuss exact and inexact differentials and their applications to chemistry, rules and methods of integration.
CO8 To perform integration between limits and its application in chemistry, types of differential equations and their solutions with their application to physico-chemical problems.

Mapping of Paper No. CHE-104

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	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO4	S	S	S	S	M	S	S	M	M	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	M	S	S	S	S	S	S	S	S	S	S
CO7	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

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, R.C. Reid.

M.Sc.- Chemistry
Semester-I

CHE-105
Statistical Techniques & its Applications

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: To provide exposure with various statistical techniques, analysis of variance, covariance, measures of central tendency, hypothesis, errors, non parametric tests.

Unit-I

Random Experiment, Sample Space, Events – Simple, Composite, Mutually Exclusive and Exhaustive Events, Various Definitions of Probability, Properties of probability function, Addition Theorem, Conditional Probability, Multiplication Theorem, Baye‘s Theorem, Independence of Events. Random Variables and Distribution Functions and properties;

Unit-II

Measures of Central Tendency: Mean, median and Mode. Measures of Dispersion: Range, Variance, Standard Deviation, Moments, Skewness and Kurtosis Probability distributions: Binomial, Poisson, Normal, Gamma, Exponential, Log-Normal. Sampling Distributions: Chi-Square, Student's t and F-distributions; their Properties and Applications. Elementary Ideas of Non-Central Distributions.

Unit-III

Testing of Hypotheses, Simple and Composite Hypotheses, Null and Alternative Hypotheses, Two Types of Errors, Critical Reason, Level of Significance, Power of the Test, Unbiased Tests, Critical Reason. Maximum Likelihood Ratio Test, Interval Estimation: Method of obtaining Confidence intervals based on Small and Large Samples, Analysis of Variance and Covariance.

Unit-IV

Non Parametric Tests: Ordinary Sign Test, Wilcoxon Signed Ranked Test, Goodness of Fit Problem: Chi-Square Test and Kolmogrov – Smirnov One Sample Test, and their Comparison. Two Sample Problems: K-S Two Sample Test, Wald – Wolfwitz Run Test, Mann –Whiteney U Test. Least-squares fitting: Linear, Polynomial, arbitrary functions: with descriptions of specific methods. Correlation and Regression.

Course Outcomes:

CO1 To know about Various Definitions and properties of Probability.

CO2 To learn about Multiplication Theorem, Baye‘s Theorem, Random Variables and Distribution Functions and properties.
CO3 To learn about Mean, median, Mode, Variance and Standard Deviation.
CO4 To know about sampling Distributions : Chi-Square, Student's t and F-distributions.
CO5 To be able to explain testing of Hypotheses, types of Errors.
CO6 To explain Confidence intervals, analysis of Variance and Covariance.
CO7 To explain Non Parametric Tests and two Sample Problems.
CO8 To learn about Least-squares fitting, arbitrary functions and correlation and Regression.

Mapping of Paper No. CHE-105

Course Outcome	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	M	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	M	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	M	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	M	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. *Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences, R.J. Barlow, John Wiley, 1989.*
2. The Statistical Analysis of Experimental Data, John Mandel, Dover Publications, 1984.
3. Data Reduction and Error Analysis for the Physical Sciences, 3rd Edition, Philip Bevington and Keith Robinson, McGraw Hill, 2003.

M.Sc.-Chemistry
Semester-I

CHE-106
Sustainable and Green Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide advance knowledge of organic chemistry reactions through green methods of synthesis, principles of green chemistry, VOC, biocatalyst and photocatalysis. The aim of the course is to train the students for solving the problems related to green synthesis of the compounds by using microwave, sonication and ballmilling process.*

UNIT-I

History of emergence of Green Chemistry, Definition, Need and role of Green Chemistry, Principles and concepts of green chemistry synthesis: Chemistry in the context of sustainable development, Green Chemistry v/s Environmental Chemistry, End of pipe v/s Cleaner production, Current status and future perspective. The twelve principles of Green Chemistry and their illustrations with examples, Evaluation of Greenness, Environmental factor, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

UNIT-II

Catalysis and Renewable raw materials. Introduction to catalysis. Homogeneous and Heterogeneous catalysis, Phase-transfer catalysis and Biocatalysis. Photocatalysis, Catalysis for Green Chemistry with examples, Renewable raw materials, Chemical products based on renewable sources.

UNIT-III

Alternative Green solvents, Volatile organic compounds (VOCs), Supercritical fluids. Alternatives in Advancement of Green Chemistry in extraction and chromatography. Ionic liquids as solvents: its types, properties and applications.

UNIT-IV

Green technology and sources of alternative energy. Photochemical and Electrochemical reactions. Green photo-chemical reactions, Green Chemical Reactions under Microwave (Microwave Assisted Synthesis), Role of Sonication and Ball milling in Green chemical synthesis with examples. Flow techniques and role of Flow chemistry for the sustainable development.

Course Outcomes:

CO1 To understand the need of green chemistry and its principles.
CO2 To have an elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted.
CO3 To know the concept of atom economy for different types of reactions.
CO4 To apply concepts of green chemistry for the synthesis of Adipic acid and Ibuprofen.
CO5 To understand catalysis and Renewable raw materials. Introduction to catalysis. Homogeneous and Heterogeneous catalysis, Phase-transfer catalysis and Biocatalysis.
CO6 To know chemical products based on renewable sources.
CO7 To discuss alternative solvents Volatile organic compounds (VOCs) Supercritical fluids. Alternatives in extraction and chromatography.
CO8 To discuss ionic liquids as solvents: its types, properties and applications.

Mapping of Paper No. CHE-106

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	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	M	S	S	S	M	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	M	M	S	S	S
CO6	S	S	M	S	S	S	M	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	M	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:-

1. S. E. Manahan, Fundamentals of Environmental Chemistry, 3rd ed. (2009) CRC Press.
2. R. A. Sheldon , I. Arends and U. Hanefeld, Green Chemistry and Catalysis, 1st ed. (2007) Wiley-VCH.
3. V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, 1st ed. (2004) Springer.
4. T. Clifford, Fundamentals of Supercritical Fluids, 1st ed. (1999) Oxford press.
5. C. –J. Li, T. –K. Chan, Organic Reactions in Aqueous Media, 1st ed. (1997) Wiley- Inter science, New york.
6. Recent review articles relevant to above topics (reprints to be handed over to students).

M.Sc.- Chemistry
Semester-I

CHE-107 Practical – I
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To impart knowledge of cerimetry and analysis of mixture of rare metals ions and insoluble oxides and sulphates.*

1. **Qualitative Analysis:**

   b) Less common metal ions- Tl, Se, Te, Mo, W, Ti, Zr &V.
   c) Insoluble - Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2); Sulphates (Lead Sulphate, Barium Sulphate Strontium Sulphate, and Calcium Sulphate); Halides (CaF_2, AgCl, AgBr , AgI).

*(2 less common metal ions and 1 insoluble to be given)

2. **Quantitative Analysis:**
   Determination of Ferrous, Oxalate, Nitrite, etc. by Cerimetry.

3.Viva-Voce (05 Marks)
4 Note Book (05 Marks)

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 titrations.
CO4 To demonstrate the various cerimetric 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. CHE-107

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	S	S	S	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	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	S	S	S	S	M	M
CO5	S	S	M	S	M	M	S	S	S	S	M	S	M	S	S
CO6	M	M	S	M	S	S	M	M	S	S	S	S	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

Suggested Readings:

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

CHE-108 Practical – II
Physical Chemistry

Max.Marks:50
Time: 6 hrs.

Course Objective: *To train students with introductory physical chemistry practical's like adsorption, surface tension, viscosity, distribution law, and conductometry. First-hand experience of conductometric studies will be provided.*

1. Viscosity

(i) Determine the viscosity of methyl acetate and ethyl acetate using Ostwald Viscometer.
(ii) Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.
(iii) Determine the Molar Mass of a polymer.

2. Conductometry

(i) Determine the strength of weak acid by conductometric titration with strong base.
(ii) Determine the strength of strong acid by conductometric titration with strong base.
(iii) Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.

3. Distribution Law

(i) Determine the distribution coefficient of benzoic acid between benzene and water.
(ii) Determine the distribution coefficient of iodine between carbon- tetrachloride and water.
(iii) Determine distribution coefficient of ammonia between chloroform and water.

4. Adsorption

(i) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid on activated charcoal.
(ii) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of oxalic acid on activated charcoal.

5. Surface Tension

(i) Determine the surface tension of given organic solvents.
(ii) Study the effect of soap concentration on the lowering of surface tension of water.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)

Note-Book : (05 Marks)

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 Conductometric titration for the determination of normality of acids.
CO4 To be able to determine Distribution coefficient between two liquids.
CO5 To determine extent of adsorption and verify Freundlich and Langmuir adsorption isotherms.
CO6 To understand the concept of surface tension and its determination for various organic solvents.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-I08

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	M	M	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	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	M	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	M	M	S	S	S	S	S	S	S
CO7	S	S	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

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.
5. Experiments in Physical Chemistry, D.P. Shoemaker
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V. Gargand A. Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.

M.Sc.-Chemistry
Semester-I

CHE-109 Practical-III **P**
Organic Chemistry

Max.Marks:50
Time: 6 hrs.

Course Objective: *The objective of the course is to provide knowledge about the general experimental techniques like purification and separation. The intent is to expose the students with the preparatory methods of simple organic compounds.*

1. **General experimental techniques:** (20Marks)
   - Common laboratory glasswares
   - Purification of organic solids
     1. Purification of organic compounds by sublimation
     2. Recrystallisation of benzoic acid from water
   - Purification of organic liquids by simple distillation.
   - Determination of melting point of solid organic compounds.
   - Determination of boiling point of liquid organic compounds.
   - Separation of organic compounds by paper, TLC, column chromatography.

2. **Organic Synthesis:** Preparation of following organic compounds: (20Marks)

   (i) Preparation of benzanilide from aniline.
   (ii) Preparation of methyl orange from aniline.
   (iii) Preparation of tribromoaniline from aniline.
   (iv) Preparation of 2,4-dinitrophenylhydrazine from chlorobenzene.
   (v) Preparation of benzanilide from benzophenone.
   (vi) Preparation of adduct of anthracene and maleic anhydride by Diels-Alder reaction.
   Any other reaction as per requirement

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

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3. Viva-Voce (05marks)
4. Note-Book (05marks)

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 understand the purification of organic compounds.
CO6 To understand the Melting point, boiling point and chromatographic techniques used in organic purification.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce after completion of course.

Mapping of Paper No. CHE-109

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	S	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S
CO 5	S	S	M	S	S	S	S	S	S	S	S	S	S	S	S
CO 6	S	S	M	S	S	S	M	S	S	S	M	S	S	S	S
CO 7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 8	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Clarke, H.T. & revised by Haynee, B. Edward Arnold, *A Hand book of Organic Analysis –Qualitative and Quantitative*, London (1975).
2. Furhen, B.S., *Vogel's Text Book of Practical Organic Chemistry*, Longman.
3. Middleton, H., *Systematic Qualitative Organic Analysis,* Edward Arnold (Publishers) Limited, London(1959).
4. Vogel, A.I., *Elementary Practical Organic Chemistry*, EXCBS Publishers and Distriibutors (1957).
5. Louis, F., Fieser, D.C., *Experiments in Organic Chemistry*, Heath and Company Boston (1955)
6. Vishnoi, N. K., *Advanced Practical Organic Chemistry*, Vikas Publishing3rd ed.(2009).

M.Sc.- Chemistry
Semester-II

CHE-201: Inorganic Chemistry-II
(Organometallic Chemistry & Molecular Clusters)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *To provide students with basic understanding of organometallic compounds, metal carbonyl/nitrosyl, dinitrogens and metal carbonyl clusters.*

Unit –I

Valence electron count (16/18 electron rules), Total electron count (TEC), Compliance and violation of the 18-electron rule, Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds. Metal Carbonyls –Structure, bonding and infrared spectroscopy of metal carbonyls, bonding modes of CO, symmetry of metal carbonyls; synthesis-and reactivity of metal carbonyls; substituted metal carbonyls and related compounds.

Unit-II

Synthesis and important reactions of carbonyl hydrides, Synthesis, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen complexes and tertiary phosphine.
Alkyls and Aryls of Transition Metals: Types, routes of synthesis, stability and decomposition pathways.

Unit-III

Characteristic reactions of organometallic complexes: oxidative addition, reductive
elimination, Migratory insertion, Catalytic Hydrogenation of alkenes, Hydrocyanation, Hydrosilylation, Hydroformylation, Methanol Carbonylation and Olefin Oxidation- Monsanto process, Cativa and Wacker process, Olefin- Metathesis, C-C and C-N cross coupling reactions, Olefin polymerization.

Unit-IV

Halide clusters [Re2X8]2-, Re3X9 and Carboxylate clusters- Re2(RCOO)4X2, Mo2(RCOO)4; Low nuclearity metal carbonyl clusters, High Nuclearity carbonyl clusters, capping rule, Mingo's rule, Carbide clusters, Isolobal analogy; Main Group Clusters- Structure and bonding in the closo, nido, archano –boranes and carboranes, styx notation; Wade-Mingos and Jemmis electron counting rule; Clusters having interstitial main group elements, cubane clusters and naked or Zintl clusters; Isolobal analogy.

Course Outcomes:

CO1 To Know the basics of organometallic compounds.
CO2 To understand the characteristics and classifications of organometallic compounds.
CO3 To discuss the synthesis, structure ,characteristics and chemical properties of metal carbonyls, metal nitrosyls.
CO4 To explain the synthesis and structural characteristics and important reactions of dinitrogen and tertiary phosphine complexes.
CO5 To discuss the Types, routes of synthesis, stability and decomposition pathways of Alkyls and Aryls of Transition Metals.
CO6 To explain the Characteristic reactions and catalytical applications of organometallic complexes.
CO7 To know the various classifications of metal cluster compounds.
CO8 To categories the metal boranes carboranes, metalloboranes and metallocarboranes and their various aspects.

Mapping of Paper No. CHE-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	M	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S	M	S
CO3	S	S	S	S	M	M	S	M	M	M	M	S	S	S	M
CO4	M	M	S	M	S	S	M	M	S	S	S	S	M	S	M
CO5	S	S	S	S	S	S	S	S	S	M	M	S	S	S	S
CO6	M	M	S	M	S	S	M	M	S	S	S	M	S	S	S
CO7	S	M	S	S	S	S	M	S	S	S	M	S	M	M	M
CO8	S	S	S	S	S	M	S	S	S	M	M	S	S	S	M

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Basic Organometallic Chemistry; Concepts, Synthesis and Applications B.D. Gupta and A.J. Elias; University Press (India), 2010.
2. Organometallic Chemistry; R.C. Mehrotra and A. Singh, New Age International.
3. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
4. Introduction to Cluster Chemistry- D.M.P. mingoos and. J. Wales, Prentice Hall, 1990
5. Molecular Clusters: A Bridge to solid-state Chemistry, T.P. Fehlnaer, J.F. Halet and J-Y. Sailard, Cambridge University press, 2007.
6. Chemistry of Elements, 2nd Edition, N.N. Greenwood and E.A. Earnshaw, Butterworth-
Heinemann, 1997.
7. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
8. Inorganic Chemistry: Priciples of structure and reactivity, J.E. Huhey, E.A. Keiter and R.L. Keiter, Pearson Education, 2006.
9. R. West, Solid State Chemistry and its Applications, John Wiley & Sons, 1984.

