Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System (CBCS)

Master of Science (M. Sc.)

Syllabus of

M. Sc. Chemistry

Implemented from

Academic year 2021 -22

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Chemistry

Sr. No.	Name	Designation	Representative
1	Dr. A. E. Athare	Chairman	HOD
2	Asso. Prof. P. S. Mutkule	Member	Faculty
3	Asso. Prof. S. B. Dare	Member	Faculty
4	Dr. S. J. Takate	Member	Faculty
5	Asst. Prof. P. B. Gaikwad	Member	Faculty
6	Asst. Prof. A. V. Karande	Member	Faculty
7	Dr. N. R. Dhatrak	Member	VC Nominee
8	Dr. B. B. Shingate (Dr. BAMU, Aurangabad)	Member	Other University
9	Dr. S. S. Kolekar (Shivaji University, Kolhapur)	Member	Other University
10	Dr. P. C. Mhaske (S. P. College, Pune)	Member	Alumni
11	Dr. D. N. Sawant (NCL, Pune)	Member	Industry/Placement

1. Prologue/ Introduction of the programme:

Academics and research in India is a priority, which depends upon the quality of education. Quality higher education include innovations that can be useful for efficient governance of higher education institutions, systems and society at a large. Fundamental approach to learning outcome-based curriculum emphasizes upon demonstration of understanding, knowledge, skills, attitudes and values in particular programme of study. This approach is intended to follow flexibility and innovation in design of the programme, its assessment and expect postgraduate attributes demonstrating the level of learning outcome. It is expected to provide effective teaching – learning strategies including periodic review of the programme and its academic standard. The learning outcome-based curriculum for M.Sc. degree in Chemistry is designed to address the needs of the students with chemistry as the core subject of study. The curriculum is expected to assist in the maintenance of the standard of chemistry degrees/programmes and periodic programme review within a broad framework of agreed/expected graduate attributes qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework is intended to allow flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students learning levels.

This curriculum for the master-level program in Chemistry is developed keeping in view of the student centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. To avoid rote-learning approach and foster imagination, the curriculum is more leaned towards self-discovery of concepts. The curriculum focuses on pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field works. The platform aims at equipping the postgraduate with necessary skills for Chemistry-related careers, careers with general postgraduate-level aptitude and for higher education in Chemistry and allied subjects. Augmented in this curriculum are postgraduate attributes including critical thinking, scientific reasoning, moral ethical reasoning, qualification descriptors that are specific outcomes pertinent to the discipline of chemistry, learning outcomes for individual courses, pedagogical methods and assessment methods. While designing syllabus, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the postgraduates. In line with recent trends in education section, this syllabus foster implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms. The framework is designed such a way to enable the learners implementing the concepts to address the real world problems. The curriculum focuses on issues pertinent to India and also of the west; for example, green chemistry and biomaterials etc. Curriculum are holistic and aim to mould responsible Indian citizen to have selective thinking, scientific temper and digital literacy in order to acquire requisite skill to be self-employed entrepreneurial.

2. Programme outcomes for M.Sc. Chemistry

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. They will have the opportunity to master the following objectives.

- To foster discovery-learning
- To enhance interest and ability for the advanced study of chemistry.
- Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Biochemistry, Drug Chemistry and related allied chemistry subjects.
- Students will be able to use the evidence based comparative chemistry approach to explainthe chemical synthesis and analysis.
- The students will be able to understand the characterization of materials.
- Students will be able to understand the basic principle of equipment, instruments used in the chemistry laboratory.
- Students will be able to demonstrate the experimental techniques and methods of their area ofspecialization in Chemistry.
- ***Disciplinary knowledge and skill***: A postgraduate student is expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest in Chemistry. The student will be capable of using of advanced instruments and related softwares for in-depth characterization of materials/chemical analysis and separation technology.
- ***Skilled communicator***: The course curriculum incorporates basics and advanced training in order to make a postgraduate student capable of expressing the subject through technical writing as well as through oral presentation.
- ***Critical thinker and problem solver***: The course curriculum includes components that can be helpful to postgraduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.
- ***Sense of inquiry***: Course curriculum will develop inquisitive characteristics among the students through appropriate questions, planning and reporting experimental investigation.
- ***Team player***: The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based situation and industry.
- ***Skilled project manager***: The course curriculum has been designed in such a manner as to enabling a postgraduate student to become a skilled project

manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

- ***Digitally literate***: The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools and use of chemical simulation software.
- ***Ethical awareness/reasoning***: A postgraduate student requires understanding and developing ethical awareness/reasoning which course curriculum adequately provides.
- ***Lifelong learner***: The curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

I. Programme Structure and Course Titles

Sr. No.	Class	Semester	Course Code	Course Title	Credits
M.Sc. I (Chemistry)					
1	M.Sc. I	I	MSC-CH111T	Inorganic Chemistry-I (Molecular Symmetry and Chemistry of Main Group Elements)	04
2	M.Sc. I	I	MSC-CH112T	Organic Chemistry-I (Basic Organic Chemistry)	04
3	M.Sc. I	I	MSC-CH113T	Fundamentals of Physical Chemistry	02
4	M.Sc. I	I	MSC-CH114P	Inorganic Chemistry Practical I	02
5	M.Sc. I	I	MSC-CH115P	Organic Chemistry Practical I	02
6	M.Sc. I	I	MSC-CH116P	Physical Chemistry Practical I	02
7	M.Sc. I	I	MSC-CH117T	Elective Option-A: Chemical Kinetics and Reaction Dynamics **OR** Elective Option-B: Mathematics for Chemists	02
8	M.Sc. I	I	MSC-CH118P	Bioanalytical Techniques (P) **OR** Chemical Biology Practical	02
9	M.Sc. I	I	MSC-CH119T	Introduction to Chemical Biology	02
10	M.Sc. I.	II	MSC-CH211T	Inorganic Chemistry -II (Coordination and Bioinorganic Chemistry)	04
11	M.Sc. I.	II	MSC-CH212T	Organic Chemistry-II (Photochemistry, Pericyclic and Organic spectroscopy)	04
12	M.Sc. I.	II	MSC-CH213T	Molecular Spectroscopy	02
13	M.Sc. I.	II	MSC-CH214P	Inorganic Chemistry Practical II	02
14	M.Sc. I.	II	MSC-CH215P	Organic Chemistry Practical II	02
15	M.Sc. I.	II	MSC-CH216P	Physical Chemistry Practical II	02
16	M.Sc. I.	II	MSC-CH217T	Elective Option-A:	02

				Nuclear and Radiation Chemistry **OR** Elective Option-B: Material Characterization Technique	
17	M.Sc. I.	II	MSC-CH218P	Analytical Chemistry Practical **OR** Interpretation and Analysis of Spectra	02
18	M.Sc. I.	II	MSC-CH219T	Organometallic and Inorganic Reaction Mechanism	02
M.Sc. II (Organic Chemistry)					
19	M.Sc. II	III	MSC-OC311T	Organic Reaction Mechanism	04
20	M.Sc. II	III	MSC-OC312T	Structure Determination of Organic Compounds by Spectroscopic Methods	04
21	M.Sc. II	III	MSC-OC313T	Stereochemistry of Organic compounds	02
22	M.Sc. II	III	MSC-OC314P	Solvent Free Organic Syntheses (P)	02
23	M.Sc. II	III	MSC-OC315P	Ternary Mixture Separation (P)	02
24	M.Sc. II	III	MSC-OC316P	Synthesis of Organic Molecules by Named Reactions (P)	02
25	M.Sc. II	III	MSC-OC317T	Elective option-A: Asymmetric Synthesis **OR** Elective Option-B: Carbohydrates Chemistry	02
26	M.Sc. II	III	MSC-OC318P	Elective option-A: Two Stage Preparations (P) **OR** Elective Option-B: Single stage Preparations (P)	02
27	M.Sc. II	III	MSC-OC319T	Advanced Heterocyclic Chemistry	**02**

28	M.Sc. II	IV	MSC-OC411T	Chemistry of Natural Products	04
29	M.Sc. II	IV	MSC-OC412T	Organometallic Reagents in Organic Synthesis	04
30	M.Sc. II	IV	MSC-OC413T	Concepts and Applications of Medicinal Chemistry	02
31	M.Sc. II	IV	MSC-OC414P	Green Chemistry Practical	02
32	M.Sc. II	IV	MSC-OC415P	Convergent Organic Syntheses (P)	02
33	M.Sc. II	IV	MSC-OC416P	Divergent Organic Syntheses (P)	02
34	M.Sc. II	IV	MSC-OC417T	Elective option-A: Designing Organic Syntheses and Protection -Deprotection **OR** Elective Option-B: Applied Organic Chemistry	02
35	M.Sc. II	IV	MSC-OC418P	Elective option-A: Isolation of Natural Products (P) **OR** Elective Option-B: Syntheses of Heterocycles (P)	02
36	M.Sc. II	IV	MSC-OC419P/T	Project / Research Methodology	02
M.Sc. II (Analytical Chemistry)					
37	M.Sc. II	III	MSC-AC311T	Electrochemical and Thermogravimetric Methods of chemical analysis	04
38	M.Sc. II	III	MSC-AC312T	Analytical Method Development and Extraction Techniques	04
39	M.Sc. II	III	MSC-AC313T	Advanced Chromatographic Methods of Analysis-1	02
40	M.Sc. II	III	MSC-AC314P	Basics of Instrumental Methods of Chemical Analysis Practical-Section I	02
41	M.Sc. II	III	MSC-AC315P	Applied Analytical Chemistry Practical- Section I	02

42	M.Sc. II	III	MSC-AC316P	Modern Analytical Chemistry Practical	02
43	M.Sc. II	III	MSC-AC317P	Elective option-A: Bioanalytical Techniques **OR** Elective Option-B: Analytical methods of Food	02
44	M.Sc. II	III	MSC-AC318P	Elective option-A: Advanced Analytical Chemistry Practical Sec I **OR** Elective option-B: Advanced Inorganic Chemistry Practical Sec I	02
45	M.Sc. II	III	MSC-AC319T	Analysis of Controlled Substance	02
46	M.Sc. II	IV	MSC-AC411T	Advanced Analytical Spectroscopic Techniques	04
47	M.Sc. II	IV	MSC-AC412T	Chemical Methods of Pharmaceuticals Analysis	04
48	M.Sc. II	IV	MSC-AC413T	Advanced Chromatographic Methods of Analysis-II	02
49	M.Sc. II	IV	MSC-AC414P	Basics of Instrumental Methods of Chemical Analysis Practical-Section II	02
50	M.Sc. II	IV	MSC-AC415P	Applied Analytical Chemistry Practical-Section II	02
51	M.Sc. II	IV	MSC-AC416P	Advanced Analytical Chemistry Practical Sec II	02
52	M.Sc. II	IV	MSC-AC417T	Elective option-A: Agricultural Analytical Chemistry **OR** Elective Option-B: Laboratory Automation and Sensor Based Techniques	02
53	M.Sc. II	IV	MSC-AC418P	Elective option-A: Advanced Analytical Chemistry	02

				Practical Sec III **OR** Elective option-B: Advanced Inorganic Chemistry Practical Sec II	
54	M.Sc. II	IV	MSC-AC419P/T	Project / Research Methodology	02
M.Sc. II (Drug Chemistry)					
55	M.Sc. II	III	MSC-DC311T	Advanced Analytical Methods	04
56	M.Sc. II	III	MSC-DC312T	Drug Discovery and Development	04
57	M.Sc. II	III	MSC-DC313T	Stereochemistry	02
58	M.Sc. II	III	MSC-DC314P	Two Stage Preparation-I (P)	02
59	M.Sc. II	III	MSC-DC315P	Synthesis of Heterocycles (P)	02
60	M.Sc. II	III	MSC-DC316P	Ternary Mixture Separation (P)	02
61	M.Sc. II	III	MSC-DC317T	Elective option-A: Asymmetric Synthesis and Biologically active Molecules. **OR** Elective Option-B: Bioinformatics, Biostatistics in Drug Discovery	02
62	M.Sc. II	III	MSC-DC318P	Elective Option-A: Microbiology, Drug Chemistry Practicals **OR** Elective Option-B: Practical For Forensic Chemistry	02
63	M.Sc. II	III	MSC-DC319T	Advanced Heterocyclic Chemistry	02
64	M.Sc. II	IV	MSC-DC411T	Advanced Medicinal Chemistry	04
65	M.Sc. II	IV	MSC-DC412T	Drug Design	04
66	M.Sc. II	IV	MSC-DC413T	Advanced Synthetic Methods in Chemistry	02
67	M.Sc. II	IV	MSC-DC414P	Two Stage Preparations- II (P)	02

68	M.Sc. II	IV	MSC-DC415P	Synthesis of Drug Molecules (P)	02
69	M.Sc. II	IV	MSC-DC416P	Divergent Organic Syntheses (P)	02
70	M.Sc. II	IV	MSC-DC417T	Elective Option-A: Organometallic Reagents in Organic Synthesis **OR** Elective Option-B: Supramolecular, Green Chemistry and Forensic chemistry	02
71	M.Sc. II	IV	MSC-DC418P	Elective Option-A: Isolation of Natural Products (P) **OR** Elective Option-B: Solvent Free Organic Synthesis (P)	02
72	M.Sc. II	IV	MSC-DC419P/T	Project / Research Methodology	02
M.Sc. II (Inorganic Chemistry)					
73	M.Sc. II	III	MSC-IC311T	Bioinorganic and Medicinal Inorganic Chemistry	04
74	M.Sc. II	III	MSC-IC312T	Inorganic Reaction Mechanism	04
75	M.Sc. II	III	MSC-IC313T	Material Science - I	02
76	M.Sc. II	III	MSC-IC314P	Modern Methods of Inorganic Analysis Practical Section - I	02
77	M.Sc. II	III	MSC-IC315P	Inorganic Instrumental analysis and Computer applications Practical Section-I	02
78	M.Sc. II	III	MSC-IC316P	Extended Practical in Inorganic Chemistry Section-I	02
79	M.Sc. II	III	MSC-IC317T	Elective option-A: Modern Instrumental methods in Inorganic Chemistry Sec I **OR** Elective Option-B:	02

				Polymer Chemistry	
80	M.Sc. II	III	MSC-IC318P	Elective Option-A: Advanced Inorganic Chemistry Practical I **OR** Elective Option-B: Advanced Analytical Chemistry Practical I	02
81	M.Sc. II	III	MSC-IC319T	Organometallic Chemistry.	**02**
82	M.Sc. II	IV	MSC-IC411T	Heterogeneous Catalysis and its Applications	04
83	M.Sc. II	IV	MSC-IC412T	Inorganic Nanomaterials	04
84	M.Sc. II	IV	MSC-IC413T	Material Science - II	02
85	M.Sc. II	IV	MSC-IC414P	Modern Methods of Inorganic Analysis Practical Section - II	02
86	M.Sc. II	IV	MSC-IC415P	Inorganic Instrumental analysis and Computer applications Practical Section-II	02
87	M.Sc. II	IV	MSC-IC416P	Extended Practical in Inorganic Chemistry Section-II	02
88	M.Sc. II	IV	MSC-IC417T	Elective Option-A: Modern Instrumental methods in Inorganic Chemistry Sec II **OR** Elective Option-B: Homogeneous Catalysis.	02
89	M.Sc. II	IV	MSC-IC418P	Elective Option-A: Advanced Inorganic Chemistry Practical II **OR** Elective Option-B: Advanced Analytical Chemistry Practical II	02
90	M.Sc. II	IV	MSC-IC419P/T	Project / Research Methodology	02

M. Sc. I Chemistry Syllabus

Semester -I	**Paper – I**
Course Code: MSC-CH 111T	**Title of the Course: Inorganic Chemistry-I** **(Molecular Symmetry and Chemistry of Main Group Elements)**
Credits: 04	**Total Lectures: 60HrS**

Course Outcomes:

- Student should visualize/ imagine molecules in 3 dimensions.
- To understand the concept of symmetry and able to pass various symmetry elements through the molecule.
- To apply the concept of point group for determining optical activity and dipole moment.
- To know about projection operator, apply projection operator to find out the normalized wave function for atomicorbital.
- Student should understand the detail chemistry of S and P block elements w.r.t. their compounds, their reactions and applications. To learn the advance chemistry of boranes, fullerene, zeolites, polymers etc.
- Organometallic chemistry of some important elements from the main groups and their applications

Detailed Syllabus:

Section I

Unit 1: Molecular Symmetry and Symmetry Groups (12L)

Symmetry elements and operations, Symmetry planes and S.R.lections, the inversion centre, proper axes and proper rotations, improper axes and improper rotation, products ofsymmetry operations, equivalent symmetry elements and equivalent atoms, general relations among symmetry elements and symmetry operations, classes of symmetry operations, symmetry elements and optical isomerism, symmetry point groups, classification of molecular point groups. Defining properties of a group, group multiplication table, some examples of group, subgroups and classes.