M.Sc.-Chemistry
Semester-II

CHE-202: Physical Chemistry-II
(Physical Chemistry: Concepts & Applications)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide students with an understanding of physical chemistry like quantum approach, enzyme kinetics, phase rule , Types of statistics: Maxwell Boltzmann, Bose-Einstein & Fermi Dirac statistics. This course will strengthen the essentials of Physical Chemistry, Statistical thermodynamics and quantum chemistry.*

Unit -I

Thermodynamics and Phase Equilibria: Third law of thermodynamics, Nernst heat theorem, determination of absolute entropy ,Gibb's phase rule, Clausius Clapeyron equation and its applications, Phase diagram for one component system, (H_2O, CO_2 and Sulphur system); Phase diagram for two completely miscible components systems, calculation of eutectic point, systems forming solid compounds A_xB_y with congruent and incongruent melting points.

Unit-II

Chemical Dynamics: Kinetics of reaction in solution, Debye smouluchowski reaction, influence of pressure, ionic strength, solvent on reaction rates, salt effect, kinetics of catalytic reactions: acid base catalysis, enzyme catalysis ,Michaelis-Menton treatment, evaluation of Michaelis's constant for enzyme- substrate binding by Line weaver - Burk plot), Heterogeneous catalysis.

Unit-III

Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, Types of statistics: Maxwell Boltzmann, Bose-Einstein & Fermi Dirac statistics and its statistical thermodynamic formulation, idea of microstates and macro states, Thermodynamic probability for three types of statistics and most probable distribution states for them, Concept of partition function, its physical significance and their relation various thermodynamic properties , Lagrange's undetermined multiplier, Stirling's approximation.

Unit-IV

Quantum Mechanics: Angular momentum operators in Cartesian coordinates, eigen function & eigen values, commutation relation between angular momentum operators (L_x, L_y, L_z, L^2), commutation relation between components of total orbital angular momentum and ladder operators, commutator of [L^2, L_+] and [L^2, L_-], application of ladder operators to an eigen function of L_z , Schrodinger wave equation for linear harmonic oscillator and its

solution using factorization method, zero point energy.

Course Outcomes:

CO1 To discuss the third law of thermodynamics, Nernst heat theorem, determination of absolute entropy.
CO2 To discuss Phase diagram for one component system, and two completely miscible components systems.
CO3 To know Michaelis-Menton treatment and Debye smouluchowski reaction.
CO4 To understand the ionic strength, solvent on reaction rates, salt effect, Kinetics of catalytic reactions
CO5 To describe Bose-Einstein, Fermi-Dirac statistics, their comparison and Stirling's approximation.
CO6 To explain types of statistics, their thermodynamics probability as well as relation of atomic partition function with various thermodynamic properties.
CO7 To know about angular momentum operators, their commutation relations and ladder operators.
CO8 To be able to setup and solve Schrödinger equation for linear harmonic oscillator.

Mapping of Paper No. CHE-202

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	M	S	S	M	S	S	S	M	S
CO3	S	S	S	S	M	M	S	M	S	S	S	M	S	M	M
CO4	S	M	S	M	S	M	S	S	M	S	M	S	M	S	M
CO5	S	S	S	S	M	S	S	M	S	S	M	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	M	S	S	M	S	S	S	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Thermodynamics for Chemists, Affiliated East-West Press.
2. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
3. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
4. Chemical Kinetics, K.J. Laidler, McGraw Hill.
5. Kinetics and Mechanism, A.A. Frost and R.G. Pearson, John Wiley and Sons.
6. Chemical Kinetics and Reaction Dynamics, Springer,2006.

7. Elements of Statistical Thermodynamics,2nd edition, Addison Wesley (1974)
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Introduction to Quantum Chemistry, A.K .Chandra, Tata McGraw Hill.
10. Quantum Chemistry. Levine, Prentice Hall.
11. Quantum Chemistry ,B.K. Sen, Kalyani Publishers

M.Sc.- Chemistry
Semester-II

CHE-203: Organic Chemistry-II

(Organic Reaction Mechanism & Rearrangements)

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *To provide the students basic knowledge about Aromatic Electrophilic Substitution, Aromatic Nucleophilic Substitution, Addition to Carbon-Carbon Multiple Bonds, Elimination Reaction and Rearrangements.*

Unit–I

Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Diazonium coupling, Gattermann-Koch reaction, Vilsmeier-Haack reaction, Reimer-Tiemann reaction, Fries rearrangement

Aromatic Nucleophilic Substitution: The ArS_N1, ArS_N2, and Benzyne mechanisms. Reactivity–effect of substrate structure, leaving group and attacking nucleophile, Smiles rearrangement.

Unit-II

Elimination Reactions: The E1, E2 and E1cB mechanisms. Orientation Effects in Elimination Reactions, Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Saytzeff and Hoffman rules, Stereochemistry of E2 elimination reactions and eclipsing effects in E2 eliminations.

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity.

Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration, Michael reaction, Sharpless asymmetric epoxidation.

Unit-III

Addition to Carbon-Hetero Multiple Bonds: Reactivity of carbonyl compounds towards addition. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds, Wittig reaction. Mechanism of metal hydride reduction ($LiAlH_4$ and $NaBH_4$) of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel,

Claisen, Mannich, Robinson, Reformatsky, Benzoin, Perkin and Stobbe reactions. Hydrolysis of ester and amides.

Unit–IV

Rearrangements: Classification and general mechanistic treatment of nucleophilic, free radical and electrophilic rearrangement; Wagner Meerwein, Pinacol-pinacolone, Benzil-benzilic acid, Favorskii, Steven, Wittig, Neber, Wolff, Beckmann, Hoffmann, Curtius, Lossen, Schmidt, Bayer-Villger oxidation.

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 Role of non-bonding electrons, sigma and π-bonds, the concept of carbocations rearrangements and migratory aptitudes.
CO4 To describe the generation, structure, stability and reactivity of free radicals.
CO5 To know the mechanisms of addition alkenes and alkynes.
CO6 To study addition to C=O group of aldehydes, ketones and acids.
CO7 To understand and reactivity of carbonyl compounds in various reactions.
CO8 To learn various name reactions related to ketones and aldehydes.

Mapping of Paper No. CHE-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	S	S	S	S	M	S	S	S	S
CO2	S	S	M	S	M	S	S	S	S	S	M	S	S	S	S
CO3	S	S	S	M	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	M	M	M	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	S	M	S	M	S	S	S	S	S	M	S	S	S	S
CO7	S	S	M	S	M	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Sykes, P.,*A Guide Book to Mechanism in Organic Chemistry*, Pearson 6th ed. (2003)
2. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Prentice–Hall 6th ed. (2001)

3. March, J., *Advanced Organic Chemistry Reactions, Mechanism and Structure*, John Wiley 6th ed. (2007).
4. Clayden, J., Greeves, N., Warren, S. & P. Wothers *Organic Chemistry*, Oxford University Press (2001)
5. Wade, L.G., Siemek, J.W., *Organic Chemistry*, Pearson (2017)
6. Solomons, G. & Fryhle, C., *Organic Chemistry*, John Wiley 7th ed. (1999)
7. McMurry, J., *Organic Chemistry*, *Mary* Finch 8th ed. (2012)
8. Pine, S.H., *Organic Chemistry*, McGraw Hill 5th ed. (1987)
9. Mukherji, S. M. & Singh, S. P., *Reaction Mechanism in Organic Chemistry*, Macmillan 3rd ed. (1984)

M.Sc.- Chemistry
Semester-II

CHE-204
Basic Pericyclic & Photochemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide the knowledge of pericyclic reactions, mechanism and applications on different groups.*

Unit I

Pericyclic Reactions I: 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, Electrocylic reaction- conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates; Cycloadditions - antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions andcheleotropic Reactions.

Unit II

Pericyclic Reactions II: Sigmatropic Rearrangements-suprafacial and antarafacial shifts of Hydride ion, 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.

Unit III

Photochemistry I: Franck-Condon Principle, Jablonski diagram, energy transfer photsensitization, 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 Photoreduction. Photochemistry of olefins and 1,3-Butadiene (cis- trans isomerisation, dimerisation and cycloadditions).

Unit IV

Photochemistry II: 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, Hofmann-Loeffler-Freytag reaction. Synthesis of vitamin D.

Course Outcomes:

CO1 To appreciate the role of Molecular Orbitals in analyzing Pericyclic Reactions.
CO2 To explain Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic Reactions.
CO3 To discuss Rearrangements-suprafacial and antarafacial shifts of Hydrogen, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements
CO4 To gain knowledge about Sommelet-Hauser, Claisen and Cope rearrangements, Group transfers and eliminations.
CO5 To understand the laws of photochemistry, Beer-Lambert law, electronic energy levels, atomic and molecular term symbols, singlet-triplet state, intensity and strength of electronic transition, selection rules for electronic transition, Jablonski diagram.
CO6 To discuss the photochemistry of carbonyl compounds and alkene.
CO7 To interpret the stereochemical course of a Pericyclic Reaction and identify the product.
CO8 To 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. CHE-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	M	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	M	S	S	S	M	S	S	S	S
CO4	S	S	S	S	M	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	M	S	S	S	M	S	S	S	S
CO7	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Pericyclic Reactions, S.M. Mukherji Macmilan India.
2. Fundamentals of Photochemistry, K.K. Rohatagi-Mukherjee, Wiley Eastern, (1978).
3. Essentials of Molecular Photochemistry, Von A. Gilbert and J. Baggott, Blackwell Scientific Publication, Oxford (1991).

4. Molecular Photochemistry, N.J. Turro, W.A. Benjamin, (1965).
5. Introductory Photochemistry, A. Cox and T. Camp, McGraw Hill, (1971).
6. Sankararaman,S., *Pericyclic Reactions-A textBook*, Wiley VCH, 2005.
7. Mukherji S.M., *Pericyclic reactions*,Mcmillan (1979).
8. Albright, T., Burdeet, J. & Whango, M., *Orbital interaction in chemistry*, Wiley VCH 2nd Edition(2013).
9. Fleming, I., *Frontier Orbitals and Organic Chemical Reactions*, Wiley, London (1976).

Semester-II

CHE-205
Group Theory & Molecular Spectroscopy

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide students with basic understanding of advanced symmetry concepts of chemical molecules, its applications and molecular spectroscopy.*

Unit-I

Symmetry Elements and Operations, Pure Rotations (C_n Rotations), Improper Rotations, Rotation-Reflection (S_n) & Rotation-Inversion (n-bar) Axes. Point Groups: Low Symmetry Point Groups (C_1, C_i, C_s), Simple Axial Point groups (S_n, $C_{nv'}$ C_{nh}),Dihedral Groups (D_n, D_{nd}, D_{nh}), the "Cubic" Groups (T_d, O_h, I_h), The "Infinite Groups"($C_{\infty v}$ and $D_{\infty h}$), Points Groups & Chirality, Multiplication Tables (i.e., operation 1 followed by operation 2) for point groups.

Unit-II

Similarity transforms, classes of symmetry elements, naming representations (Mulliken Symbols), subgroups and non-commutative Operations. Representations of Groups, irreducible representations, character tables, their derivations and use of their contents, matrix representation of symmetry operations, "Full Form" of the character table, application of group theory to atomic orbitals in ligand fields, molecular orbitals, hybridization.

Unit-III

Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, determination of bond lengths and atomic masses from microwave data, intensities of rotational spectral lines, isotopic effect, non- rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules, First order Stark effect, 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, Breakdown of the Born-Oppenheimer approximation, nuclear spin effect.

Unit-IV

Classical and quantum theories, Pure rotational Raman spectra of linear molecules, Raman activity of vibrations, Vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines, Structure determination from Raman and Infra-Red spectroscopy.

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 To discuss Rotational spectroscopy of diatomic molecules based on rigid rotator approximation.
CO4 To calculate bond lengths and atomic masses from microwave data, intensities of rotational spectral lines.
CO5 To discuss breakdown of the Born-Oppenheimer approximation, nuclear spin effect.
CO6 To explain classical and quantum theories, Pure rotational Raman spectra of Linear molecules.
CO7 To explain Raman activity of vibrations, Vibrational Raman spectra, mutual exclusion principle.
CO8 To discuss structure determination from Raman and Infra-Red spectroscopy.

Mapping of Paper No. CHE-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	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	M	M	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M	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	S	S	S	S	S	M
CO8	S	S	S	S	s	S	M	S	S	M	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Theory of Groups and its applications to Physical Problems, S. Bhagavantam, and T. Venkatarayudu, Academic Press, New York, (1969).
2. Symmetry in molecules, J.M., Hollas, Chapman & Hall, (1972).
3. Group theory and Chemistry, David M. Bishop, Dover Publications (1989).
4. Chemical Applications of Group Theory, F. A. Cotton, 3rd Edition, John Wiley (1990).
5. Molecular Symmetry and Spectroscopy, P.R. Bunker, and P. Jensen, NRC Press, Ottawa, Canada, (1998).
6. Symmetry in Chemistry, H.H. Jaffe and M. Orchin, Dover Publications (2002).
7. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill (1962).

8. Basic Principles of Spectroscopy, R.Chang, McGraw Hill, (1971).
9. Physical Methods for Chemists, R.S. Drago, Saunders College, (1992).

Semester-II

CHE-206
Polymer Materials

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide advance knowledge of the various classes of polymers, polymerization mechanism, thermoplastics, thermosets and elastomers.*

UNIT-I

General introduction to polymers with emphasis on important concepts such as monomers, precautions and synthesis of some monomers, functionality and physical state (amorphous and crystalline), classification of polymers on the basis of source, elemental composition, heat, pressure, chemical reactivity, Chemical/monomer composition, geometry and stereo regularity. Concept of molecular weight, Nomenclature of Polymers.

UNIT-II

Chemistry and mechanism of Polymerization- Definition of polymerization, Factors affecting on polymerization, Addition polymerization (free radical, ionic and co-ordination polymerizations), Condensation polymerization-molecular weight in step growth polymerization, Ring opening polymerization. Photo polymerization, Electro chemical Polymerization, Metathesis polymerization, Group transfer polymerization- synthesis and applications.

UNIT-III

Thermoplastics- Polyolefin and allied polymers, Vinyl polymers - Styrene and its copolymers, Acrylics. Polyamides, Polyesters, PU, Cellulose and its derivatives, Polycarbonates, Polyacetals, Polyacrylic acid, PVA, Polyvinyl acetals.

Thermosets- PF, MF, UF, Epoxy resins, Unsaturated polyester, Vinyl esters, Cyanate esters, Furan resins and silicone polymers.

UNIT-IV

Elastomers- Natural Rubber, isoprene rubber, butyl rubber, Nitrile rubber, chloroprene Rubber and Styrene-butadiene Rubber, EPDM, Vulcanization, Rubber chemicals.

Course Outcomes:

CO1: To understand chemistry of polymers and polymerization.
CO2: To understand and analyze thermal physical and chemical properties of polymers.
CO3: To discuss the factors affecting on polymerization, Addition polymerization, Condensation polymerization, Ring opening polymerization.
CO4: To understand the Photo polymerization, Electro chemical Polymerization, Metathesis polymerization, Group transfer polymerization-synthesis and their applications.
CO5: To gain the knowledge about thermoplastic polymers.
CO6: To understand properties and types o thermo sets polymers.
CO7: To know the elastomer polymers
CO8: To understand chloroprene Rubber and Styrene-butadiene Rubber, EPDM, Vulcanization, Rubber chemicals.