Unit 2: Representations of Groups (08L)

Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part), wave function as basis for irreducible representations.

Unit 3: Symmetry Adapted Linear Combinations (06L)

Projection operators and their use of construct SALC (Construction of SALC for sigma bonding for molecules belonging point groups: $D_{2h,}$ D_{3h} D_{4h}, C_{4v}, Td., Oh., normalization ofSALC, transformation properties of atomic orbital, MO's for sigma bonding, ABn molecules, tetrahedral AB_4 and Oh AB_6 cases.

Unit 4: Application of Group theory to Infrared Spectroscopy (04L)

Introduction, selection rules, polyatomic molecules, possible vibrations in a linearmolecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR spectra related to symmetry of some compounds, IR spectraof complex compounds.

Suggested Readings:

1) Chemical Applications of Group Theoryby F. A. Cotton
2) Symmetry and spectroscopy of molecules by K. VeeraReddy
3) Group Theory and its Chemical Application, P.K. Bhattarchrya
4) Inorganic Chemistry by Shriver and Atkins
5) Concise Inorganic Chemistry by J. D. Lee
6) Inorganic chemistry: principle of structures and reactivity by Huheey, Keiter, Medhi

Section II

Unit 1: Hydrogen and its compounds: (02L)

Introduction, Isotopes of Hydrogen, Ortho and Para Hydrogen, Classification of Hydrides, electron deficient, electron precise and electron rich hydrides.; PH_3, SbH_3, AsH_3 , Selenides, Tellurides.

Unit 2: Alkali and Alkaline Earth Metals **(02L)**

Solutions in non - aqueous media, application of crown ether in extraction of alkali and alkaline earth metal, Cryptands.

Unit 3: Boron Group **(04L)**

Boron Hydrides, preparation, structure, properties and Bonding with reference to LUMO and HOMO, interconversion of lower and higher boranes, metalloboranes, carboranes, reactions oforganoboranes, STYX rules and structure of higher boranes.

Unit4: Carbon Group **(04L)**

Allotropes of carbon, Diamond, Graphite, Graphene, Fullerenes, Carbon nanotube withsynthesis, properties, Structure- single walled and multi walled and its application, Intercalation compounds of Graphite, Silicates including Zeolites.

Unit 5: Nitrogen Group **(04L)**

Nitrogen activation, Boron nitride, Oxidation states of nitrogen and their interconversion, PN and SN Compounds, Applications of PN and SN compounds**.**

Unit 6: Oxygen Group **(04L)**

Metal Selenides and Tellurides, oxyacids, and oxoanions of Sulphur and nitrogen. Ring, Cage and Cluster compounds of p-block elements.

Unit 7: Halogen Group **(03L)**

Interhalogens, pseudohalogen, Synthesis, Properties and Applications, Structure, Oxyacidsand Oxyanions of Halogens.

Unit 8: Noble gases **(03L)**

Occurrence**,** Compounds of Xenon-with fluorine and Oxygen and its uses.

Unit 9: Organometallic Compounds **(04L)**

Organometallic Compounds of Li, Mg, Si, Pb, As, with Classification, Nomenclature, Synthesis, Structure Properties and Uses.

Suggested Readings:

1. Inorganic Chemistry by Shriver and Atkins.
2. Concise Inorganic Chemistry by J. D. Lee.
3. Inorganic chemistry by Principle of Structures and Reactivity by Huheey, Keiter, Medhi.
4. Inorganic Chemistry by Catherine Housecraft.
5. Inorganic Chemistry by MeisslerandTarr.
6. Organometallics by Christoph Elschenbroich.
7. Organometallics by A Concise Introduction by Christoph Elschenbroich and Albrechtalzer.
8. Basic Organometallic Chemistry by B. D. Gupta and A. J. Elias.

Semester -I	Paper - II
Course Code: MSC-CH 112T	Title of the Course: Organic Chemistry-I (Basic Organic Chemistry)
Credits: 04	Total Lectures: 60HrS

Course Outcomes:

- To understand some fundamental aspects of organic chemistry, to learn the concept aromaticity, to understand the various types of aromaticity
- To study heterocyclic compound containing one and two hetero atoms with their structure, synthesis and reactions.
- To know stereochemistry of organic compounds
- To study reaction of intermediates, rearrangement reaction with specific mechanism and migratory aptitude of different groups. and ylides
- To understands the basis of redox reaction; acquire knowledge about the reagents which causes selective oxidation / reduction in various compounds; learn the basic mechanism of oxidation / reduction in organic compounds

Detailed Syllabus

SECTION-I

Unit 1: **Structure and Reactivity:** **(06 L)**

Aromaticity: Benzenoid and non-benzenoid compounds, Huckel's rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, proton sponges, current concepts of aromaticity.

Unit 2: Heterocyclic Chemistry **(10 L)**

Five and six membered heterocycles with one and two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocyclic compounds, Furan, Pyrrole, Thiophene, Pyridine, Pyrimidine.

Unit 3: Stereochemistry: (14 L)

a) Stereochemical principles, enantiomeric relationship, diastereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds, Prochiral relationship, stereospecific and stereoselective reactions, optical activity in biphenyls, spiranes, allenes, Topicity.

b) Conformational analysis of 5-membered rings; Conformations, Physical and Chemical Properties of 6 membered rings; Tri, tetra-substituted 5 -6 membered rings.

SECTION-II

Unit 1: **Structure, Stability and Reactions of Reactive Intermediates (08 L)**

a) Carbocation, Carbanion, Free Radical, Carbenes and nitrenes.

b) NGP: Neighbouring group participation.

Unit 2: **Rearrangements: (08 L)**

Migration of Group on **Nitrogen**- Hoffmann, Curtius, Lossen, Schmidt, Beckmann.

Migration of Group on **Carbon**- Wagner-Meerwein, Pinacol-pinacolone, Tiffeneau Demjanov, Wolff, Benzil-benzilic acid**,** Sommelet, Favorskii.

Migration of Group on **Oxygen**-Bayer-Villiger,

Migration of group from **N to C**- Stevens.

Unit 3: **Ylides: (02 L)**

Phosphorus, Nitrogen and Sulphur ylides

Unit 4: **Oxidation and Reduction Reactions (12 L)**

Oxidising Reagents: CrO_3, PDC, PCC, $KMnO_4$, MnO_2, Swern, SeO_2, $Pb(OAc)_4$, Pd-C, RuO_4, OsO_4, m-CPBA, O_3, $NaIO_4$, HIO_4, TEMPO, IBX, CAN, Dess-Martin, DDQ, Ag_2O.

Reducing agents: Boranes and hydroboration reactions, reduction with H_2/Pd-C, Raney-Ni, $NaBH_3CN$, Willkinson's catalyst, DIBAL-H and MPV, Wolff-Kishner, Birch, Clemmenson reduction.

Suggested Readings:

1. Organic Chemistry–by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford).
2. Advanced Organic Chemistry –by J. March 6th Edition.
3. Advanced Organic Chemistry (Part A) –by A. Carey and R.J. Sundberg.
4. Stereochemistry of carbon compound-by E.L. Eliel.
5. Stereochemistry of organic compound-by Nasipuri.
6. Stereochemistry conformations and mechanism by P.S. Kalsi.
7. Modern Synthetic reactions- H.O. House.
8. Organic Synthesis – M.B. Smith.

9. Organic chemistry –by Cram, Hammond, Pine and Handrickson.
10. Mechanism and structure in Organic Chemistry – E. S. Gould.
11. Heterocyclic Chemistry -T. Gilchrist.
12. An introduction to the chemistry of heterocyclic compounds-R M Acheso.
13. Heterocyclic Chemistry- J A Joule and K Mills.
14. Principles of modern heterocyclic chemistry- A Paquette.
15. Handbook of Heterocyclic Chemistry- A R Katritzky, A F Pozharskii.
16. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt.
17. IUPAC recommendations 2006 and 2008.

Semester -I	**Paper – III**
Course Code: MSC-CH 113T	**Title of the Course: Fundamentals of Physical Chemistry**
Credits: 2	**Total Lectures: 30Hrs**

Course Outcome:

- Student will be able to understand laws of thermodynamics
- Student will be exposed to different applications of quantum chemistry
- They learn the fundamental of chemical bonding
- Student will gain the conceptual knowledge about free energy changes

Detailed Syllabus:

Unit 1: **Thermodynamics** **(06 L)**

State function, path function, exact differential and inexact differential, internal energy and enthalpy, temperature dependent internal energy and enthalpy, reversible and irreversible adiabatic expansion. The entropy of irreversible changes, the Helmholtz and Gibbs function, Entropy and entropy change in an ideal gas with temperature and pressure, Clausius inequality, chemical potential, chemical potential of a substance in a mixture.

Unit 2: **Combining First & Second law** **(04L)**

Thermodynamics of Gibbs function of mixing, colligative properties: Elevation in boiling point, depression in freezing point and osmosis.

Unit 3: **Quantum Chemistry** **(10 L)**

Applications of quantum chemistry- blackbody radiation, photoelectric effect, de Broglie hypothesis and uncertainty principle and its experimental evidence. Schrödinger wave equation, particle in one dimensional box, Normalization and orthogonality of wave function, particle in three dimensional box, hydrogen like atoms (no derivation).Operators: algebra of operators, commutative property, linear operators, commutator operator, the operator ∇ and ∇2.

Unit 4: **Chemical Bonding** **(10 L)**

Valence bond theory, hybrid orbitals, geometry and hybridization, molecular orbital theory for di and tri atomic molecule, linear variation method, approximations underlying Huckel theory, applications to simple π-systems.

Suggested Reading:

1. Physical Chemistry by P.W.Atkin and De Paul.
2. Physical Chemistry by T.Engel and P. Reid.
3. Physical Chemistry and molecular approach by D. Mequarie and J. Siman.
4. Physical Chemistry for biological sciences by Raymond Chang (Universal books, 2000).
5. Physical Chemistry by Merron and C.F. Prouton.
6. Physical Chemistry by G.M. Barrow.
7. Quantum Chemistry by I. Levine.
8. Quantum Chemistry by R.K. Prasad.

Semester -I	**Paper – IV**
Course Code: MSC-CH 114P	**Title of the Course: Inorganic ChemistryPractical I**
Credits: 02	**Total Lectures: 60Hrs**

Course Outcome:

- Students are trained to different purification techniques in Inorganic chemistry like recrystallization, distillation, steam distillation and extraction.
- Students are made aware of safety techniques and handling of chemicals.
- Students are made aware of carrying out different types of reactions and their workup methods.
- This practical course is designed to make student aware of green chemistry and role of green chemistry in pollution reduction.

Detailed Syllabus:

Unit 1: Analysis (at least two of the following)

1. Determination of Silica and Manganese from Pyrolusite ore.
2. Determination of Aluminum and Silica from Bauxite ore.
3. Determination of silica and iron from Hematite ore.
4. Determination of copper and iron from Chalcopyrite ore.

Unit 2: Alloy Analysis (at least two of the following)

5. Determination of tin and lead from Solder alloy.
6. Determination of iron and chromium from Stainless steel alloy.
7. Determination of copper and nickel from Cupranickel alloy.

Unit 3: Synthesis of solid state materials / nano-materials (any three)

8. Synthesis of ZnO from zinc oxalate - precursor method and determine band gap by absorption spectroscopy.
9. Synthesis of TiO_2 $TiCl_4$ or Ti-Isopropoxide by Sol-gel method and determine band gapby absorption spectroscopy.
10. Synthesis of Colloidal silver nanoparticles and determine band by absorptionspectroscopy.
11. Synthesis of Fe_2O_3 nanoparticles sol-gel / co-precipitation / hydrothermal (any one.method).
12. ZnO, TiO_2, Fe_2O_3 nanoparticles powder XRD, SEM, TEM (at least one spectral analysis should be done).

Unit 4: Applications of Solid State Materials

13. Removal and kinetics of photocatalytic dyes, degradation (methylene blue) by ZnOTiO_2 photocatalysis.
14. Study of adsorption of phosphate ion on α-Fe_2O_3.

Suggested Reading:

1. Text book of Quantitative Analysis by A.I. Vogel 3rd edition (1963).
2. Experimental Inorganic Chemistry by Mounir A. Malati, Horwood.
3. Nanotechnology by S. K. Kulkarni.

Semester -I	Paper – V
Course Code: MSC-CH 115P	Title of the Course: Organic Chemistry Practical I
Credits: 02	Total Lectures: 60Hrs

Course Outcomes:

- This course is designed to make students aware of how to handle organic compounds in laboratory and aware of safety techniques.
- The synthesis of organic compounds /derivatives, will help them while working in research laboratory / in industry
- This practical course is also designed to make student aware of green chemistry, role of green chemistry in pollution reduction and solvent free reaction with ecofriendly experimental procedures.
- Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.

Detailed Syllabus:

Unit 1: Introduction to Laboratory Safety (compulsory)

Meaning of safety signs on container of chemicals, safety handling of chemicals, MSDS sheets: Detailed explanation at least for 4 different types of substances (e.g. nitric acid, benzene, potassium dichromate, bromine, etc.), Handling of glassware's and care to be taken, handling of organic flammable as well as toxic solvents in laboratory, use of safety goggles, shoes and gloves, fire extinguisher and its use, action to be taken in accidental cases e.g. cleaning of acid spill over, use eye wash station and bath station in emergency, etc.

Unit 2: Purification Techniques (Compulsory) (8 Experiments)

1. Purification of **two** organic solids by recrystallization using solvents other than water.
2. Purification of **two** organic liquids by upward/downward/traditional distillation technique.
3. Column Chromatography technique should be performed for any one of the following preparation.

4. Sublimation Technique **one** Compound.
5. Thin Layer Chromatography technique **two mixtures.**

Unit 3: Introduction to Green Chemistry (Compulsory 1 Practical)

Concept of green chemistry twelve principals of green chemistry, applications of green chemistry for sustainable development, Atom economy, Monitoring of reaction using TLC.

Unit 4: Green Chemistry Experiments (any two)

1. Preparation of Schiff's bases in aqueous medium.
2. Preparation of dihydropyrimidinone under solvent free conditions (Biginelli Reaction).
3. Preparation of acetanilide from aniline using Boric acid.

Suggested Reading:

1. Vogel's Textbook of Practical Organic Chemistry, Fifth edition – Brian S Furniss, Antonny J Hannaford, Peter W G Smith and Austin R. Tatchell.
2. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
3. Monograph on Green Chemistry Laboratory Experiments by Green ChemistryTask Force Committee, DST.

Semester -I	**Paper – VI**
Course Code: MSC-CH 116P	**Title of the Course: Physical Chemistry Practical I**
Credits: 2	**Total Lectures: 60Hrs**

Course Outcome:

- Student will get hands on instruments like colorimeter, pH meter, potentiometer etc.
- Student will gain the problem solving ability, data analysis.
- Student will able to understand the importance of time and temperature in chemical reaction.
- They will understand the pros and cons of a radioactive material practical.

Detailed Syllabus:

Time allotted: Two practical sessions of 4 hours per week for one semester (one practical session for Section-I and one practical session for Section-II per week iscompulsory)

Physical Chemistry Practical (11 Experiments)

Unit 1: Chemical Kinetics: (Any three)

1. Kinetic decomposition of diacetone alcohol by dilatometry.
2. Determination of an order of a reaction.
3. Brönsted primary salt effect.
4. Kinetics of oxidation of ethanol by $K_2Cr_2O_7$

Unit 2: Non-Instrumental: (Any Three)

5. Determination of surface excess of amyl alcohol or TX-100 surfactant by Capillary rise method.
6. Determination of molecular weight by steam distillation.
7. Glycerol radius by viscosity.
8. Partial Molar Volume (Polynometry) Determination of the densities of a series of solutions and to calculate the molar volumes of the components.

Unit 3: Colorimetry and spectrophotometry (Any four)

9. Simultaneous determination of Ni and Co by spectrophotometry.
10. Simulations determination of $KMnO_4$ and $K_2Cr_2O_7$ by spectrophotometry.
11. To study the adsorption of certain dyes such as methyl violet, picric acid or malachite green on charcoal.
12. To determine the indicator constant of bromocresol purple by half height method
13. Estimation of Cu(II) by titration with Na_2 EDTA by colorimetry.

Unit 4: Radioactivity (Any one)

14. Half-life of a radioactive nuclide and counting errors.
15. Determination of E-max of β radiation and absorption coefficients in Al.

Unit 5: Data Analysis

18. Statistical treatment of experimental data (calculation of mean and standard deviation for given data and least square method for calibration curve method) (compulsory)

Suggested Reading:

1. Practical Physical Chemistry, A. Findlay, T. A. Kitchner (Longmans, Green and Co.).
2. Experiments in Physical Chemistry, J. M. Wilson, K. J. Newcombe, A. R. Denko. R. M. W. Richett (Pergamon Press).
3. Senior Practical Physical Chemistry, B. D. Khosla and V. S. Garg (R. Chand and Co., Delhi.).
4. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
5. Physical Chemistry by Wien (2001).
6. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut).

7. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House.
8. Practical Physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books.

Semester -I	**Paper – VII**
Course Code: MSC-CH 117T	**Title of the Course:** **Elective Option-A: Chemical Kinetics and Reaction Dynamics** **OR** **Elective Option-B: Mathematics for Chemists**
Credits: 2	**Total Lectures: 30Hrs**

Elective Option-A: Chemical Kinetics and Reaction Dynamics

Course Outcome:

- Students will understand the fundamentals of chemical kinetics
- They will be exposed to the mechanism of gas phase reactions
- Student will be able to acquire the knowledge of energy changes during the reactions
- They will know the role of enzyme as a catalyst of a reaction
- Student will understand the mathematical aspect of thermodynamics

Detailed Syllabus:

Unit 1: Rate Laws **(06 L)**

Recapitulations of basic concept, the temperature dependent reaction rates, reaction moving towards equilibrium, consecutive reaction, parallel reactions, pre-equilibria, unimolecular reactions.

Unit 2: Kinetics of Complex Reactions **(04 L)**

Fast reactions: flash photolysis, flow technique, stopped flow technique, relaxation method, the steady state approximation, chain reactions - free radical polymerization reaction between H_2 and Br_2, explosive reaction.

Unit 3: Molecular Reaction Dynamics **(06 L)**

Collision theory of bimolecular gas phase reactions, diffusion controlled and activation controlled reaction in solution, activated complex theory of reaction rate, transition-state theory.

Unit 4: Enzyme Catalysis **(06 L)**

Michaelis mechanism, effect of pH and temperature on enzyme catalyzed reactions,

limiting rate, Lineweaverburk and Eadie equation and plots, inhibition of enzyme action, competitive inhibition and non- competitive inhibition.

Unit 5: Molecular Thermodynamics (08 L)

Molecular energy levels, Boltzmann distribution law, partition functions and ensembles, translational, rotational and vibrational partition function of diatomic molecule, Maxwell- Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Suggested Reading:

1. Physical Chemistry by P. W. Atkin and De Paul.
2. Physical Chemistry by T. Engel and P. Reid.
3. Physical Chemistry and molecular approach by D. Mequarie and J. Siman.
4. Physical Chemistry for biological sciences by Raymond Chang (Universal books, 2000).
5. Physical Chemistry by S. H. Maron and C. F. Prutton.
6. Physical Chemistry by G. M. Barrow.
7. Quantum Chemistry by I. Levine.
8. Quantum Chemistry by R. K. Prasad.

Elective Option-B: Mathematics for Chemists

Course Outcome:

1. Student will gain the problem solving ability, data analysis.
2. Student will be able to acquire the knowledge of energy changes during the reactions
3. Student will understand the mathematical aspect of thermodynamics

Detailed Syllabus:

Unit 1: Functions (16 L)

Differential and integral calculus, limits, derivatives, physical significance, basic rules of differentiation, maxima and minima, application is chemistry, exact and inexact differentiation, Taylor and McLaurin Theorem, curve sketching, partial differentiation, rules of integration, separation of variable, substitution, partial function method to solve to indefinite integrals in chemistry

Unit 2: Differential Equations (06 L)

Separation of variables, homogeneous, exact, linear equations of second order, series solution method.

Unit 3: Vectors Matrices, and Determinants (08 L)

Vectors, dot, Cross and triple products, introduction to matrix algebra, addition and multiplication of matrices, inverse, adjoins and transport of matrices, unit and diagonal matrices.

Suggested Reading:

1. Chemical Maths Book, E. Steiner, Oxford University Press (1996).
2. Maths For Chemists Vol. 1 and 2, Martin MCR Cockett and G. Doggett, Cambridge (2003).
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill (1972).

Semester -I	**Paper – VIII**
Course Code: MSC-CH 118P	**Title of the Course:** **Elective Option -A: Bioanalytical Techniques** **OR** **Elective Option -B: Chemical Biology Practical**
Credits: 2	**Total Lectures: 60Hrs**

Elective Option -A: Bioanalytical Techniques

Course Outcome:

- Student will learn the preparation of buffer and measurement of pH.
- Student will obtain hands on training in handling the electrophoresis unit.
- Student will obtain hands on training in handling the paper chromatography and TLC.
- Student will learn the difference between various separation techniques

Detailed Syllabus:

1. Determination of pH using pH meter and pH indicators.
2. Separation and detection of amino acids by using paper chromatography/TLC.
3. Separation plant pigments by using paper chromatography.
4. Separation carbohydrate mixture by using paper chromatography.

5. Separation of proteins by polyacrylamide gel electrophoresis.
6. Separation of DNA by agarose gel electrophoresis.
7. Separation/ Purification of biomolecules by using dialysis.
8. Verification of Lamberts-Beer's Law using Colorimeter/Spectrophotometer.
9. Absorption spectrum of proteins and determination of its λ_{max}.
10. Absorption spectrum of nucleic acids and determination of its λ_{max}.
11. To isolate, purify and determination of λ_{max} of chlorophyll from spinach / β-carotene from carrot / betanine from beet root.
12. To determine quality of milk by Methylene blue reduction test (MBRT).

Suggested Reading:

1. Biochemical methods by S. Sadasivam and A. Manickam (Third edition).
2. Laboratory manual in Biochemistry by J Jayaraman (second edition).
3. Experimental Biochemistry A Student Compansion by Beedu Sashidhar Rao and Vijay Deshpande (first edition).
4. An introduction to practical Biochemistry by David T Plummer (Third edition).

Elective Option -B: Chemical Biology Practical

Course Outcome:

- The students will gain experimental training for preparation of solutions of various concentration and different buffers.
- The students will gain experimental training for isolation of biomolecules from variety sources.
- They will be able to qualitatively analyse different biomolecules such as proteins, carbohydrates, DNA, RNA, amino acids, etc.

Detailed Syllabus:

1. Calculation, preparation of normal, molar and percentage solutions.
2. Specific reactions for carbohydrate.
3. Specific reactions for amino acids.
4. Specific reactions for fatty acids.
5. Isolation of albumin and globulin from egg.
6. Isolation of cholesterol and lecithin from egg.
7. Isolation of casein by IpH precipitation from milk.
8. Isolation of starch from potato and its characterization.

9. Isolation of DNA from bacterial/plant/animal source.
10. Isolation of RNA from yeast/plant.
11. Determination of saponification value.
12. Determination of acid value.

Suggested Reading:

1. A reference book of Biochemistry Practicals by Sadashivam.
2. Practical approach to biochemistry by Plummer.
3. Martin Holtzhauer, Basic Methods for the Biochemical Lab, First Edition, Springer.
4. Practical Biochemistry by J. Jayaraman.

Semester -I	**Paper – IX**
Course Code: MSC-CH119T	**Title of the Course: Introduction to Chemical Biology**
Credits: 2	**Total Lectures: 30Hrs**

Introduction to Chemical Biology

Course Outcome:

1. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
2. Students will be able to function as a member of an interdisciplinary problem solving team.
3. Students will be able to learn the chemistry of carbohydrates, amino acids, proteins and nucleic acids etc.
4. Students will be able to describe the chemical basis for replication, transcription, translation and how each of these central processes can be expanded to include new chemical matter.
5. Developskillstocriticallyreadtheliteratureandeffectivelycommunicateresearchinapeer setting.

Detailed Syllabus:

Unit 1: Overview of biochemical concepts (05 L)

-Structure of prokaryotic and eukaryotic cells and subcellular components.

-Overview of cell metabolism.

- Biomolecules as potential drug targets.

-Chemistry of biomembranes: Structure, composition, properties and functions of membrane.

Unit 2: Carbohydrates **(06 L)**

-Classification, structure and properties and functions of carbohydtates.

-Glycoproteins and glycolipids with their significance.

Unit 3: Lipids **(06 L)**

-Classification, Structure and Properties of lipids.

-Lipoproteins.

Unit 4: Amino Acids and Proteins **(07 L)**

-Introduction, Classification of amino acids, Physico-chemical properties, Optical properties.

-Peptide bond, Primary, Secondary, Tertiary and Quaternary structure of proteins.

-Protein-ligand interactions.

- Denaturation and renaturation of proteins.

- Oligopeptide synthesis.

-Concept of proteomics.

Unit 5: Nucleic Acids **(06L)**

-Structure, functions and difference between DNA and RNA.