Mapping of Paper No. CHE-206

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	M	S	M	S	S	S	M
CO2	S	S	S	S	S	S	S	S	M	S	M	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	M	S	M	S	S	S	S
CO5	M	M	S	S	S	M	M	S	S	M	S	S	S	S	M
CO6	M	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	M	M	M	M	S	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	M	S	S	M	S	S	M	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

1. Plastic materials 7th Edition –Brydson.-Elsevier 1965.
2. Rubbery materials and their compounds – Brydson.- Elsevior Applied Science.1988
3. Rubber technology and manufacture – C.M. Blow. .- Institution of Rubber Industry.2011
4. High performance polymers, their origin and development- R.B. Seymour and G.S. Krishenbaum. -Elsevier 1986.
5. Hand book of plastics materials and technology – Rubin. .-Wiley-Inter Science1990.
6. Plastics in Packaging – A.S. Athalye (Tata McGraw - Hill Publishing company, New Delhi).1992
7. Polymer science- V.R Gowrikar, N V Viswanathan, Jayaadev Sreedhar-Newage International Publishers.1986
8. Polymer A Property Data Base-Bryan ellis, Ray Smith- CRS Press.1999
9. J.A. Brydson, “Plastics Materials”, Butterworth- Heinemann - Oxford, 6th Ed., 1995.
10. Feldman.D and Barbalata.A, “Synthetic Polymers”, Chapman Hall, 1996.

M.Sc.-Chemistry

Semester-II

CHE-207

IT Skills

Max.Marks:50
Time: 2 hrs

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *To provide the knowledge of the computers, operating systems, internet, networks, data bases, MS Word, MS Excel, MS PowerPoint, worksheets and graphing.*

Unit-I

Fundamentals of Computer: Introduction to computer, Classification & Generations of Computer, Block diagram and Anatomy of Computer, Input and Output devices, Basic concept of Data & Information, Software: Types of Software, Operating System, Functions of OS, Types of OS, Features of OS (Based on Windows).

Unit-II

Introduction to Internet & Networking: Data Communication: Types and applications of Data Communications, Concept of Network, Types of Networks, Topologies, Computer Protocols, History of Internet, Intranet, Web Browsers, Search Engine, Applications of Internet, E-Commerce: Types, Tools Electronic Payment System.

Unit-III

Business Data Processing: Concept of Database, Architecture of Database, Types of Database Introduction to Data Processing, Data Storage, Data Hierarchy, Methods of Organizing Data Various Data Processing Files, File Organizing, Various Utilities of Files.

Unit-IV

Applications & Packages: File Management: Start Menu and Taskbar, Types of Icons, Viewing, Arranging, and Working with Files and Folders MS Word: Toolbars**,** Menu, editing a Document, Previewing Document, Printing Documents, Mail Merge MS Power Point: Basics, Insert, Tools, Format, Slide Show, Formatting Slides, Create Presentations MS Excel: Entering and Editing Worksheet Data,

Worksheet Operations, Introducing Tables, Graphing and Summarizing Data MS Access: Toolbars, Entering & Editing the Data, Data Operations, Introduction Tables, Data Analysis.

Course Outcomes:

CO1 To give basic knowledge of computer, Classification & Generations of Computer.
CO2 To explain Types of Software, Operating System, Functions of OS, Types of OS ,Features of OS (Based on Windows).
CO3 To discuss types and applications of Data Communications, Concept of Network.
CO4 To explain history of Internet, Intranet, Web Browsers, Search Engine.
CO5 To discuss concept of Database, Architecture of Database, Types of Database.
CO6 To explain methods of Organizing Data Various Data Processing Files, File Organizing.
CO7 To introduce with toolbars, Menu, editing a Document, Previewing Document, Printing Documents.
CO8 To explain Data Operations, Introduction Tables, Data Analysis.

Mapping of Paper No. CHE-207

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	M	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	M	M	S	S	S	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	M	S	S	S	S	S	S
CO6	S	S	S	S	S	M	S	S	S	M	S	S	S	S	S
CO7	S	S	S	S	s	S	S	S	S	M	S	S	S	S	M
CO8	S	S	S	S	s	S	S	S	S	M	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Nippani, K. S., Murthy, B. K., *Digital India: Governance Transformation,* Vitasta Publishing Pvt Ltd.
2. Kamal, R.& Saxena, P., *Big Data Analytics*, McGraw Hill Education.
3. Maheshwari, A., *Big Data*, McGraw Hill Education.
4. Bhushan, M., Rathore, R.S. & Jamshed, A., *Fundamentals of Cyber Security*, BPB Publication.
5. Bahga, A. & Madisetti, V., *Internet of Things*, Orient Black Swan

M.Sc.- Chemistry
Semester-II

CHE-208 Practical- I
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To impart knowledge of gravimetry and experimental spectroscopic techniques.*

1. Determination of some metal ions, such as iron, nickel, manganese, chromium, vanadium etc. and fluoride, nitrite and phosphate etc. by Spectrophotometric Method.
2. Preparation of acetylacetonato complex of Fe (III), Cu (II), Ni (II) and determine the λmax of the complex using Spectrophotometer.
3. Quantitative Analysis:
Separation and determination of two metal ions such as Ag- Cu, Cu- Ni, Cu- Zn, Ni- Zn, Cu-Fe, Ba-Cu, Fe-Ni, Cu-Mg, Pb-Cu, Zn-Mg. etc. involving volumetric and gravimetric methods.

4. Viva-Voce (05 Marks)
5. Note Book (05 Marks)

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.
CO4 To determine concentration of metal ions by spectrophotometric method.
CO5 To perform experimentation and evaluate the results.
CO6 To Know how to perform iodometric titrations.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-208

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	S	S	S	S	S	S	S	S	M	S	S	S	S
CO6	S	S	S	M	S	M	S	S	M	S	S	M	S	S	M
CO7	S	S	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

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.
3. Laboratory manual: Analytical Chemistry - principles and techniques by Larry G. Hargis, Prentice Hall.

M.Sc.-Chemistry
Semester-II

CHE-209: Practical-II
Physical Chemistry

Max.Marks:50
Time:6 hrs.

Course Objective: *To provide students exposure of chemical kinetics, refractometry , pH-metry and potentiometry, and turbidity metry. Advanced experiments such as potentiometry and pH-metry will be carried out. First-hand experience of Electrochemical techniques will be provided.*

1. **Chemical Kinetics**
   (i) Study kinetics of hydrolysis of an ester in the presence of acid.
   (ii) Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.
   (iii) Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

2. **Potentiometry**
   (i) Determine the strength of strong acid by potentiometric titration with strong base.
   (ii) Determine the strength of weak acid by potentiometric titration with strong base.
   (iii) Determine the strength of a given solution of ferrous ammonium sulphate byPotentiometric titration with $K_2Cr_2O_7$ solution.

3. **pH metry**
   (i) Determine the strength of strong acid by pH-metric titration with strong base.
   (ii) Determine the strength of weak acid by pH-metric titration with strong base

4. **Refractometry**
   (i) Determine the refractive index of the given liquid.

5. **Electrochemical techniques**
   (i) Find corrosion rate from Tafel plots using Stern-Gerry equation.
   (ii) Record cyclic Voltammogram and find anodic and cathodic oxidative peaks.

Experiment Marks: 40 Marks

Viva-Voce : (05Marks)
Note-Book : (05Marks)

Course Outcomes:

CO1 To study and conduct experiments related to chemical kinetics for the determination of the order and rate constant of the reaction.
CO2 To understand and master the fundamentals of potentiometric experiments.
CO3 To study the pH-metric titration for the determination of normality of acids.
CO4 To determine refractive index of any Liquids.
CO5 To Find corrosion rate from Tafel plots using Stern-Gerry equation.
CO6 Record cyclic Voltammogram and find anodic and cathodic oxidative peaks.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-209

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	M	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	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	S	S	S	M	S
CO5	S	S	S	S	S	S	M	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	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

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. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V. Garg and A. Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing

M.Sc.- Chemistry
Semester-II

CHE-210 Practical-III
Organic Chemistry

Max.Marks:50
Time:6 hrs.

Course Objective: *To acquire experimental skills important for the identification of organic compounds using different chemical tests like preliminary tests, tests for extra elements and functional groups and lastly by derivatization.*

1. Qualitative Analysis (40 Marks)
   Identification of the given organic compound by (i) Chemical tests,
   (ii) derivatization. (One set to be given in the examination)
2. Viva-Voce (05Marks)
3. Note-Book (05marks)

Course Outcomes:

CO1 To introduce chemical identification of simple organic compounds.
CO2 To analyse qualitatively the presence of extra elements and functional groups in organic compounds along with understanding of chemical reaction involved.
CO3 To make them able to differentiate between aromatic/aliphatic, saturated/unsaturated, hydrocarbon/ heterocycles and develop the capabilities of preparing derivatives of different organic compounds bearing various organic functionalities.
CO5 To understand the significance of preparing derivatives.
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. CHE-210

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	M	S	M	S	S	S	M
CO2	S	S	S	S	S	S	S	S	M	S	M	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	M	S	M	S	S	S	S
CO5	S	M	S	S	S	M	M	S	S	M	S	S	S	S	M
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	M	M	M	S	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	M	S	S	M	S	S	M	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Furniss, B.S., Vogel, A. I., Smith, P. W., *Vogel's Text Book of Practical Organic Chemistry*, Longman-Group Ltd. (1978)
2. Vogel, A.I., *Elementary Practical Organic Chemistry*,Longmans,Green,2nd Edition(1959).
3. Fieser, F., *Experiments in Organic Chemistry by* D.C. Heath and Company Boston, (1935).
4. Mann F.G., & Saunders. B.C., *Practical Organic Chemistry* Pearson Education India (2009).
5. Campbell, B.N. and Ali M., *Organic chemistry experiments: Microscales and semi microscales*, McCarty M, Brooks/Cole,(1994).
6. Ault A., *Techniques and experiments for organic chemistry*, University Science Books,(1998).
7. Lehman, *Multiscale operational organic chemistry: A problem solving approach to laboratory course,* Pearson Prentice Hall,2nd Edition (2009).
8. Clarke, H.T., *A Hand book of Organic Analysis -Qualitative and Quantitative*, Edward Arnold London(1975).
9. Vishnoi N.K., *Advanced Practical Organic Chemistry,* Vikas Publishing(2009).

M.Sc.-Chemistry
Semester-III

CHE 301: Organic Spectroscopy

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide the advance knowledge and understanding of organic spectroscopy, both the theoretical and application aspect of various spectroscopic techniques (UV-Visible, IR, NMR spectroscopy and mass spectrometry) and to the solve problems related to structure determination of organic compounds.*

Unit-I

Ultraviolet and Visible Spectroscopy: 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. Fisher-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

Infrared Spectroscopy: Instrumentation and sample handling. 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.

Unit-II

Nuclear Magnetic Resonance Spectroscopy: General introduction and definition, chemical shift, spin- spin interaction, shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei, 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. Further tools for simplification (chemical and instrumental) to elucidate structures by NMR - Deuteration, changing solvents, trifluoroacetylation, basification and acidification, shift reagents, spin decoupling.

Carbon-13 NMR Spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect (NOE).

Unit-III

Mass Spectrometry: Introduction of methods of fragmentation of organic compounds - EI, CI, FD and FAB, factors affecting fragmentation, ion

analysis, ion abundance. 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, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

Unit-IV

Problems: Problems pertaining to sections A, B and C.

Course Outcomes:

CO1 To know the basic concept of Ultraviolet and Visible Spectroscopy, and the Beer-Lambert law, effect of solvent on electronic transitions.
CO2 To apply Fieser-Woodward rules for calculating **λ**max for conjugated dienes and carbonyl compounds.
CO3 To introduce mass spectrometry and difference with spectroscopy and to discuss the methods of fragmentation of organic compounds - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance.
CO4 To explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.
CO5 To introduce and discuss the chemical shift and coupling constant in relation to stereochemical structure of the organic compound and to explain the difference between First order and second order NMR spectra and Tools used for simplification of complex NMR spectrum (instrumental and chemical).
CO6 To know the difference between 1 H-NMR and 13 C-NMR and their applications in structure determination of organic compounds.
CO7 To introduce the concept of 2D-NMR and to explain the principle of IR spectroscopy and its application in determining different functional groups present in organic compounds.
CO8 To apply various spectroscopic techniques discussed above for solving/determining the structure of organic compounds (composite problems).

Mapping of Paper No. CHE-301

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	S	M	M	S	S	S	S	S
CO2	S	S	M	S	M	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	M	S	S	S	M	S	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	S	S	S	S	S	S
CO6	S	S	M	S	S	S	S	M	S	S	S	S	S	S	S
CO7	S	S	S	S	S	S	S	M	M	S	S	S	S	S	S
CO8	S	S	M	S	S	S	S	M	M	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2ndEdn. 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. Da s & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

M.Sc.- Chemistry
Semester-III

CHE 302: Inorganic Spectroscopy

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course objective: *To provide exposure with various spectroscopic techniques required to characterize inorganic complexes and coordination compounds.*

Unit-I

Polarography: Electrochemical reactions, General principles, diffusion current, dropping mercury electrode, IIkovic equation (without proof), Half-wave potentials, Polarographic waves (Anodic and Cathodic), Conditions for performing Polarographic determinations, Oxygen interference, maxima, function of supporting electrolyte.Presentation and interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum, Applications of mass spectroscopy to inorganic compounds - finger print application, molelcular weight determination, evaluation of heat of sublimation of high melting solids.

Unit-II

Nuclear magnetic resonance spectroscopy: Application of chemical shifts, signal intensities and spin spin coupling to structure determination of inorganic compounds carrying NMR active nuclei like 1H,11B, 15N, 19F, 29Bi, 31P, 183W, 195Pt, etc. Effect of fast chemical reactions, coupling to quadrupolar nuclei,NMR of paramagnetic substances in solution, contact shift, pseudo contact shift, factoring contact and pseudo contact shift for transition meta lions. Contact shift and spin density, π delocalization, simplified M.O. diagram for Co (II) and Ni (II), Application to planar tetrahedral equilibrium, Contrast agents.

Unit-III

Electronic paramagnetic resonance spectroscopy: Basic Principle and EPR spectrometers, Presentation of spectra, Hyperfine coupling, Hyperfine splitting in isotropic systems, Factors affecting magnitude of g value, EPR of triplet states, zero field splitting, Kramer's rule, survey of EPR spectra of first row transition metal ion complexes, applications to inorganic free radicals, study of electron exchange reactions.

Unit-IV

Mossbauer Spectroscopy: Basic Principles, Spectral display, Doppler shift and recoil energy, isomer shift and its interpretation, quadrupole interactions, effect of magnetic field on Mossbauer spectra, applications to metal complexes, metal carbonyls. Nuclear Quadrupolar Resonance (NQR) Spectroscopy: Basic principles, Quadrupolar moment, and effect of asymmetry parameters and energy lends. Effect of an external magnetic field, selected examples for elucidation of structural aspects of inorganic compounds using NQR spectroscopy.

Course Outcomes:

CO1 To introduce various basic concepts of polarography to the students.
CO2 To discuss the various application of mass spectrometry.
CO3 To discuss the various theories applicable in polarography.
CO4 To explain NMR spectroscopy and its significance in chemistry.
CO5 To discuss Contact shift and spin density simplified M.O. diagram for Co (II) and Ni (II), Application to planar tetrahedral equilibrium, Contrast agents.
CO6 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.
CO7 To apply the Mossbauer technique for the determination of structure and bonding in iron and tin complexes
CO8 To know the basic principle of Nuclear Quadrupolar Resonance Spectroscopy and to understand the application of Electron Spin Resonance spectroscopy.

Mapping of Paper No. CHE-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	S	M	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	M	S	S	S	S	S	M	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	M	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	M	S	S	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. John Roboz, Introduction to Mass Spectrometry: Instrumentation and Techniques, Inter science(1968).
2. D.C. Harris and M.D. Bertolucchi, Symmetry and Spectroscopy: An introduction to vibrational and electronic spectroscopy, Dover Publications.
3. C .N. Banwell and E. M. McCash, Fundamentals of Molecular spectroscopy, Tata McGraw HillPub. Co. New delhi (2016)
4. E.A.O. Ebsworth, Structural Methods in Inorganic Chemistry, Blackwell Scientific Publications (1991).
5. L. Que Jr., Physical Methods in Bioinorganic Chemistry, University Science Books (2000).
6. F. Hammer, Inorganic Spectroscopy and related topics, Sarup & Sons Publications (2008).
7. R. S. Drago, Physical Methods in Inorganic Chemistry, East-West Press Pvt. Ltd. New Delhi (2012).

M.Sc. - Chemistry
Semester-III

CHE 303: Analytical Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide students with an understanding of Analytical chemistry like Chromatography, Atomic Absorption Spectroscopy, Electrogravimetry, and Thermal methods to strengthen the essentials of Analytical Chemistry.*

Unit-I

Data analysis: Mean and standard deviation, absolute and relative errors, linear regression, covariance and correlation coefficient.

Chromatography: Types, planar chromatography - paper and Thin Layer Chromatography, Stationary and mobile phases, Gas chromatography – Theory, instrumentation and applications, High Performance Liquid Chromatography (HPLC), Column chromatography, Gel Chromatography.

Unit-II

Atomic Absorption Spectroscopy: Principle, instrumentation, Absorption and emission line profile, Hollow cathode lamp, Application of atomic absorption spectroscopy, sensitivity and detection limits, interferences in AAS, Advantages and Disadvantages of Atomic Absorption Spectroscopy.
Flame photometry: Theory of flame photometry, Effect of Solvents in Flame photometry, Factors that influence the intensity of emitted Radiation in Flame photometry, limitations, application of flame photometry, Interferences in Flame photometry.

Unit-III

Thermal Methods: Introduction to Thermo gravimetric Analysis (TGA) and Derivative Thermo gravimetric Analysis (DTG), Instrumentation, thermo gram, factors affecting thermo grams, application of thermo gravimetry, Differential Thermal Analysis (DTA), DTA curves, factors affecting DTA curves, Instrumentation, applications of DTA.
Differential Scanning Calorimetry (DSC): Introduction, Instrumentation, DSC curves, factors affecting DSC curves, applications.

Unit-IV

Electro gravimetry: Introduction, theory, Instrumentation for constant-current methods, Applications, Electrolysis, coulometric titrations, applications of coulometric titrations, Amperometric titrations: Introduction, apparatus, and technique of Amperometric titrations, advantages and application of Amperometric titrations, and cyclic voltammetry.

Course Outcomes:

CO1 To learn Mean and standard deviation, absolute and relative errors.
CO2 To learn about various chromatography techniques and their application.
CO3 To understand the Principle, instrumentation and Application of atomic absorption spectroscopy.
CO4 To understand the Principle, instrumentation and Application of Flame photometry.
CO5 To know about details of Thermo gravimetry (TG) and Differential thermal analysis (DTA), technique and its applications.
CO6 To discuss Differential Scanning Calorimetry (DSC), its theory, instrumentation and applications.
CO7 To discuss the theory, Instrumentation and applications of constant-current methods.
CO8 To understand the advantages and application of Amperometric titrations.

Mapping of Paper No. CHE-303

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	M	M	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	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	M	S	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. D.A. Skoog, D. M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Thomson (2004).
2. A.I. Vogel, A text book of Quantitative Analysis, 5th Edition Revised by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS (1989).
3. A. K. De, S. M. Khopkar and R. A. Chalmers, Solvent Extraction of Metals, Van Nostrand, Reinhold (1970).
4. L. R. Snyder and J. J. Kirkland, Introduction to Modern Liquid Chromatography, 2nd Edition, Wiley (1979).
5. Jose A. C. Broekaert, Analytical Atomic Spectrometry with flames and Plasmas, Wiley-VCH (2002).

M.Sc.- Chemistry
Semester-III

CHE 304(a): Inorganic Chemistry Special-I
Medicinal and Bioinorganic Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *To provide exposure of various biomolecules containing metal ions that comprises many important proteins and enzymes alongwith their anticancer potential.*

Unit-I

Biochemical basis of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies; Different classes of Inorganic drugs, Inorganic compounds as antacids, Drugs in hypo and hyper activity of thyroids.
Porphyrins, metalloporphyrins, structure and functions of hemoglobin and myoglobin,

Unit-II

Metal Ions in Biological Systems: Fundamentals of inorganic biochemistry, essential, non-essential and trace elements in bio-systems, Role of alkali/alkaline earth metals in bio-systems; Bioinorganic chemistry of Na+, K+, Mg2+ and Ca2+, Ionophores, active transport of cations across membranes, sodium pump, blood clotting, neurotransmitter
Metal Storage Transport and Bio-mineralization- Ferritin, transferrin, and siderophores.
Metal ions as antioxidants, metal ion enhancing catalytic activity of enzymes (Biocatalysts). Inhibitions as competitive and non-competitive.

Unit-III

Carcinogens and Carcinostatic agents, Role of zinc in tumor growth and inhibition, Anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and gold complexes, anticancer activity of Selenium, alkylating agents as anticancer drugs. Antibacterial and antiviral properties of metal complexes and chelating drugs
Mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut. Ligand induced toxicity, interference with haemoglobin in oxygen transport system, interference with metallo-enzymes, beneficial effects of ligand chelation;
Nuclear medicine Therapy.

Unit-IV

Metallo-protein and enzymes*:* Zinc Enzymes –Carboxypeptidase, Carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Iron Enzymes

–Catalase, Peroxidase and Cytochrome P- 450, Copper Enzymes –Superoxide dismutase, blue copper electron transfer enzyme, Molybdenumoxatransferase enzymes –Xanthine oxidase Coenzymes –Vitamin B12.

Course Outcomes:

CO1 To introduce the basic principle of Bioinorganic chemistry.
CO2 To discuss about Metal Storage, their Transportations in living organisms and Biomineralization.
CO3 To learn about role of Alkali and alkaline earth metal in biological system.
CO4 To explain structural characteristics and role of vitamin B6 and vitamin B12.
CO5 To describe the types of zinc containing metalloenzymes, their structure and mechanistic approach in involving various reactions occurring in living organisms.
CO6 To explain the structure and role of copper and molybdenum enzymes in biological systems.
CO7 To discuss the metal ion enhancing catalytic activity of enzymes (Biocatalysts).
CO8 To describe the Copper Enzymes –Superoxide dismutase, blue copper electron transfer enzymes.

Mapping of Paper No. CHE- 304(a)

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	S	S	S	S	S	S	S	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	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	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

Suggested readings:

1. S.J. Lippard and J.M. Berg, Principles of Bioinorganic Chemistry, University Science Books, Mill Valley, 1994.
2. S. J. Lippard, Progress in Inorganic Chemistry, Wiley-Inter science, 1991.
3. Fenton, Biocoordination Chemistry, Oxford Chemistry Print, 1995.
4. Kaim and Schwederski, Bioinorganic: Inorganic Perspective in the Chemistry of Life, 1994.
5. S.E. Manahan, Environmental Chemistry; Lewis Publisher.

6. A.K. De, Environmental Chemistry; Wiley Eastern.
7. S.M. Khopkar, Environmental Pollution Analysis; Wiley Eastern.
8. S.K. Banerji, Environmental Chemistry; Prentice - Hall.

M.Sc.- Chemistry
Semester-III

CHE 304(b): Physical Chemistry Special-I
Advanced Quantum Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: ***There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.***

Course Objective: *To provide students with an understanding of physical chemistry like quantum approach, Schrodinger wave equation for three-dimensional Rigid rotator, valance bond method, Variation Method, Huckel molecular orbital (HMO) theory.*

Unit-I

Chemical Bonding: Valance bond method, valance bond method to hydrogen, hydrogen molecule ion (their symmetric and anti-symmetric solution without actual valuation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation, Concept of resonance and its role in the stability of hydrogen molecule ion.

Unit-II

Schrodinger wave equation for three-dimensional Rigid rotator and its solution using method of variable separation, energy of rigid rotator, Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution, probability distribution function, radial distribution function and shape of atomic orbital's (s, p & d).

Unit-III

Variation Method: Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method, need of approximate methods, Approximate Methods: The variation theorem, Linear variation Principle, perturbation theory (first order, second order and non-degenerate), applications of variation method and perturbation theory to the Helium atom.

Unit-IV

Molecular Orbital Theory: Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications of HMO theory (i) Set up and solve Huckel determinant equation (ii) Calculate resonance energy (iii) Wave functions for molecular orbitals (iv) Molecular diagrams of (a) Ethylene molecule (b) Butadiene (c) Cyclobutadiene (d) Allyl system(Allyl radical and related ions) (e) Cyclopropenyl system (cyclopropenyl radical and the related ions), (f) Benzene ring, Calculation of properties- Delocalization energy, electron density, bond order.

Course Outcomes:

CO1 To utilize valance bond methods in determining energy of hydrogen atom, hydrogen molecule ion.
CO2 To understand the role of resonance in the stability of hydrogen molecule ion.

CO3 Able to setup and solve Schrödinger equation for three-dimensional Rigid rotator.
CO4 To introduce about Schrodinger wave equation, its solution for hydrogen atom and shape of atomic orbitals
CO5 To explain time-independent perturbation theory and variational methods.
CO6 To discuss the Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method
CO7 To discuss Hückel theory of conjugated systems and apply it to various organic molecules.
CO8 To understand the concept of Delocalization energy, electron density, bond order.

Mapping of Paper No. CHE-304(b)

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	M	M	S	S	S	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	S	S
CO5	S	S	S	S	M	S	S	M	S	S	M	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	M	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	M	S	S	M	S	M	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Physical Chemistry, G.W. Castellan, Narosa
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, I.M. Levine, Prentice Hall.
4. Quantum Chemistry, B. K. Sen, Kalyani Publishers
5. Quantum Chemistry, R. Prasad, New Age International.
6. Quantum Chemistry & Spectroscopy – Thomas Engel
7. Quantum Chemistry MC. Quarrie D.A. Viva
8. Physical Chemistry A molecular approach Univ. Science (2001)

M.Sc.- Chemistry
Semester-III

CHE 304(c): Organic Chemistry Special-I
Reagents for Organic Synthesis

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *The aim of the course is to equip the students with the knowledge of oxidizing and reducing agents, preparation and applications of organometallic reagents and metal mediated C-C and C-X couplings.*

Unit-I

Oxidation reagents: Principle, reactions and mechanism of following oxidizing agents: **Manganese oxidants** – $KMnO_4$, MnO_2; **Chromium oxidants** - Chromic acid, PCC, PDC, Collins & Jones reagent; Peracids and Peroxides; **Miscellaneous oxidants** – Oxygen, Ozone, Lead tetra-acetate, Selenium dioxide, OsO_4, Periodic acid, Silver Carbonate (Fetizons reagent), Thallium nitrate, Woodward and Prevost reagents.

Unit-II

Reduction reagents: Principle, reactions and mechanism of following reducing agents: PtO_2 (Adam's catalyst), $Pd/CaCO_3$ (Lindlar's catalyst), $Pd/BaSO_4$, Raney Ni, $NaBH_4/CeCl_3$ (Luche reagent), $NaBH_3CN$, $NaBH(OAc)_3$, $LiAlH(OR)_3$, $LiBH_4$, DIBAL-H, Sodium-liquid ammonia, Sodium alcohol, Zinc hydrochloricacid, hydrazine, diimide, silanes, stannous chloride.

Unit-III

Organometallic reagents: Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. Lithium cuprates (Gillman's reagent), organocadmium, organosulphur reagent (1,3-dithiane), organosilicon reagent (trimethylsilyliodide TMSI), organoiodines, organotin(tributyltin hydride TBTH), organozirconium (Swartz reagent), Organotitanium (Tebbe olefination).

Unit-IV

Other reagents in organic synthesis: Principle, preparations, properties and applications of the following in organic synthesis with mechanistic detail- DDQ, DCC, IBX, NBS, LDA, DABCO, TEMPO. Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi and Sonogashira.

Course Outcomes:

CO1 To understand the principle, reactions and mechanism of different oxidizing agents.
CO2 To be able to know Manganese oxidants, Chromium oxidants and Miscellaneous oxidants including Thallium nitrate, Woodward and Prevost reagents.
CO3 To understand the principle, reactions and mechanism of reducing agents like PtO_2 (Adam's catalyst), $Pd/CaCO_3$ (Lindlar's catalyst), $Pd/BaSO_4$, Raney Ni, $NaBH_4/CeCl_3$ (Luche reagent), $NaBH_3CN$, $NaBH(OAc)_3$, $LiAlH(OR)_3$, $LiBH_4$, DIBAL-H.
CO5 To know the applications of Sodium-liquid ammonia, Sodium alcohol, Zinc hydrochloricacid, hydrazine, diimide, silanes, stannous chloride.
CO4 To know about the role of various Organometallic Reagents of Li, Cd, Cu, Zr, S, Si, I, Sn, Pd, Cr and Ti compounds in organic synthesis along with their preparations, properties and applications of these reagents with mechanistic details.
CO5 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
CO6 To learn about applications of DDQ, DCC, IBX, NBS, LDA, DABCO, TEMPO.
CO7 To understand the general pathways of reduction reactions. Reduction of Hydrocarbons – alkanes, alkenes, alkynes, substituted and unsubstituted aromatic rings.
CO8 To be able to understand the metal mediated C-C and C-X coupling reactions like Heck, Stille, Suzuki, Negishi and Sonogashira.

Mapping of Paper No. CHE-304(c)

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	S	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	S	S	S	S	S	S	S	S	S
CO 5	S	S	M	S	M	S	M	S	S	S	M	S	S	S	S
CO 6	S	S	M	S	M	S	S	S	S	S	M	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

Suggested Readings:

1. Morrison, R.T& Boyd R.N., *Organic Chemistry*,Pearson,6thEdition(1992).

2. W., *Modern Methods of Organic* Carruthers *Synthesis*, Cambridge University Press,(1996).
3. Turro, N.J., *Modern Molecular Photo chemistry*, University Science Books (1991).
4. Coxan, J. M. & Halton, B., *Organic Photochemistry*, Cambridge University Press(1987).
5. Gilbert, A. & Baggot, J., *Essentials of Molecular Photochemistry*, CRC Press (1991).
6. Griesbeck, A. G., Oelgemoller, M., Ghetti, F., *CRCH and book of Organic Photo chemistry and Photobiology*, CRC Press (2012).
7. Cary, F. A. & Sundberg, R. I., *Advanced Organic Chemistry*, *Part A and B*, Springer, 5th Edition(2009).
8. March, J., Smith, M. B., *March's Advanced Organic Chemistry Reactions, Mechanisms & Structure*, Wiley, 6thEdition (2007).
9. Warren, S., *Organic Synthesis, The disconnection Approach*, John Wiley &Sons, 2004.
10. Tsuji, J., *Palladium Reagents and Catalysts, New Perspectives for the 21st Century*, John Wiley &Sons(2003).
11. Ojima, I., *Catalytic Asymmetric Synthesis*,Wiley−VCH,NewYork,2ndedition(2000).
12. Carruthers,W., *Modern Methods of Organic Synthesis*, Cambridge University Press, (1996).
13. Noyori, R., *Asymmetric Catalysis in Organic Synthesis*, John Wiley &Sons(1994).