-Central dogma of molecular biology: Overview and inhibitors of replication, transcription, translation.

- Gene cloning, Gene Therapy, Applications of Biotechnology.

Suggested Reading:

1. Principles of Biochemistry by Albert Lehninger (CBS Publisher and Distributers Pvt. Delhi.
2. Harper's Biochemistry by R. K. Murray, D. I. Granner, P. A. Mayes, (Prentice Hall International Inc.).
3. Biochemistry by U. Satynarayana.
4. Biochemistry by J. L. Jain.
5. Biophysical Techniques by Upadhyaya Nath.
6. Biochemistry by L. Stryer (2^{nd} edition).

Semester -II	Paper – I
Course Code: MSC-CH 211T	Title of the Course: Inorganic Chemistry -II (Coordination and Bioinorganic Chemistry)
Credits: 4	Total Lectures: 60Hrs

Course Outcome:

- Student should able to find out the no of microstates and meaningful term symbols, construction of microstate table for various configuration.
- Student should understand inter electronic repulsion.
- Student should know the concept of weak and strong ligand field.
- Student able to find out splitting of the free ion terms in weak ligand field and strong ligand field.
- To draw correlations diagram for various configurations in Td an Oh ligand field.

Detailed Syllabus:

SECTION-I

Coordination Chemistry

Unit 1: Concept and Scope of Ligand Fields: (06L)

Quantum numbers, Free ion Configuration, Terms and States, Energy levels of transition metal ions, free ion terms, microstates, term wave functions, spin-orbits coupling.

Unit 2: Ligand Field Theory of Coordination Complexes (08L)

Effect of ligand field on energy levels of transition metal ions, weak cubic ligand field effect on Russell- Saunders terms, Orgel diagrams, strong field effect, correlation diagrams, Tanabe-Sugano Diagrams, Spin-Pairing energies.

Unit 3: Electronic spectra of Transition Metal Complexes (08L)

Introduction, band intensities, band energies, band width and shapes, transition metal spectra of 1^{st}, $2^{nd}$and 3^{rd} row ions and complexes, electronic spectra of Lanthanide and Actinide, spectrochemical and nephelauxetic series, charge transfer and luminescence spectra, calculations of Dq, B, β parameters, percentage of covalent character for metal complexes.

Unit 4: Magnetic Properties of Coordination Complexes (08 L)

Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexes-Para magnetism, $1^{st}$and 2^{nd} Ordered Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A, E and T ground terms in complexes, spin free and spin paired equilibria, temperature dependence of magnetism.

Suggested Reading:

1. Ligand field theory and its applications by B.N. Figgis and M.A. Hitachman.
2. Symmetry and spectroscopy of molecules by K. Veera Reddy.
3. Elements of Magneto chemistry by R. L. Datta and A. Syamal.

Section-II:

Bioinorganic Chemistry

Detailed Syllabus:

Unit 1: Overview of Bioinorganic Chemistry (05L)

Historical Background and current relevance, role of Cu, Fe, Mn and Mo in metalloprotein and metalloenzymes.

Unit 2: Concepts of Inorganic Chemistry in Bioinorganic Chemistry (10L)

Thermodynamic aspects - HSAB concept, chelate effect and Irving-William series, pK_a values of coordinated ligands, Tuning of redox potential, Biopolymer effects. Kinetic aspects- Electron transfer reaction, Electronic substitution reaction. Reactions of coordinated ligands and Template effect, concept of spontaneous self-assembly model compounds.

Unit 3: Functions and Transport of Alkali and Alkaline Earth Metal Ions (05L)

Importance of alkali and alkaline earth metals, Distribution of cationic and anionic electrolytes in blood plasma and intracellular fluid, Ionophores: Natural and Synthetic, Application of ionophores, Different mechanism involved in exchange of ions across cell wall, Na^+/K^+-ATPase ion pump for active transport of Na^+ and K^+.

Unit 4: Biochemistry of following Elements (10L)

(a) Ca in Blood coagulation.

(b) Magnesium in Photosystem I

(c) Manganese in Photosystem II

(d) Iron in Ferritin, Transferrin, Fe-S clusters, Porphyrin based system.

Suggested Reading:

1. Principle of Bioinorganic Chemistry by S.J. Lippard and J. M. Berg
2. Bioinorganic Chemistry: Inorganic Elements in Chemistry of Life by W. Kaim and B.Schwederski.
3. An Introduction to Bioinorganic Chemistry by R. K. Sharma
4. Bioinorganic Chemistry by E. I. Ichiro ochiai.
5. Bioinorganic Chemistry by Rehder B., 2014, Oxford.
6. Bioorganic, Bioinorganic and Supramolecular Chemistry by J. P. Kalsi, P. S. Kalsi.

Semester -II	**Paper – II**
Course Code: MSC-CH 212T	**Title of the Course: Organic Chemistry-II (Photochemistry, Pericyclic and Organic spectroscopy)**
Credits: 4	**Total Lectures: 60Hrs**

Course Outcome:

- Students should able to understand free radicals' formation, stability and reactivity and should also be able to use the basic understanding in writing probable reaction mechanisms.
- Students should able to calculate λ_{max} of organic compounds.
- Students should able to solve ^{1}H-NMR problems and should also able to draw the ^{1}H-NMR spectrum.
- Students should able to use ^{13}C-NMR data to interpret the structure NMR problems
- Students should know various key factors responsible for the spectroscopic data acquisition and should able to solve Problems based on UV, IR, MS, ^{1}H-NMR,^{13}C-NMR.

.

SECTION-I

Photochemistry and Pericyclic Reactions

Detailed Syllabus:

Unit 1: Photochemistry [12 L]

Principles of Photochemistry, photochemistry of carbonyl compounds, alkenes, dienes, and aromatic compounds, photo rearrangements, Barton reaction.

Unit 2: Pericyclic Reactions [18 L]

Cycloaddition reactions, Analysis by correlation diagrams, FMO approach, Electrocyclic, Sigmatropic and Ene reactions, 1, 3-dipolar additions.

Suggested Reading:

1. Advanced Organic Chemistry, Part A by F. A. Carey and R. J. Sundberg
2. Excited states in Organic Chemistry by J.A. Barltrop and J. D. Coyle
3. Organic photochemistry: A visual approach by Jan Kopecky
4. Conservation of orbital symmetry by R. B. Woodward and R. Hoffmann
5. Orbital Symmetry: A problem solving approach- R. E. Lehr and A. P. Marchand
6. Pericyclic Reactions by A. P. Marchand, Roland E. Lehr
7. Organic reactions and orbital symmetry, 2nd Ed. T. L. Gilchrist and R. C. Storr

8. Molecular Orbitals and Organic Chemical Reactions by Ian Fleming
9. Pericyclic Reactions by Ian Fleming
10. Pericyclic Reactions by A Mechanistic and Problem-Solving Approach by Sunil Kumar Vinod Kumar S.P. Singh
11. Essentials of Pericyclic and Photochemical Reactions by Dinda and Biswanath
12. Pericyclic Reactions - A Textbook: Reactions, Applications and Theory by S. Sankararaman, Roald Hoffmann (Foreword by)

SECTION-II

Spectroscopic Methods in Structure Determination of Organic Compounds

Detailed Syllabus:

Unit 1: UV and IR Spectroscopy **[04L]**

UV: Recapitulation of UV spectroscopy, Calculation of λ_{max} of organic compound,

IR: IR spectra of important functional groups 1. With and without conjugation, 2. Ring size effect 3. Effect of H-bonding, 4. Resonance effect 5. Inductive effect.

Unit 2: ^{1}H-NMR **[16L]**

Understanding of basic principle, chemical and magnetic nonequivalence, Homotopism, Enantiotopism, diastereotopism, chemical shifts and factors influencing chemical shift: electronegativity, NMR solvent polarity, temperature, anisotropic effect, chemical shifts of acidic protons, D_2O exchange, Multiplicity patterns and Coupling Constants: Pascal's triangle, understanding of tree diagram, complex splitting patterns in aromatic, vinylic, saturated monocyclic compounds, bicyclic compounds (fused and bridged rings), Integration: NMR of racemic mixture, relationship between integration and ee % in diasterotomers.

Problems: complex problems based on multiple coupling constants should be discussed and drawing of expected ^{1}H-NMR spectrum along with complex multiplicity patterns and coupling constants. Drawing of multiplicity patterns and determination of coupling constants of complex multiplets should be discussed.