M.Sc.- Chemistry
Semester-III

CHE-306 (a) Practical- I
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To gain knowledge about various techniques for the characterization of inorganic and coordination compounds through hands- on - practice.*

1. Synthesis of inorganic complexes/compounds, their characterization and interpretation by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.
(i) Metal acetylacetonates- eg. VO $(acac)_2$, $Mn(acac)_3$, $Cr(acac)_3$. *Inorg. Synth. 1957, 5, 130; 1963, 1, 183.*
(ii) Preparation of Ferrocene, *J. Chem. Educ. 1966, 43, 73; 1976, 53, 730.*
(iii) Preparation of triphenyl phosphene Ph_3P, and its transition metal complexes.
(iv) $[Co(NH_3)_5Cl]Cl_2$; $[Co(NH_3)_5NO_2]Cl_2$; $[Co(NH_3)_5ONO]Cl_2$
(v) Reaction of Cr(III) with multidentate ligands, a kinetics experiment. *J. Am. Chem. Soc*., 1953,**75**, 5670.
(vi) $Ni(dmg)_2$, $[Ni(en)_3]S_2O_3$, $[Ni(NH_3)_6]Cl_2$
(vii) Metal complexes of dimethyl sulfoxide (IR): $CuCl_2$.2DMSO, $RuCl_2$.4DMSO *J.Chem. Educ.*, 1982, 59, 57.
(viii) Synthesis and thermal analysis of group II metal oxalate hydrates.
(ix) Preparation of copper glycine complex-cis and trans bis (glycinato Cu(II); *J. Chem. Soc. Dalton* 1979, 1901; *J.Chem Edu.* 1982,59, 1052.
(x) Other new novel synthesis reported in literature from time to time

2. Instrumentation
(i) pH –metry –Composition of mixture of strong and weak acids, pKa value of organic acids.
(ii) Determination of concentration of sulphate ions in the given solution by Turbidimetry.
(iii) Determination of composition of metal ion complexes by colorimeter.

2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

Course Outcomes:

CO1 To demonstrate the synthesis of selected inorganic compounds.
CO2 Able to interpret the structure of synthesized inorganic complexes by various spectroscopictechniques.
CO3 To determine the composition of metal ion complexes by colorimeter.
CO4 To Determine the concentration of sulphate ions in the given solution by Turbidimetry.
CO5 To find out the Composition of mixture of strong and weak acids, pKa value of organic acids by PH- metery.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-306(a)

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	S	S	S	S	S	M	S	S	M	M
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	M	M	S	S	S	S
CO6	S	S	S	M	S	M	S	S	S	S	S	S	M	S	S
CO7	M	S	S	S	S	S	S	S	M	S	S	S	S	S	M
CO8	S	S	M	S	M	S	S	S	S	M	M	S	S	M	M

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-III

CHE-307 (a) Practical- II
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To enable students, analyze and characterize the inorganic samples with the knowledge of chromatography and volumetric titration.*

1. Estimation and Separation Processes
(i) Separation of cations and Anions by Column Chromatography- Ion exchange
(ii) Paper and Thin Layer Chromatography: For Identification of metal cations and complexes.
(iii) Solvent Extractions - Metal ion separation. Effect of pH, solvent, time.
iv) Argentometry titration
(v) Identification of Inorganic compounds using spectroscopic methods (IR, UV, NMR, Mass, TGA & DTA).
2. Instrumentation
(i) Estimation of metal ions by Atomic Absorption Spectrophotometry.
(ii) Determination of pK value of an indicator Spectrophotometrically.
(iii) Conductometrically –Composition of mixture of weak and strong acids, precipitation and displacement titrations.

2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

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 the conductometric titrations.
CO4 Understand the concept of Solvent Extractions.
CO5 To explain the fundamentals of paper and thin layer chromatography.
CO6 Learn to perform experimentation and evaluation of the results.

CO7 Develop the ability to compile interpreted information in the form of lab record.
CO8 Develop the ability to express during Viva -Voce.

Mapping of Paper No. CHE-307(a)

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	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M
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	M	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	M	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

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-III

CHE-308 (a) Practical- III
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To train students to prepare samples of various coordination complexes and perform redox titrations.*

1. Redox Titrations.
2. Synthesis of inorganic complexes/compounds, their characterization and interpretation by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.

   Silver metal nanoparticles

   Tris(acetylacetonato)chromium(III)

   Sodium Cobaltinitrite

   Potassium Chromithiocynate

   Sodium Ferrioxalate

   Ammonium hexachlorostannate

   Dichlorotetra pyridine iron(II)
   Sodium polyacrylate
   Potash Alum
   Chrome Alum
3. Viva-Voce (05 Marks)
4. Note Book (05 Marks)

Course Outcomes:

CO1 To know about the basic concept of titrations and its utilization in the quantitative analysis of metal ions.
CO2 To demonstrate the synthesis of selected inorganic compounds.
CO3 Able to interpret the structure of synthesized inorganic complexes by various spectroscopic techniques.

CO4 To prepare silver metal nanoparticle.
CO5 To perform redox titration.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-308(a)

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

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
2. Inorganic Preparations: W. G. Palmer.
3. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
4. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-III

CHE-306 (b) Practical-I
Physical Chemistry

Max.Marks:50
Time:6 hrs

Course Objective: *To provide students exposure of ultrasonic interferometry, Flame Photometry, potentiometry and conductometry experiments. Advanced experiments such as ultrasonic interferometry and conductometry will be carried out. First-hand experience of Flame Photometric studies will be provided.*

1. Conductometry

(i) Determine the strength of acetic acid by titrating it against ammonium hydroxide.
(ii) Ba $(NO_3)_2$ vs. Na_2SO_4titration.
(iii) (HCl+ CH_3COOH+$CuSO_4$) mixture vs. NaOH.

2.Potentiometry

(i) Determination of solubility and solubility product of sparingly soluble salts ($BaSO_4$) and AgCl.
(ii) Determination of degree of hydrolysis of aniline hydro chloride.
(iii) Determine the dissociation constant of weak acid.
(iv) Determination of strength of HCl and CH_3COOH in a mixture using NaOH.

3.Ultrasonic Interferometry

(i) Determination of speed of sound for various liquids.
(ii) Determination of speed of sound of mixtures using interferometer.

4.Flame Photometry

(i) To determine the concentration of Na^+, Li^+, Ca^{++}ions in the given solution.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)
Note-Book : (05 Marks)

Course Outcomes:

CO1 To determine strength of acids and combination of acids by titrating it against alkalis using conductometer
CO2 To apply the technique of Potentiometry to determine the degree of hydrolysis of aniline hydrochloride and determine the dissociation constant of weak acid.
CO 3 To describe the functioning and application of ultrasonic interferometer.
CO 4 To determine speed of sound of mixtures using interferometer.
CO 5 To apply flame photometry technique in determining concentration of various ions in liquids.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-306(b)

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	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	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker.
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.

8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc.- Chemistry
Semester-III

CHE-307(b) Practical-II
Physical Chemistry

Max.Marks:50
Time:6 hrs.

Course Objective: *To provide students exposure of refractometry, colorimetry, viscometry and pH-metry experiments. Advanced experiments such as pH metry and colorimetry will be carried out.*

1.Colorimeter

(i) Verify Lambert Beer's Law and
(ii) Determine the concentration of $KMnO_4/K_2Cr_2O_7$ in a given solution calorimetrically.

2.pHmetry

(i) HCl vs. NH_4OH
(ii) CH_3COOH vs. NH_4OH
(iii) Determine the dissociation constant of weak acid.
(iv) Determine the strength of ammonia solution by titrating it against acid.

3.Refractometer

(i) To determine percentage composition of liquids in the given binary mixture.
(ii) To determine the molar refraction of homologues methyl, ethyl and propyl alcohol. Show the constancy contribution to the molar refraction of $-CH_2$ group.

4.Viscometry

(i) To study the variation of co-efficient of viscosity with different composition of given liquid (like sucrose solution) using Ostwald's Viscometer.
(ii) To determine the percentage Composition of a binary mixture (non-interacting mixture) by viscosity method (benzene and toluene).
(iii) To determine the relative and absolute viscosity of given liquid using Ostwald' Viscometer.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)
Note-Book : (05 Marks)

Course Outcomes:

CO1 To apply the technique of spectrophotometry for Verifying Lambert-Beer's law and determining composition of various mixtures.
CO2 To apply pH-metry in performing acid-base titrations.
CO3 To apply pH-metry in determining degree of hydrolysis.
CO4 To determine the refractive index of various organic solvents and percentage composition of liquids in the given binary mixture.
CO5 To describe the functioning and application of ultrasonic interferometer.
CO6 To determine the percentage composition of a binary mixture and relative and absolute viscosity of given liquid using viscometer.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce

Mapping of Paper No.CHE-307(b)

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	M	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	S	S	S	S	S	M	S	S
CO7	S	S	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker.
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc.- Chemistry
Semester-III

CHE-308(b) Practical-III
Physical Chemistry

Max.Marks:50
Time:6 hrs.

Course Objective: *To provide students exposure of chemical kinetics , polarimetry and nanotechnology experiments. Advanced experiments such as sol-gel, co-precipitation method will be carried out. First-hand experience of nanotechnology will be provided. At the end of this course students will be equipped to carry out instrumental analysis at the research level.*

1. **Polarimetry**
   - (i) Determination of the specific and molecular rotation of sucrose or glucose at a number of concentrations.
   - (ii) Estimation of concentration of optical active substance in the given solution.
   - (iii) Determination of rate constant for hydrolysis/inversion of sugar

2. **Thermochemistry**
   - (i) Determination of heat of neutralization
     - (a) NaOH vs. HCl
     - (b) NaOH vs.CH_3COOH
   - (ii) Determination of enthalpy of solution of Calcium chloride.

3. **Chemical Kinetics**
   - (i) Compare the relative strength of acids.
   - (ii) To determine the temperature coefficient for 1^{st} order reaction.

4. **Synthesis of nanoparticles**
   - (i) Synthesize metal nanoparticles by sol-gel method.
   - (ii) Synthesize metal nanoparticles by co-precipitation method.
   - (iii) Synthesize metal nanoparticles by micro emulsion method.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)
Note-Book : (05 Marks)

Course Outcomes:

CO1 To apply the technique of polarimetry for determining specific and molecular rotation of sucrose or glucose
CO2 To apply the technique of polarimetry for determining the percentage of optically active substance in a mixture.
CO3 To determine the heat of neutralization (a) NaOH vs. HCl (b) NaOHvs.CH_3COOH
CO4 To study and conduct experiments related to chemical kinetics for the determination of temperature coefficient of 1^{st} order reaction.
CO5 To Compare the relative strength of acids.
CO6 To Synthesize metal nanoparticles by sol-gel and co-precipitation method
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-308(b)

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	M	S	M	S	S	S	S	S	S	S	S	M	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	M	S	S	S	S	S
CO6	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO7	S	S	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker.
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc. Chemistry
Semester-III

CHE-306(c) Practical-I Max.Marks:50
Organic Chemistry Time: 6 hrs.

Course Objective: *The objective of the practical is to impart basic skills for the chemical separation and identification of binary solid-solid organic mixture. The conformation of the two components by derivative formation and using spectroscopic techniques will also be taught practically.*

1. **Qualitative Analysis**: Separation of components of a binary (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).

(40 marks)

3. Viva-Voce (05Marks)
4. Note Book (05Marks)

Course Outcomes:

CO 1	To understand the basics of qualitaive analysis of functional groups in organic compounds.
CO 2	To have practical experience about separating the solid-solid binary mixture.
CO 3	To know spectroscopic confirmation of the components of binary mixtures using TLC.IR, NMR spectra.
CO 4	To understand the operation of different instruments used in identification of organic compounds.
CO 5	To practice tests to determine the various elements and functional groups present in an organic compound.
CO 6	To evaluate, compile and present and explain the results.
CO 7	To develop the ability to compile interpreted information in the form of lab record.
CO 8	To face viva-voce.

Mapping of Paper No. CHE- 306(c)

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	M	M	S	S	S	S
CO2	S	S	M	S	M	S	M	S	S	S	S	S	S	S	S

CO3	S	S	M	S	M	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	S	M	S	M	M	S	S	S	S
CO5	S	S	M	M	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	M	S	S	S	M	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. R.M. Roberts, Gilbert, L.B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston (1969).

2. Vogel,A.I.,*Elementary Practical Organic Chemistry*,Longmans,Green,2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers (2015).
5. Advanced Practical Organic Chemistry, N.K. Vishnoi,2009,Vikas Publishing.

M.Sc. Chemistry
Semester-III

CHE-307(c) Practical- II
Organic Chemistry

Max. Marks: 50
Time:6 hrs.

Course Objective: *To acquire experimental skills important for estimation of various organic compounds.*

1. Estimation of Organic Compounds (40 Marks)
    1. Estimation of glucose
    2. Estimation of phenol by brominating mixture
    3. Estimation of glycine
    4. Estimation of formaldehyde
    5. Estimation of cane-sugar
    6. Estimation of number of acetyl groups
    7. Estimation of saponification value of a fat or oil
    8. Estimation of iodine value of a fat or oil
    9. Any other relevant estimation.

2. Viva-Voce (05Marks)

3. Note Book (05Marks)

Course Outcomes:

CO 1 To analyze and estimate sugars, fats, amino acids in samples.
CO 2 To isolate, and determine enzyme activity.
CO 3 To estimation of number of acetyl groups
CO4 To find out the saponification value of a fat or oil
CO5 To Estimate of iodine value of a fat or oil
CO 6 To evaluate, compile and present and explain the results.
CO 7 To develop the ability to compile interpreted information in the form of lab record.
CO 8 To face viva-voce.

Mapping of Paper No. CHE-307(c)

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
CO5	S	S	M	S	S	S	M	M	S	S	S	S	S	S	S
CO6	S	S	S	S	S	S	M	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	M	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry,* Holt, Ranehartand Winston Inc., J. C NewYork (1969).
2. Vogel, A.I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition (1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry,* The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry,* Pragati Prakashan Educational Publishers (2015).
5. Vishnoi N. K., *Advanced Practical Organic Chemistry,* Vikas Publishing(2009)

M.Sc. Chemistry
Semester-III

CHE-308(c) Practical-III
Organic Chemistry

Max. Marks: 50
Time:6 hrs

Course Objective: *To acquire practical training of colorimetric determination of important organic compounds like Carbohydrates, Ascorbic acid, Amino acids, Proteins, Cholesterol and Urea.*

1. **Colorimetric determination of the following:** (40 Marks)
    a. Carbohydrates
    b. Ascorbic acid
    c. Amino acids
    d. Proteins
    e. Cholesterol
    f. Urea

5. Viva-Voce (05 Marks)
6. Note Book (05 Marks)

Course Outcomes:

CO1 To quantitatively estimate carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea colorimetrically.
CO2 To quantitatively estimate proteins, cholesterol, urea colorimetrically.
CO3 To purify natural products from raw material.
CO4 To perform experimentation, evaluation, compilation and presentation of results.
CO5 Skill development to explain the results.
CO6 To gain the instrumental knowledge.
CO7 To develop the ability to compile interpreted information in the form of lab record.

CO8 To face viva-voce.

Mapping of Paper No. CHE-308(c)

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	M	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	M	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	M	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

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

M.Sc. Chemistry
Semester-IV

CHE 401(a): Inorganic Chemistry Special-II

Chemistry of Main Group Elements

Maximum Marks:100
Theory Examination:80
InternalAssessment:20
Max. Time: 3hrs**.**

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *The objective of the course is to explain VESPER theory, Walsh diagrams, hybridization in various metal ligand Complexes, Nobel gas and boron compounds, application of carbon nanotubes and compounds of carbon, silicon, nitrogen, selenides, tellurides, oxygen and halogen group elements*

Unit-I

Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory, Walsh diagrams (tri- atomic molecules), Hybridization including energetics of hybridization, dπ-pπ bonds, Bent rule and energetics of hybridization, Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen-(i) Atomic inversion (ii) Bery pseudo rotation (iii) Nucleophilic displacement (iv) Free radical mechanism.

Unit-II

Hydrogen, alkali and alkaline earth metals: Classification of hydrides - e-deficient, e-precise & e-rich hydrides, Application of crown ethers in extraction of alkali and alkaline earth metals.
Noble gases: Isolation and properties. Preparation and structure of noble gas compounds
Boron compounds: Preparation, structure, bonding, reactions and applications of boron halides, phosphine boranes, boron heterocycles, borazines.

Unit-III

Compounds of carbon and silicon: Fullerenes and their compounds, Intercalation compounds of graphite, Synthesis, structure, properties, and applications of carbon nano-tubes, Carbides, fluorocarbons, silanes, silicon halides, silicates, aluminosilicates and silicones.

Unit-IV

Compounds of nitrogen group elements: Nitrogen activation. Oxidation states of nitrogen and their interconversion. Preparation, structure and bonding of Oxyacids of Phosphorous, Phosphazenes.
Compounds of oxygen group elements: Metal selenides, tellurides, oxoacids of Sulphur, Structural features and reactivity of SN heterocycles
Compounds of halogen group elements: Synthesis, properties, and applications of interhalogens, pseudohalogens, oxyacids of halogens.

Course Outcomes:

CO1 To explain VESPER theory, walsh diagram and hybridization in various metal ligand complexes.
CO2 To introduce the preparation, properties and structure of Nobel gases compound and boron compounds.
CO3 To instruct about application of carbon nanotube.
CO4 To impart knowledge of compound of carbon, silicon, nitrogen, selenides, tellurides, oxygen and halogen group elements.
CO5 To discuss Application of crown ethers in extraction of alkali and alkaline earth metals.
CO6 To explain Preparation, structure and bonding of Oxyacids of Phosphorous, Phosphazenes.
CO7 To discuss reactivity of SN heterocycles Compounds of halogen group elements.
CO8 To explain classification of hydrides - e-deficient, e-precise & e-rich hydrides.

Mapping of Paper No. CHE-401(a)

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	M
CO2	S	S	S	S	S	S	S	S	S	S	M	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	S	S	S	S	M	S	S	S	S
CO5	S	S	S	M	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	M	S	S	S	S	S	S	M	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M

S = Strong, M = Medium, W = Weak

Suggested readings:

1. D.F.Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, Oxford Univ.Press,1998
2. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry: Principle of StructureandReactivity, Pearson Education,2004.
3. F.A. Carey, G. Wilkinson, C.A. Murillo and M. Bochman, Advanced Inorganic Chemistry, Wiley Interscience,2003.
4. C.E. Housecroft and A.G. Sharpe, Inorganic Chemistry, Prientice Hall,2005.
5. N.N Greenwood and A. Earnshow, Chemistry of the Elements, Pergamon.

6. W.W. Porterfiels, Inorganic Chemistry: A unified Approach, Elsevier
7. A.G. Sharpe, Inorganic Chemistry, Pearson Education Ltd.
8. G. L. Miessler and D.A Tarr, Inorganic Chemistry, Pearson Publications.
9. G. Wulfsberg, Inorganic Chemistry, , University Science Books, Viva Book

M.Sc.- Chemistry
Semester-IV

CHE 402(a): Inorganic Chemistry Special-III
Organotransition Metal Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *The purpose of the course is to impart fundamental understanding of organometallic compounds, reactions of various organometallics and their usefulness.*

Unit-I

Types of M-C bonds: Alkenes and Alkynes as ligands-synthesis, bonding and important reactions of metal bound alkenes and alkynes, concept of Umploung; 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,

Unit-II

Transition Metal π–Complexes: allyl, dienyl, arene and trienyl complexes, preparation, properties and nature of bonding and structural features. Important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis. Transition Metal Compounds with Bonds to Hydrogen
Davis-Green- Mingos (DGM) rules; 1HNMR and 13C Spectra of organometallic compounds.

Unit-III

Organometallic Reagents: Principle, preparations, properties and applications of the reagents of metals/metalloids/ non-metals with mechanistic details: Li, Mg, B, Si, S, I, Ti, Cr,

Unit-IV

Organometallic Reagents: Principle, preparations, properties and applications of the reagents of metals/metalloids/ non-metals with mechanistic details Fe, Co, Ni, Cu, Zn,Rh, Pd, Cd.

Course Outcome:

CO1 To explain the use of organocopper compounds in organic synthesis.
CO2 To explain the structure and bonding of T. M. carbene complexes.
CO3 To introduce with structure and bonding of T. M. carbyne complexes, Allyl, dieny and arene complexes.
CO4 To introduce with organometallic reagents**.**
CO5 To be able to understand the Davis-Green- Mingos (DGM) rules; 1HNMR and 13C Spectra of organometallic compounds.
CO6 To discuss Principle, preparations, properties of organometallic reagents.
CO7 To Know the classification of transition metal pi complexes, their synthesis, structural characteristics and their important reactions.
CO8 To Understand the structural characteristics, nucleophilic and electrophilic reactions of transition metal – carbon multiple bonds.

Mapping of Paper No. CHE-402(a)

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	M	S	S	S	S
CO 3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 4	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 6	S	S	S	S	S	S	S	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	S	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

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

M.Sc.- Chemistry
Semester-IV

CHE 403(a): Inorganic Chemistry Special-IV
Solid State Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max. Time: 3 hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *The course focuses on fundamental understanding of crystal structure of some binary and ternary compounds, solid state lasers, inorganic phosphor materials and principle of electron microscopy.*

Unit-I

Solid State Structure: Primitive lattice vectors - reciprocal lattice - crystal systems and desymmetrization schemes. Bravais lattices; closed packed structures, octahedral and tetrahedral holes, Crystal structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, crystobalite, layerlattices- CdI_2, corundum, pervoskite, Ilmenite and Calcite, Normal and inversespinels.

Unit-II

Defects and Non-stoichiometry: Intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry 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, pnjunctions, superconductors, Optical and Magnetic properties.

Unit-III

Solid State Lasers (Ruby, YAG and tunable lasers): Inorganic phosphor materials; Synthesis and advantages of optical fibres over conducting fibres. Diffusion in solids, catalysis and Zone refining of metals. Preparation of nanomaterials and their characteristic differences overbulk materials. Principles of Electron Microscopy, Dynamic Light Scattering and characterization of nanomaterials.

Unit-IV

Symmetry elements in crystals, criteria for determining unit cell of lattice, Bragg condition, Millerindices for plane, space lattices, space groups. Bragg method, Laue method, Debye-Scherrer method of X-ray structural analysis of crystals, identification of unit cells from systematic absences in diffraction pattern. Structure factor calculations for primitive, body-centered and face centered unit cells. Various techniques for nanomaterial

synthesis(Hydrothermal, solvothermal, solgel, precipitation, reverse micelle synthesis, application of nanoscience and nanotechnology in various field.

Course Outcomes:

CO1 To know about crystal structure of some binary and ternary compounds.
CO2 To learn about the primitive lattice vectors and reciprocal lattice.
CO3 To explain about Electronic structure of solids and their optical and magnetic properties.
CO4 To discuss about solid state lasers, inorganic phosphor materials and principle of electron microscopy.
CO5 To learn about Symmetry elements in crystals, criteria for determining unit cell of lattice.
CO6 To explain about Bragg condition, Miller indices for plane, Bragg method, Laue method, Debye-Scherrer method of X-ray structural analysis of crystals.
CO7 To learn about the synthesis, applications of nanoscience and nanotechnology in various fields.
CO8 To discuss about synthesis and advantages of optical fibres over conducting fibres.

Mapping of Paper No. CHE-403(a)

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	M	S	S	S	S
CO 2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M
CO 3	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO 4	S	S	S	S	S	S	S	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	S	S	S	S	S	S	S	S	S
CO 7	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO 8	S	S	S	S	S	S	M	S	S	S	M	S	S	S	M

S = Strong, M = Medium, W = Weak

Suggested readings:

1. H.V. Keer, Principles of the Solid State, Wiley Eastern Ltd. New Delhi (1993).
2. A.R. West, Solid State Chemistry and its Applications, John Wiley & Sons New York (2005).
3. N. Hannay, Treatise on Solid State Chemistry, Plenum (1976).
4. A.K. Cheetham and P. Day, Solid State Chemistry Techniques, Clarendon Press, Oxford (1987)
5. G. Timp, Nanotechnology Springer-Verlag , New York. (1999).

6. N.N. Greenwood, Ionic crystals, lattice defects and non-stoichiometry,.
7. Material Science and Engineering. An Introduction, W.D. Callister, Wiley, New York (1985).
8. E. Moore and L. Smart, Solid State Chemistry: An Introduction 2nd Ed. Chapman & Hall (1996)
9. L. Smart, E. Moore, Solid State Chemistry (3rd Ed), Taylor & Francis (2005).
10. W. Massa, Crystal Structure Determination 2nd Ed. Springer (2004).
11. B.E. Warren, X-Ray Diffraction 1st Ed. Dover Publications (1990).
12. D. E. Sands, Introduction to Crystallography Reprint Dover Publications (1994).
13. M. Ladd and R. Palmer Structure Determination by X-ray Crystallography.
14. McKie and McKie, Essentials of Crystallography, Blackwell Scientific Publications, (1986).

M.Sc. - Chemistry
Semester-IV

CHE 401(b): Physical Chemistry Special-II
Statistical Thermodynamics and Advanced Electrochemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *To provide students with an understanding of advanced physical chemistry like statistical thermodynamics, Electrodics, Corrosion of metals and their alloys. . This course will strengthen the essentials of Physical Chemistry, statistical thermodynamics, and Corrosion.*

Unit-I

Statistical Thermodynamics (I): Partition function and factorization of partition function, Translational partition function and calculation of absolute entropy of an ideal monoatomic gas – Sackur - Tetrode equation. Separation of internal partition functions for diatomic molecule, Rotational & vibrational energy, and entropy due to internal degrees of freedom. Calculation of various thermodynamic properties.

Unit-II

Statistical Thermodynamics (II): Partition function and equilibrium constant, Einstein theory and Debye theory of heat capacities of monatomic solids, Microcanonical, canonical, and grand canonical ensembles. Transport Phenomenon: Diffusion coefficients, Fick's first and second laws, Einstein relation, Nernst-Einstein equation, Stokes-Einstein equation.

Unit-III

Corrosion: Forms of Corrosion, Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion-corrosion, microbial induced corrosion, filiform corrosion, and exfoliation.

Unit-IV

Chemical Electrodics: Rate of charge- transfer reactions under zero field, under the influence of an electric field, the equilibrium exchange current density, non-equilibrium drift-current density (Butler-Volmer) equation, Some general and special cases of Butler -Volmer equation, high-field and low-field approximations, Butler-Volmer equation, Tafel equation, Polarizable and non-polarizable interfaces.

Course Outcomes:

CO1 To introduce about Partition function its factorization and Separation of internal partition functions for diatomic molecules.
CO2 To know the Calculation of various thermodynamic properties
CO3 To understand Einstein's theory Fick's first and second laws, and types of ensembles.
CO4 To understand Einstein's theory and Debye's theory of heat capacities of monatomic solids.
CO5 To describe the galvanic corrosion, pitting corrosion and crevice corrosion
CO6 To discuss hydrogen embrittlement, erosion-corrosion, microbial induced corrosion
CO7 To discuss Some general and special cases of Butler-Volmer equation, the high-field and low-field approximations
CO8 To describe Polarizable and non-polarizable interfaces.

Mapping of Paper No. CHE-401(b)

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	M	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	M	S	S	M	S	M	M	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	M	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	M	S	S	M	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Electrochemistry, S. Glasstone, Affiliated East -West Press
2. Physical Chemistry, G.W. Castellan, Narosa.
3. Electrochemical Methods : Fundamentals and applications, 2nd Ed., A.J. Bard and L. R. Faukner John Wiley & Sons : New York, 2002.
4. Modern Electrochemistry 1 : Ionics 2nd Ed., Springer (1998), J.O. M. Bockris & A.K. Reddy.
5. Modern Electrochemistry 2B: Electrodics in Chemistry, Enginnering, Biology and Environmental Science 2nd Ed., Springer (2001), J.O. M. Bockris & A.K. Reddy.
6. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O. M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.

7. Introduction to Statistical Thermodynamics Zwanzig, R., H. Dole.
8. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.
9. Thermodynamics, Lewis and Randall. 6. Chemical Physics, J.C. Slater
10. Thermodynamics & Introduction to Thermostastics by Callen H B
11. Physical Chemistry by Levine Ira N., Tata McGraw Hill
12. Physical Chemistry by Atkins P.W and Paula J. De, W.H. Freeman
13. Thermodynamics for chemists by Glasstone S.
14. Principles of Equilibrium Thermodynamics by Denbigh K G
15. McQuarrie, D. A. Statistical Mechanics

M.Sc.- Chemistry
Semester-IV

CHE 402(b): Physical Chemistry Special-III
Fast Kinetics & Surface Phenomenon

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *The course is intended for the understanding of advanced physical chemistry like Fast Reactions, unimolecular reactions, and chemistry of surfactant and chemical dynamics.*

Unit-I

Adsorption: Introduction, Physical adsorption & Chemisorption, Freundlich Adsorption isotherm, Langmuir Theory of adsorption, BET theory of multilayer adsorption, BET equation, Determination of surface area of the adsorbent, Gibb's adsorption equation.

Unit –II

Surface Chemistry: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), surface films on liquids (electro kinetic phenomenon).
Surface active agents: General features, structure & classification, micellization, mass action model and phase separation model, hydrophobic interactions, critical micelle concentration (CMC), factors affecting CMC of surfactants, thermodynamics of micelle formation, counter ion binding to micelles, reverse micelles.

Unit-III

Chemical Dynamics: Theory of absolute reaction rates, potential energy surfaces, activation energies, London-Eyring-Polanyi method for the calculation of energy of activation, Theories of unimolecular reactions: R.R.K. and R.R.K.M. theories.

Unit-IV

Fast Reactions: Steady-state kinetics of chain reaction such as (pyrolysis of acetaldehyde, decomposition of ethane), photochemical (H_2-Cl_2) reactions & oscillatory reactions (Belousov-Zhabotinsky reaction).

Relaxation methods for fast reactions: general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis, and NMR method.

Course Outcomes:

CO1 To discuss the Langmuir adsorption isotherm and its kinetic derivation .
CO2 To discuss the BET theory of multilayer adsorption and determination of surface area of the adsorbent
CO3 To describe capillary action, pressure difference across a curved surface.
CO4 To discuss critical micellar concentration (CMC), factors affecting CMC of surfactants
CO5 To know about the Rice-Ramsperger-Kassel (RRK) theory of unimolecular reactions and Marcusextension (RRKM) of RRK theory.
CO6 To be able to explain the London-Eyring-Polanyi method of calculation of the energy of activation.
CO7 To Steady the kinetics of chain reaction .
CO8 To know about the techniques of studying fast reactions i.e., flash photolysis, flow methods, relaxation techniques and shock tubetechnique.

Mapping of Paper No.CHE-402(b)

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	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	M	S	S	S	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	S	S	S	S	S	S	S	S	S	S	S
CO8	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Micelles, Theoretical and Applied Aspects,V.Moroi, Plenum.
2. Chemical Kinetics, K.J. Laidler, McGraw Hill
3. Theories of Chemical Reaction Rates, K.J. Laidler, McGraw Hill.
4. Theory of Rate Processes, S. Glasstone, K.J. Laidler and H. Eyring, McGraw Hill.
5. Reaction Kinetics Oxford Press (1997), M. J. Pilling and P. W. Seakins.