Unit 3: ^{13}C-NMR **[04L]**

Basic of ^{13}C-NMR: Chemical shift and factors affecting chemical shifts in ^{13}C NMR, off resonance and proton decoupled spectra. Simple problems on ^{13}C-NMR.

Unit 4: Mass spectrometry (MS) **[06L]**

Basic principle of MS, significance of M+ (m/z) in determination of molecular formula, Rule of 13. Genesis of m/z fragments: Aliphatic and aromatic hydrocarbons, alcohols, amines.

Problems: Based on 2-3 fragments of above mentioned functional groups should be discussed.

Combined problems: Problems based on UV, IR, MS, ^{1}H-NMR, ^{13}C-NMR should be solved.

Suggested Reading:

1. Introduction to Spectroscopy by Donald L. Pavia and Gary M. Lampman
2. UV-VIS Spectroscopy and Its Applications by Perkampus, Heinz-Helmut
3. Infrared Spectroscopy: Fundamentals and Applications by Barbara H. Stuart
4. Infrared Spectroscopy by James M. Thompson
5. Spectrometric Identification of Organic Compounds by Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce
6. Introduction to Spectroscopy by Donald L. Pavia
7. Understanding NMR Spectroscopy by James Keeler
8. Spin Dynamics: Basics of Nuclear Magnetic Resonance by Malcolm H. Levitt
9. Guide to Spectroscopic Identification of Organic Compounds by Karen Feinstein
10. Principles of Nuclear Magnetic Resonance in One and Two Dimensions by Richard R. Ernst, Geoffrey Bodenhausen, Alexander Wokaun
11. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry by Harald Günther.
12. Basic One- and Two-Dimensional NMR Spectroscopy by Horst Friebolin
13. Principles of Nuclear Magnetism by A. Abragam
14. Principles of Magnetic Resonance by Charles P. Slichter
15. Nuclear Magnetic Resonance by Peter Hore
16. Applications of NMR Spectroscopy by Atta-Ur-Rahman, M. Iqbal Choudhar
17. Solving Problems with NMR Spectroscopy by Atta-Ur-Rahman, Muhammad Choudhary Atia-tul-Wahab.

Semester -II	**Paper – III**
Course Code: MSC-CH 213T	**Title of the Course: Molecular Spectroscopy**
Credits: 2	**Total Lectures: 30Hrs**

Course Outcome:

- Student will gain the basic knowledge about the principle of spectroscopic technique.
- They will know the quantization concept of energy.
- Student will expose to different instrumental components of spectrophotometer.
- They will understand the electromagnetic spectrum and its various

characteristics.

- Student will be able to differentiate between various spectroscopic technique.

Detailed Syllabus:

Unit 1: Introduction to molecular spectroscopy (04 L)

Characterization of electromagnetic radiation, quantization of energy, regions of the spectrum, representation of spectra, basic elements of practical spectroscopy, Signal-to-Noise: Resolving power, width and intensity of spectral transitions.

Unit 2: Microwave Spectroscopy (04 L)

Types of molecules on the basis of moment of inertia and rotational spectra of di- and poly-atomic molecules.

Unit 3: Infra-red Spectroscopy (06 L)

The vibrating diatomic molecule, harmonic and Anharmonic oscillator, The diatomic vibrating rotator, breakdown of the Born-Oppenheimer approximation, The vibrations of polyatomic molecule, Fourier transform spectroscopy and its advantages, The carbon dioxide laser, Applications.

Unit 4: Raman Spectroscopy (06 L)

Quantum and classical theory of Raman effect, pure rotational Raman spectra, vibrational Raman spectra, polarization of light and Raman effect, structure determination from Raman and Infra-red spectroscopy, applications.

Unit 5: Electronic Spectroscopy of molecules (06 L)

Electronic spectra of diatomic molecules - The Born- Oppenheimer approximation, Vibrational coarse structure, Frank- Condon principle, dissociation energy and dissociation product, Rotational fine structure of electronic-vibration transition.

Unit 6: Mossbauer Spectroscopy (04 L)

Principle, Instrumentation and Applications of Mossbauer Spectroscopy.

Suggested Reading:

1. Fundamentals of molecular spectroscopy by C. N. Banwell and E. M. McCash.
2. Atomic and molecular spectroscopy by V. K. Jain.
3. Fundamental of Molecular spectroscopy by P. S. Shindhu.
4. Atomic and molecular spectroscopy – Basic concepts and application, Cambridge University press, 2015.
5. Molecular spectroscopy Jeanne L. McHale,2nd edition, CNC press.
6. Molecular spectroscopy by Jack D Graybeal, revised 1st edition.

Semester -II	Paper – IV
Course Code: MSC-CH 214P	Title of the Course: Inorganic Chemistry Practical II
Credits: 2	Total Lectures: 60Hrs

Course Outcome:

- Students are trained to different purification techniques in Inorganic chemistry like recrystallization, distillation, steam distillation and extraction.
- Students are made aware of safety techniques and handling of chemicals.
- Students are made aware of carrying out different types of reactions and their workup methods.
- This practical course is designed to make student aware of green chemistry and role of green chemistry in pollution reduction.

Detailed Syllabus:

Time allotted: Two practical sessions of 4 hours per week for one semester (one practical session for Section-I and one practical session for Section-II per week is compulsory)

Part-I: Synthesis of coordination complexes (any three)

1. Synthesis and Purity of $[Mn(acac)_3]$.
2. Synthesis and Purity Chloropentaamminecobalt(III) chloride.
3. Synthesis and Purity Nitropentaamminecobalt(III) chloride.
4. Synthesis and Purity Bis[TrisCu(I)thiourea].

Part-II: Inorganic Conductometry (any two)

1. Structural determination of metal complexes by conductometric measurement.
2. To study complex formation between Fe(III) with sulfosalicylic acid by conductometry.
3. To verify the Debye Huckel theory of ionic conductance for strong electrolytes KCl,$BaCl_2$, K_2SO_4 and $[K_3Fe(CN)_6]$.
4. Determination of Pb(II) in solution with Na_2SO_4 solution and determination of solubilityproduct of $PbSO_4$.

Part-III: Inorganic characterization techniques (any two of the following)

1. Determination of equilibrium constant of M – L systems Fe(III)–Sulphosalicylic acid or Fe(III)–β–resorcilic acid by Job's continuous variation method.
2. Solution state preparation of $[Ni(en)_3]S_2O_3$, $[Ni(H_2O)_6]Cl_2$, $[Ni(NH_3)_6]Cl_2$. Record absorption spectra in solution of all three complexes and calculate 10

Dq. Arrange threeligands according to their increasing strength depending on your observations.

3. Determination of magnetic susceptibility (χg and χm) of mercury tetracyanato cobalt or $Fe(acac)_3$ or Ferrous ammonium sulfate by Faraday or Gouy method.

Part-IV: Inorganic Kinetics Experiment (any two)

1. Synthesis and photochemistry of $K_3[Fe(C_2O_4)_3].3H_2O$.
2. Kinetics of substitution reaction of $[Fe(Phen)_3]^{2+}$
3. Kinetics of formation of Cr(III)-EDTA complex

Part-V: Ion – Exchange Chromatography

1. Separation of mixture of Zn(II) and Mg(II) using Amberlite IRA 400 anion exchangerand quantitative estimation of separated ions Zn(II) and Mg(II).

Part-VI: Solvent Extraction and colorimetric (any one experiment)

1. Determination of Cu(II) by solvent extraction as Dithiocarbamate complex.
2. Determination of iron by solvent extraction techniques in a mixture of Fe(III) +Al(III) orFe(III) + Ni(III) using 8–hydroxyquinoline reagent.

Suggested Reading:

1. Vogel's Textbook of Inorganic quantitative analysis.
2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in ChemicalScience (Horwood publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House.
4. General Chemistry Experiments, Anil. J Elias, University Press (2002).
5. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books.

Semester -II	**Paper – V**
Course Code: MSC-CH 215P	**Title of the Course: Organic Chemistry Practical II**
Credits: 2	**Total Lectures: 60Hrs**

Course Outcome:

1. Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
2. Students are made aware of safety techniques and handling of chemicals.
3. This course is designed to make students aware of how to perform organic compounds in laboratory.
4. The course includes synthesis of some derivatives and organic compounds, which will help them while working in research laboratory in future.

5. Making derivatives of organic compounds will help them in industry or while doing research in medicinal chemistry for Drug development.
6. This practical course is also designed to make student aware of green chemistry and role of green chemistry in pollution reduction.
7. The students learn how to avoid solvents and do solvent free reaction.
8. Also the work-up procedure in many experiments is made more eco-friendly to environment.