M.Sc. - Chemistry
Semester-IV

CHE 403(b): Physical Chemistry Special-IV
Polymer chemistry, Photochemistry and Solid-state Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20 Max.
Time: 3 hrs.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Course Objective: *The objective is to provide students with an understanding of advanced physical chemistry like polymer chemistry, Photochemistry, and solid-state chemistry.*

Unit-I

Macromolecules: Basics of Polymers and Polymerization, 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.

Unit-II

Molecular mass of Polymers: Concept of number average and mass average molecular weights, Methods of determination of molecular weights (1) viscometry (2) osmometry (3) sedimentation (4) Light Scattering methods (5) GPC method.

Unit-III

Solid-state Chemistry: Introduction: unit cell its classifications, lattice, lattice planes, Weiss indices, miller indices, d spacing formulae, interfacial angle, some ionic solid structures:- rock salt, zinc blende or sphalerite, fluorite, antifluorite, wurtzite, cesium chloride, rutile structure, perovskite, carbide(CaC_2).
Electronic structure of solids– Band theory, Superconductivity, Theory of insulators, semiconductors, and metals.

Unit-IV

Photochemistry: Laws of photochemistry: (Grothus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency, singlet and triplet state, Jablonski diagram, photophysical processes: (radiative and non-radiative) fluorescence, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time, Kinetics of quenching: Stern Volmer equation.

Course Outcomes:

CO1 To understand the Basics of Polymers and Polymerization and applications.
CO2 To understand the Mechanism and Kinetics of step-growth polymerization and chain-growth polymerization.
CO3 To understand the Concept of number average and mass average molecular weights.
CO4 To explain molecular weight determination of polymers using osmotic pressure, sedimentation, light scattering, and gel permeation chromatography.
CO5 To explain some ionic solid structures like rutile structure, perovskite, carbide(CaC_2)etc.
CO6 To understand the Superconductivity, Theory of insulators, semiconductors, and metals.
CO7 To know about basic concepts of photochemistry viz photochemical laws, quantum yield, electronically excited states, lifetime – measurements.
CO8 To study the Kinetics of photophysical processes and Kinetics of quenching: Stern Volmer equation.

Mapping of Paper No.CHE-403(b)

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	M	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	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	M	S	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
CO7	S	S	S	S	S	S	M	S	S	S	S	S	S	M	S
CO8	S	S	S	S	S	S	M	S	S	S	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Principles of solid state, Keer H.V., Wiley Eastern

2. Solid state chemistry, Chakrabarty D.K., New Wiley Eastern.
3. Solid state chemistry: An introduction, Moore E., and Smart L., Chapman Hall, 1996.
4. Crystallography made crystal clear: A guide for users of macromolecular models, Rhodes G., Elsevier, 2006. 5. X-ray diffraction, Warren B., Dover Publications.
5. The chemical physics of surfaces by Roy S. Morrison, S. Roy, 1990. 5. H.R. Allcock, F.W. Lampe and James Mark, Contemporary Polymer Chemistry, Prentice Hall, Inc. (1990).
6. M.P. Stevens, Polymer Chemistry: An Introduction (2nd Edition) Oxford University Press 91990).
7. F.W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition) Wiley-Inter Science (1984) paperback.
8. A. Ravve, Principles of Polymer Chemistry
9. Handbook of Thermal Analysis and Calorimetry; M. E. Brown.
10.Fundamentals of Photochemistry, K.K. Rohtagi & Mukherjee, Wiley Eastern.
11.Photochemistry, J.G. Calvert and J.N. Pitts, Wiley.
12.Photochemistry and Spectroscopy, J.P. Simons, Wiley Interscience.
13.Principles and Applications of Photochemistry by Brian Wardle.

M.Sc.-Chemistry
Semester-IV

CHE-401 (c): Organic Chemistry Special-II
Bioorganic and Medicinal Chemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective: *The course is aimed to develop the understanding for biomolecules like amino acids, proteins, enzymes, coenzymes, carbohydrates, and fatty acids. The course will also elaborate the concept of lead compounds, prodrugs, soft drugs, drug metabolism, molecular modeling and medicinal uses of important drugs.*

Unit-I

Amino Acids, Peptides and Proteins: Introduction, classification and structure, Isoelectric point with numerical problems. General methods of preparation, Ninhydrin reaction. Peptide bond, protein structure, Chemical and enzymatic hydrolysis of proteins to peptides.
Enzymes: 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 labelling. Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Unit-II

Coenzyme Chemistry: Biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD.
Carbohydrates: Introduction, nomenclature, monosaccharide & their configuration with the determination of the size of sugar rings, basic elementary idea of structure of starch, cellulose, sucrose, maltose.
Fatty Acids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerol phosphor lipids, sphingolipids

Unit-III

Drug Design: Introduction, historical development, factors affecting development of new drugs, concept of lead compounds and its modification.

Concepts of prodrugs and soft drugs; Chemical and physicochemical parameters in drug design. Drug metabolism–introduction, biological transformation like oxidation, reduction, hydrolysis and conjugation. Structure based drug design–introduction and process; Molecular modeling using computers–introduction and uses.

Unit-IV

Introduction, general mode of action, synthesis and medicinal uses of important drugs in the following categories.
Antipyretic analgesics (paracetamol, aspirin), antimalarials (chloroquine, pyrimethamine), antitubercular (Isoniazid, ethambutol), antihelmintic (albendazole, thiabendazole), and sulfa drugs (sulfanilamide, dapsone).

Course Outcomes:

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 andLineweaver-Burk plots and kinetics of reversible and irreversible inhibition.

CO3 To be familiar with mechanisms of enzyme catalyzed reactions, Transition-statetheory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain ordistortion. 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.

CO5 Demonstrate understanding of the basic principles of drug action, design and the terminology involved therein. Apply the knowledge of drug design in developing new drugs using rational approach to drug design.

CO6 Explain synthesis, general mode of action and medicinal uses of listed classes of drugs.

CO7 Describe synthesis, structure elucidation and medicinal uses of penicillins and cephalosporins as cell wall biosynthesis and protein synthesis inhibitors.

CO8 Relate physiological action of enzyme and their classification based on nitrogen heterocyclic ring.

Mapping of Paper No. CHE-401 (c)

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
CO3	S	S	S	S	S	S	S	S	S	M	M	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

CO6	S	S	S	S	M	S	M	S	S	M	M	S	S	S	S
CO7	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S
CO8	S	S	S	M	S	S	M	M	S	S	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Dugas, H., *Bioorganic Chemistry. A Chemical approach to enzyme action*,Springer-Verlag,2nd Edition(1989).
2. Metzler, D.E., *Biochemistry- The Chemical Reactions of a Living Cell*, Academic Press,(1977).
3. Ed.Dugas, H., *Bioorganic Chemistry Frontiers Vol.2*, Springer-Verlag(1990).
4. Lehninger, A.L.et.al., *Lehninger Principles of Biochemistry*, W.H. Freeman(2005).
5. Voet,D.,Voet, J.G.,Pratt, C.W., *Principles of Biochemistry*,Wiley, 3rd Edition(2008).
6. Burger, *Medicinal Chemistry*, Vol. I-III, Wiley Inter science Publications, New York(1995).
7. Foye, W.O., *Principles of Medicinal Chemistry*, Lea & Febiger /Varghese Publishing House,Bombay,3rd Edition(1989).
8. Lednicer, D.& Mitscher, L.A., *The Organic Chemistry of Drug Synthesis*, Vol. IIII, Wiley Inter science(1977).
9. Kar, A., *Medicinal Chemistry*, Wiley Eastern Ltd., New Delhi(1993).
10. Terrett, N.K., *Combinatorial Chemistry*, Oxford Univ. Press, Oxford(1998).
11. Lednicer,D., *Strategies for organic drug synthesis and design*,John Wiley & Sons, New York(2009).

M.Sc.-Chemistry
Semester-IV

CHE-402 (c): Organic Chemistry Special-III
Heterocyclic Chemistry and Disconnection Approach

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective*:* *This paper will provide the knowledge of the chemistry of heterocyclic compounds including heterocycle reactivity, synthesis and chemical reactions of small to large heterocycles. Breakdown of complex molecules into simple building blocks will be learned. A few case studies of total synthesis to understand the actual application of synthetic methods in real life problem solving will also be explained.*

Unit-I

Nomenclature of heterocyclic compounds: Replacement and Systematic (Hantzsch-Widman) nomenclature for monocyclic, fused ring and bridged heterocyclic systems.
Aromatic heterocycles: Classification (structural type) Aromaticity, bond lengths,^{1}H NMR, resonance energy, charge distribution, reactivity, tautomerism.
Non-aromatic heterocycles: Bond angle and torsional strains and their consequences in small ring heterocycles.
Small ring heterocycles: Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, azetidines.

Unit-II

Five membered heterocycles: Methods of synthesis and reactions including mechanism (addition on nitrogen: protonation, N-alkylation, N-acylation; reactions with electrophilic and nucleophilic reagents) of the following five -membered 1,2- and 1,3-heterocycles: pyrazole, isoxazole, isothiazole, imidazole, oxazole, thiazole; their basic character. Reactions with oxidizing and reducing agents.
Six membered heterocycles: Methods of synthesis and reactions including mechanism of the following six-membered heterocycles: purines and pyrimidines

Unit-III

Disconnection Approach: An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, on group C-X disconnections and two-group C-X disconnections, chemo selectivity, cyclisation reactions, amine synthesis.

Protecting Groups: Principles of protection of alcohol, amine, carbonyl and carboxyl groups.

Unit-IV

One Group C-C Disconnections: Alcohols and carbonyl compounds, region selectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two Group C-C Disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, 1,5-difunctionalised compounds. Michael addition and Robinson annelation.

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 inter conversions 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 and practical aspects of chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.

CO4 To know the application of wittig reagents and acetylene for the synthesis of alkenes.

CO5 To understand application of aliphatic nitro compounds in organic synthesis and to learn about different strategies for the synthesis of three, four, five and six membered rings.

CO6 To explore the use of ketenes in organic synthesis.

CO7 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.

CO8 To know the strategy about control in carbonyl condensation and the principles of protection and deprotection approach in synthetic organic chemistry with special reference of alcoholic, amino, carbonyl and carboxylic groups.

Mapping of Paper No. CHE-402 (c)

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	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	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	S	S	S	S	S	S	S	M	S	S	S	S	S
CO8	S	S	M	S	S	S	S	S	M	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Gilchrist, T.L., *Heterocyclic Chemistry*, Prentice Hall(1997).
2. Paquette, L.A., *Principles of Modern Heterocyclic Chemistry*, W.B. Benjamin, Inc. (1978).
3. Joule, J.A. & Mills, K., *Heterocyclic Chemistry*, Wiley, Fifth Edition (2010).
4. Warren, S., *Organic Synthesis, The disconnection Approach*, John Wiley & Sons, 2004.
5. Gupta, R.R., Gupta, V. & Kumar, M., *Heterocyclic chemistry: Volume II: Five-Membered Heterocycles*, Springer(2013).
6. Bansal, R.K., *Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms*, Wiley Eastern Ltd.(1990).
7. Acheson, R.M., *An Introduction to the Chemistry of Heterocyclic Compounds*, Inter science Publishers,2ndEdition(1967).
8. Eicher, T.& Hauptmann, S., *The chemistry of Heterocycles*, Wiley-VCH, Weinheim, (2003).

M.Sc.-Chemistry
Semester-IV

CHE-403(c): Organic Chemistry Special-IV

Chemistry of Natural Products

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Max.Time:3hrs.

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Objective*:* *This paper will provide a basic and advanced knowledge of the chemistry of natural products including structure determination and chemical reactions of alkaloids, terpenoids, steroids. The explanations of biosynthetic pathways are also provided.*

Unit-I

Alkaloids: Definition, nomenclature and physiological action, occurrence and isolation; Structure elucidation of alkaloids– a general account; degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Synthesis of Ephedrine, coniine, Nicotine, Quinine, and Reserpine.

Unit-II

Terpenoids: Classification, general aspects of structure determination of terpenoids, isoprene rule. Synthesis of Citral, menthol, Geraniol, α-terpeneol, α-pinene, camphor.

Carotenoids: General method of structure elucidation and synthesis of β-carotene, Vitamin A and abietic acid.

Unit-III

Steroids: Isolation, nomenclature basic skeleton, Diel's hydrocarbon, stereochemistry, structural elucidation with special reference to Cholesterol; Synthesis of Bile acids, Synthesis of Testosterone from Cholesterol, Synthesis of Progesterone from Cholesterol

Prostaglandins: Introduction, nomenclature and synthesis of PGE2 and PGF22.

Unit-IV

Natural Pigments: Occurrence nomenclature and general methods of structure determinations; Synthesis of Cyanin, Quercetin, myrcetin, hirsutidin and Chrysin.

Course Outcomes:

CO1 Understand the general aspects of natural products including structures, stereochemistry and synthesis of alkaloids like Nicotine, Quinine, and Reserpine

CO2 To understand definition and classification of terpenoids, isoprene and special isoprene rule, general methods of structure elucidation of terpenoids.

CO3 To understand general method of structure elucidation and synthesis of β-carotene,Vitamin A and Abietic acid.

CO4 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.

CO5 To know about steroids and their classification, Isolation and nomenclature, structure elucidation, synthesis and stereochemistry of cholesterol.

CO6 To the understand synthetic pathways of testosterone, progesterone, 5α- and 5β-cholanic acids from Cholesterol.

CO7 To know nomenclature and general methods of structure determinations, isolation and synthesis of Cyanin, Quercetin, and Chrysin

Mapping of Paper CHE-403 (c)

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	M	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	M	S	S	S	M	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	M	S	S	S	S
CO5	S	S	S	S	M	S	M	M	S	M	S	S	S	S	S
CO6	S	S	S	M	M	S	S	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	M	M	S	S	M	S	S	S	S
CO6	S	S	S	M	M	S	S	S	S	M	M	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

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

CHE-404(a) Practical- IV
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective*: To train students to prepare samples of various coordination complexes. Also impart knowledge to analyse compounds through spectroscopic techniques.*

1. Synthesis of inorganic complexes/compounds, their characterization and interpretation by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.
(xi) Cis and trans isomers of $[Co(en)_2Cl_2]Cl$ *J. Chem. Soc.*, 1960, 4369.
(xii) Separation of optical isomers of cis$[Co(en)_2Cl_2]Cl$, *J.Chem Soc*. 1960, 4369.
(xiii) Determination of Cr(III) complexes; $[Cr(H_2O)_6]NO_3.3H_2O$; $[Cr(H_2O)_4Cl_2]Cl.2H_2O$;
$[Cr(en)_3]Cl_3$.
(xiv) Prussian blue
(xv) $Hg[Co(SCN)_4]$
(xvi) $K_3[Fe(C_2O_4)_3]$, $K_3[Al(C_2O_4)_3]$
(xvii) Mixed valence dinuclear complex of Mangenese (III,IV).
(xviii) Preparation of Tin (IV) Iodide and Tin(II) Iodide (Inorganic synthesis 1953, 4, 119).
(xix) Tris(Thiourea) Copper(I) Sulphate. (Estimation of Cu- Iodomedtrically)
(xx) Other new novel synthesis reported in literature from time to time

2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

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 learn preparation of Mixed valence dinuclear complex of Mangenese (III,IV).
CO4 To separate of optical isomers of cis$[Co(en)_2Cl_2]Cl$,

CO5 To perform iodometric titration.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-404(a)

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	S	S	S	S	S	M	S	S	M	M
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	M	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO6	S	S	S	M	S	S	S	S	S	S	S	S	M	S	S
CO7	M	S	S	S	S	M	S	S	M	S	S	S	S	S	M
CO8	S	S	M	S	M	M	S	S	S	M	M	S	S	M	M

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Synthesis and Characterisation of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-IV

CHE-405(a) Practical- V
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To impart knowledge about water analysis through complexometric titration and separation of mixture solution by column chromatography.*

1. Estimation and Separation Processes
(i) Ion Exchange –Cation and Anion Exchange.
(ii) Complexometry –using EDTA and Sequestering agent. Masking and Demasking.
(iii) Column Chromatography
(iv) Polarography- Estimation of Half Wave Potential
(v) Identification of Inorganic compounds using spectroscopic methods (IR, UV, NMR, Mass,TGA &DTA).
(vi) Flame photometric determinations of - sodium and potassium when present together;
lithium/calcium/barium/strontium; calcium and magnesium in tap water.
(vii) Potentiometry- redox titrations, precipitations, simultaneous determination of Halide ions.
(viii) Determination of composition of a complex by pH metry
2. Viva-Voce (05 Marks)
3. Note Book (05 Marks)

Course Outcomes:

CO1 To determine the calcium and magnesium in tap water.
CO2 To separate the mixture solution by column chromatography.
CO3 To perform complexometric titration using EDTA and sequestering agent.
CO4 To introduced with Flame photometric technique.
CO5 To determine composition of a complex by pH metry.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-405(a)

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	M	S	S	S	M
CO3	S	S	S	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	S	S
CO5	S	S	S	S	S	S	S	S	S	S	M	S	S	S	S
CO6	S	S	S	M	S	S	S	S	S	S	S	S	M	S	S
CO7	M	S	S	S	S	S	S	S	M	S	S	S	S	S	M
CO8	S	S	M	S	M	M	S	S	S	M	M	S	S	M	M

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-IV

CHE-406(a) Practical- VI
Inorganic Chemistry

Max. Marks: 50
Time: 6 hrs.

Course Objective: *To train students to prepare samples of various coordination complexes and perform precipitation and neutralization titrations.*

1. Precipitation Titrations.
2. Neutralization Titrations.
3. Synthesis of inorganic complexes/compounds, their characterization and interpretation by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.

   Tris(acetyl-acetonato) manganese (III)

   Tris(acetyl-acetonato) cobaltate (III)

   Lead tetra acetate

   Urea formaldehyde resin

   Cuprous chloride

   Microcosmic salt

   Ferrous Oxalate

   Barium Dithionate

   Tetrammine cupric sulphate

4. Viva-Voce (05 Marks)
5. Note Book (05 Marks)

Course Outcomes:

CO1 To know about the basic concept of titrations and its utilization in the quantitative analysis of metal ions.

CO2 To demonstrate the synthesis of selected inorganic compounds.
CO3 Able to interpret the structure of synthesized inorganic complexes by various spectroscopic techniques.
CO4 To prepare Urea formaldehyde resin.
CO5 To perform precipitation titration.
CO6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-406(a)

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

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
2. Inorganic Preparations: W. G. Palmer.
3. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
4. Inorganic Preparations: a systematic course of preparations by Alexander King, London, T. Murphy

M.Sc.- Chemistry
Semester-IV

CHE-404(b) Practical- IV
Physical Chemistry

Max.Marks:50
Time: 6 hrs

Course Objective: *To provide students exposure of refractometry, Dipolemetry, Colorimetry, and conductometry experiments. First-hand experience of dipolemetric studies will be provided.*

1. **Conductometry**

(i) Determination of solubility and solubility product of sparingly soluble salt (AgCl, $PbSO_4$)
(ii) To determine the molar conductivity of 0.1 M NaCl and verification of Debye-HuckelS-Onsagar (DHO) equation.
(iii) Determination of degree of hydrolysis and hydrolysis constant of aniline hydro-Chloride in aqueous solution.
(iv) To determine the amount of (N/10) $BaCl_2$ present in the given solution by conductometric precipitation titration against (N/10) Na_2SO_4 solution.
(v) To determine the amount of lead present in given solution of lead nitrate by conductometric precipitation titration with Na_2SO_4.

2. **Refractometer**

(i) Determine the refractive index of simple organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
(ii) To verify the law of refraction of mixtures (i.e; glycerol and water) using Abbe's refractometer.

3. **Colorimeter**

(i) Determine the dissociation constant of an indicator.
(ii) To determine the composition of the complex formed between ferric ions and salicylic acid colorimeterically using job's method.

4. **Dipolemetry**

(i) To determine the dielectric constant of various liquids

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)

Note-Book : (05 Marks)

Course Outcomes:

CO1 To apply the conductometry method for Determining solubility of sparingly soluble salts and degree of hydrolysis and hydrolysis constant of aniline hydrochloride in aqueous solution.
CO2 To apply the conductometry method for Determining the amount of (N/10) $BaCl_2$ present in the given solution and amount of lead present in a given solution of lead nitrate .
CO3 To determine refractive index of simple organic liquids.
CO4 To verify the law of refraction of mixtures using Abbe's refractometer.
CO5 To apply the technique of spectrophotometry for Verifying Lambert-Beer's law and determining composition of various mixtures.
CO6 To determine the dielectric constant of various liquids
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No.CHE-404(b)

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	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

9. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
10. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.

11. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.
12. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
13. Experiments in Physical Chemistry, D.P. Shoemaker.
14. Experiments in Physical Chemistry, D.V. Jahagirdhar.
15. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.
16. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc.- Chemistry
Semester-IV

CHE-405 (b) Practical- V
Physical Chemistry

Max.Marks:50
Time: 6 hrs.

Course Objective: *To provide students exposure of polarimetry, chemical kinetics, thermochemistry, and turbidity metry. Advanced experiments such as potentiometry and polarimetry will be carried out.*

1. Thermochemistry

(i) Determination of Heat of hydration of anhydrous Copper sulphate Calorimetrically.
(ii) Construction of phenol-water phase diagram and determination of upper critical solution temperature.

2.Polarimetry

(i) Determination of percentage composition of optical substances in the given binary mixture (Glucose + Fructose or Tartaric acid)
(ii) Determination of intrinsic rotation of a solution of cane sugar.

3.Chemical Kinetics

(i) Determination of activation energy for the hydrolysis of ethyl acetate in presence of acid.
(ii) Study of Iodination of acetone.

4.Turbidimetry

(i) Determine the concentration of sulphate ions in the given solution.

5.Characterization Techniques

(i) Characterization of metal nanoparticles by UV-Visible and FTIR spectroscopy technique.
(ii) Estimate direct and indirect optical energy band gap of metal nanoparticles by UV-visible spectroscopy technique.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)
Note-Book : (05 Marks)

Course Outcomes:

CO1 To determine the Heat of hydration of anhydrous Copper sulphate Calorimetrically.
CO2 To construct the phenol-water phase diagram and determination of upper critical solution temperature
CO3 To describe the functioning and application of polarimeter.
CO4 To apply Turbidimetry to determine the concentration of sulphate ions in the given solution.
CO5 To Characterize metal nanoparticles by UV-Visible and FTIR spectroscopy techniques.
CO6 To apply UV-visible spectroscopy technique in the estimation of the direct and indirect optical energy band gap of metal nanoparticles .
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No.CHE-405(b)

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	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	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.

4. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker.
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc.- Chemistry
Semester-IV

CHE-406 (b) Practical- VI
Physical Chemistry

Max.Marks:50
Time: 6 hrs.

Course Objective: *To provide students exposure of Ph-metry , Spectrophotometry , nephelometry, and chromatography experiments. Advanced experiments such as nephelometry, and chromatography experiments will be carried out.*

1.pH-metry

(i) pK_a and K_a (dissociation constant) of a weak acid by pH metric titration with strong base.

(ii) Determination of the degree of hydrolysis of aniline hydrochloride.

(iii) Determine the Hammett constant of a given substituted benzoic acid by pH measurements.

(iv) Determination of composition of Copper amine complex from $CuSO_4$ vs. NH_4OH.

(v) Preparation of buffer solution of various pH and the determination of their pH values.

(vi) To determine the concentration of a reductant or an oxidant i.e. Ferrous ammonium sulphate, $K_2Cr_2O_7$and $KMnO_4$.

2.Chromatography

(i) To separate a mixture of ortho- and para-nitroanilines by adsorption on an alumina column.

(ii) To differentiate common sugars/amino acids by paper chromatography.

(iii) To check by column or TLC technique the number of components in various inks.

3.Spectrophotometry

(i) Study the influence of pH on the spectrum of potassium dichromate solution.

(ii) Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture by the MLRA method.

(iii) Study the effect of structure on the UV spectra of organic compounds.

4.Nephelometry

(i) Estimate the concentration of sulphate ions in solution and in a sample of tap water by precipitation with barium chloride.

(ii) Estimate chloride ions in a given solution/ water from various sources.

Experiment Marks: 40 Marks
Viva-Voce : (05 Marks)
Note-Book : (05 Marks)

Course Outcomes:

CO1 To apply pH-metry in performing acid-base titrations.
CO2 To apply pH-metry in determining degree of hydrolysis.
CO3 To apply pH-metry in determining buffer solutions and determining their pH values.
CO4 Attain the Skills for analysing and developing new sustainable methods.
CO5 To apply Spectrophotometry in Study the effect of structure on the UV spectra of organic compounds.
CO6 To apply Nephelometry in determining chloride ions in a given solution from various sources.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO8 To face viva-voce.

Mapping of Paper No. CHE-406 (b)

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	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	M	M	S	M	S	S	M	S	M	S	S	S	M
CO8	S	S	S	S	M	S	M	S	M	M	S	S	S	M	S

S = Strong, M = Medium, W = Weak

Suggested Readings:

1. Practical Physical Chemistry, A.M. Jamesand F.E. Prichard, Longman.
2. Findley‘s Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palitand S.K. De, Science.

4. Experimental Physical Chemistry, R.C. Dasand B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker.
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V.Garg and A.Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing.

M.Sc. Chemistry
Semester-IV

CHE-404(c) Practical-IV Max.Marks:50
Organic Chemistry Time: 6 hrs

Course Objective: *To gain the knowledge and skill for isolating and purifying important components from natural sources. To learn the methods to isolate and purify alkaloids, terpenoids, carotenoids and proteins from plant and animal sources.*

1. Isolation of natural products (40 marks)
    a. Isolation of caffeine from tea leaves
    b. Isolation of piperine from black pepper
    c. Isolation of β-carotene from carrots
    d. Isolation of eugenol from cloves
    e. Isolation of casein and lactose from milk
    f. Any other relevant isolation
2. Viva-Voce (05 marks)

3. Note Book (05 marks)

Course Outcomes:

CO1 To know general aspects of extraction of natural products from plant and animal sources.
CO2 To understand specific methods for the extraction and purification of alkaloids/phenols of plant origin.
CO3 To know specific methods for the extraction of terpenoids, carotenoids and milk protein from the natural sources.
CO4 To know the hand-on practice of different apparatus used for the isolation of natural products.
CO5 To analyse the structure of natural product isolated.
CO6 To develop the ability to compile interpreted information in the form of lab record.
CO7 Skill development to explain the results.
CO8 To face viva-voce.

Mapping of Paper No. CHE-404 (c)

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	M	S	S	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	M	S	S	M	S	S	S	M	S	S	M	S
CO5	S	S	S	S	S	S	M	S	S	M	S	S	S	S	S
CO6	S	S	S	S	S	S	M	S	S	M	S	S	S	S	S
CO7	S	S	S	M	S	S	S	S	S	S	M	S	S	M	S
CO8	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

1.Roberts, R. M., Gilbert, J. C., Rodewald, L. B. & Wingrove, A. S., An Introduction to Modern Experimental Organic Chemistry, Holt, Ranehart and Winston Inc., J.C New York (1969).
2.Vogel, A. I., Elementary Practical Organic Chemistry, Longmans, Green, 2nd Edition (1959).
3.Adams, R., Johnson, J. R. & Wilcox, C.F., Laboratory Experiments in Organic Chemistry, The Macmilan Limited, London (1970).
4.Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., Advanced practical chemistry, Pragati Prakashan Educational Publishers (2015).
5.Vishnoi N.K., Advanced Practical Organic Chemistry, Vikas Publishing (2009).

M.Sc. Chemistry
Semester-IV

CHE-405(c) Practical-V Max.Marks:50
Organic Chemistry Time: 6 hrs.

Course Objective: *The objective of the practical is to impart practical knowledge or the chemical separation and identification of binary organic mixture of solid-liquid and liquid-liquid components. The conformation of two components by derivatization and using spectroscopic techniques will also be taught.*

1. Qualitative Analysis: Separation of components of a binary (liquid-liquid, liquid-solid) organic mixture using physical and chemical method. Characterization of these components with the help of physical analysis and derivative formation.
2. Spectroscopic confirmation of the components of binary mixtures by using IR and NMR tools (IR &NMR spectra will be provided).

(40 marks)

3. Viva-Voce (05 marks)
4. Note-Book

(05 marks)

Course Outcomes:

CO 1 To understand the basics of qualitative separation of binary mixture containing solid-liquid and liquid-liquid organic compounds .
CO 2 To know Safe laboratory conduct and good practices.
CO 3 To know spectroscopic confirmation of the components of binary mixtures (liquid-liquid, liquid-solid) using TLC.IR, NMR spectra.
CO 4 To understand the operation of different instruments used in identification of organic compounds.
CO 5 To conformation the identification of two components by derivatization.
CO 6 To evaluate, compile and present and explain the results.
CO 7 To develop the ability to compile interpreted information in the form of lab record.
CO 8 To face viva-voce.

Mapping of Paper No. CHE-405(c)

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	M	M	S	S	S	S

CO2	S	S	M	S	M	S	M	S	S	S	S	S	S	S	S
CO3	S	S	M	S	M	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	M	S	M	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
CO8	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

S = Strong, M = Medium, W = Weak

Suggested readings:

1. Roberts, R. M., Gilbert, J. C.,Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York(1969).
2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition(1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers(2015).
5. Vishnoi N.K., *Advanced Practical Organic Chemistry*, Vikas Publishing(2009).

M.Sc. Chemistry
Semester-IV

CHE-406(c) Practical-VI Max.Marks:50
Organic Chemistry Time: 6 hrs.

Course Objective: *To acquire hands-on experience in multistep organic synthesis and students will understand the knowledge of various important parameters used in multistep organic synthesis preferably in greener approaches. Further, they would be able to know 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.*

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. Any other multi step reaction as per requirement

All the students must check the progress of reaction and purity of Final products forall 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	Marks: 05
Viva-voce	Marks: 05

Course Outcomes:

CO1 To understand the concept of stepwise synthesis of a product and their purification.
CO2 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.
CO4 To be 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.
CO5 Synthetic skills to plan and execute multi step protocols.
CO 6 To perform experimentation and evaluate the results.
CO7 To develop the ability to compile interpreted information in the form of lab record.
CO 8 To face viva-voce.

Mapping of Paper No. CHE-406 (c)

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	M	S	S	S	S
CO2	S	S	M	S	M	S	M	M	S	M	M	S	S	S	S
CO3	S	S	M	S	M	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	M	S	S	M	S	S	S	S
CO5	S	S	M	S	M	S	M	M	S	M	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

S = Strong, M = Medium, W = Weak

Suggested readings:

1. Roberts, R. M., Gilbert, J. C.,Rodewald, L. B. & Wingrove, A. S., *An Introduction to Modern Experimental Organic Chemistry*, Holt, Ranehart and Winston Inc., J.C New York(1969).

2. Vogel, A. I., *Elementary Practical Organic Chemistry*, Longmans, Green, 2nd Edition(1959).
3. Adams, R., Johnson, J. R. & Wilcox, C.F., *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London (1970).
4. Singh, J., Yadav, L. D. S., Singh, R. K. P., Siddiqui, I. R., Singh, J., Srivastava, J., *Advanced practical chemistry*, Pragati Prakashan Educational Publishers(2015).
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