Detailed Syllabus:

1. Base catalyzed aldol condensation using $LiOH.H_2O$ as a Catalyst.
2. Bromination of trans-stilbene using sodium bromide and sodium bromate
3. [4+2] cycloaddition reaction.
4. Benzil-Benzilic acid rearrangement under solvent free condition
5. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate.
6. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium.
7. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst.
8. Preparation of 1, 1-bis-2-naphthol from 2-napthol.
9. Solvent free aldol condensation between 3, 4-dimethoxybenzaldehyde and 1-indanone.
10. Synthesis of Azalactone from Hippuric Acid.
11. Preparation of thioamide from benzaldehyde in water.
12. Alkyne-azide cycloadditon (click Chemistry).

Note: Students should perform a) Column chromatography. b) Spectroscopic interpretation. c) How to draw schemes and mechanism using Chemsketch/Chemdraw / ISIS Draw etc.

Suggested Reading:

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
2. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.

Semester -II	**Paper – VI**
Course Code: MSC-CH 216P	**Title of the Course: Physical Chemistry Practical II**
Credits: 2	**Total Lectures: 60Hrs**

Course Outcome:

- Student will get hands on training for instruments like conductometer, Polarography.

- Student will able to perform graphical analysis.
- They will able to perform data analysis from the experimental data.
- Student will understand the working mechanism of pH meter.

Detailed Syllabus:

Time allotted: One practical Session of 4 hours per week for one semester total
11 practical to be conducted.

Part-I: Conductometry (Any three)

1. Hydrolysis of NH_4Cl or CH_3COONa or aniline hydrochloride.
2. Determination of λ_0 or λ_α and dissociation constant of acetic acid.
3. Hydrolysis of ethyl acetate by NaOH.
4. Determination of ΔG, ΔH, and ΔS of silver benzoate by conductometry.
5. Determination of critical micellar concentration (CMC) and ΔG of micellization of sodium Lauryl Sulphate / Detergent

Part-II: Polarography (any one)

6. Determination of half wave potential $E_{1/2}$ and unknown concentration of Cu or Pb or Zn ion.
7. Amperometric titration of $Pb(NO_3)_2$ with $K_2Cr_2O_7$.

Part-III: Potentiomerty: (Any three)

8. Stability Constant of a complex ion.
9. Solubility of a sparingly soluble salt.
10. To determine the ionic product of H_2O
11. Estimation of halide in mixture.

Part-IV: pH metry (any two)

12. Determination of the acid and base dissociation constant of an amino acid and hence the isoelectric point of the acid.
13. Determination of dissociation constants of tribasic acid (phospheric acid).
14. Construct pH curve for titration of strong base – strong acid, strong base - weak acid and predict the best indicator in these titrations (methyl orange, methyl orange, bromocresol green, phenolphthalein, etc.)

Part-V: Table Work (any two)

15. Analysis of powder XRD of $SrTiO_3$ and Ag metal or any two compounds.

(Calculation d, constant, crystal volume and density, and assigning planes to peaks using JCPDS data)

19. Detailed interpretation of Raman spectra of diatomic molecules.

Suggested Reading:

1. Practical physical chemistry, A. Findlay, T. A. Kitchner (Longmans, Green and Co.)
2. Experiments in Physical Chemistry, J. M. Wilson, K. J. Newcombe, A. R. Denko. R. M. W. Richett(Pergamon Press)
3. Senior Practical Physical Chemistry, B. D. Khosla and V. S. Garg (R. Chand and Co., Delhi.).
4. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
5. Physical chemistry by Wien (2001)
6. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut)
7. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
8. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books

Semester -II	**Paper – VII**
Course Code: MSC-CH 217T	**Title of the Course:** **Elective Option-A: Nuclear and Radiation Chemistry** **OR** **Elective Option-B: Material Characterization Technique**
Credits: 2	**Total Lectures: 30Hrs**

Elective Option-A: Nuclear and Radiation Chemistry

Course Outcome:

- Student will understand the basic mechanism of radioactive decay.
- They will know the hazards and harms of radiations.
- Student will understand the applications of radioactive elements in the various fields.
- They will understand the working mechanism of nuclear reactors and its Applications.
- Student will acquire the basic knowledge about determining the radioactivity.

Detailed Syllabus:

Unit 1: Radioactivity (06 L)

Types of radioactive decay, general characteristics of radioactive decay, decay kinetics, general expression for the activity of a daughter nuclide, Geiger- Nuttalis law, α-decay: A problem in classical physics, Internal conversion and the Auger effect.

Unit 2: Elements of Radiation (06 L)

Chemistry: Interaction of radiation with matter, interaction of γ radiation with matter, units for measuring radiation absorption, Radiation dosimetry, Radiolysis of water, free radicals in water radiolysis, Radiolysis of some aqueous solutions.

Unit 3: Nuclear Reactor (08 L)

The fission energy, The Natural uranium reactor, the four factor Formula- The reproduction factor K, the classification of reactor, Reactor power, Critical size of thermal reactor, excess reactivity & control, the Breeder reactor, The Indians nuclear energy programme, Reprocessing of spent fuel, Recovery of Uranium & Plutonium, Nuclear waste management, Natural nuclear reactor.

Unit 4: Applications of Radioactivity (10 L)

Typical reaction involved in the preparation of radioisotopes, The Szillard- Chalmers reaction, Radiochemical principles in the use of tracers, Isotopes in elucidating reaction mechanism and structure determination, physic-chemical research - The solubility of a sparingly soluble substances, surface area of a powder or precipitate rates of diffusion, Analytical applications- Isotope dilution analysis, Neutron activation analysis, Radiometric titrations, Medical applications-Thyroiditis, Assessing the volume of blood in a patient, Industrial applications thickness measurements and control, friction and wear out, gamma radiography.

Suggested Reading:

1. Elements of Nuclear Chemistry by H. J. Arnikar
2. Source book of Atomic energy by S. Glasstone and D. Van.
3. Chemical applications of radioisotopes by H. J. M. Brown
4. Nuclear and radiochemistry fundamentals and applications by Kratz J. V., Liser K. H. 3rd edition, 2016, Wiley.
5. Handbook of Nuclear Chemistry by Sheron M., Sheron M.
6. Modern Nuclear Chemistry by Seaborg G. T., D. J. Morrissey, Loveland W., Wiley.
7. Nuclear Chemistry Malik R. K., Neelam Kumari, Sabarwal P. S., Pragati publications.

Elective Option-B: Material Characterization Technique

Course Outcome:

At the end of course student will understand / able to explain

- Different characterization technique of solids.
- Principle of XRD, instrumentation of powder XRD, Brags law, applications of XRD for crystal structure determination, numerical problems.
- Principle of SEM, instrumentation of SEM and interpretation of surface morphology of solid from SEM.
- Principle of TEM, instrumentation of TEM and interpretation of TEM images.
- Basics of X-rays, Principle of XRF, types of XRF, instrumentation, qualitative and quantitative analysis, numerical.

Detailed Syllabus:

Unit 1: X-Ray Diffraction Methods (06 L)

Miller and Weiss indices, X-Ray Radiation, Generation of X-Rays, X-Ray Absorption, Theoretical Background of Diffraction, Diffraction Geometry, Bragg's Law, Reciprocal Lattice, Diffraction Intensity, Structure Extinction, X-Ray Diffractometry, Instrumentation, System Aberrations, Samples and Data Acquisition, Sample Preparation, Acquisition and Treatment of Diffraction Data, Distortions of Diffraction Spectra, Crystallite Size, Applications, Crystal-Phase Identification, Quantitative Measurement , Wide-Angle X-Ray Diffraction and Scattering, Wide-Angle Diffraction, Wide-Angle Scattering. Problem on XRD (Calculation of d values, assigning planes, calculation of crystal parameters).

Unit 2: Transmission Electron Microscopy (06 L)

Instrumentation, Electron Sources, Thermionic Emission Gun, Field Emission Gun, Electromagnetic Lenses , Specimen Stage, Specimen Preparation, Prethinning, Final Thinning, Electrolytic Thinning, Ultramicrotomy, Image Modes (Mass–Density Contrast, Diffraction Contrast, Phase Contrast), Selected-Area Diffraction (SAD), Selected-Area Diffraction Characteristics.

Unit 3: Scanning Electron Microscopy (06 L)

Instrumentation, Optical Arrangement, Signal Detection, Detector, Probe Size and Current Contrast Formation, Electron–Specimen Interactions, Topographic Contrast, Compositional Contrast, Operational Variables, Working Distance and Aperture Size, Acceleration Voltage and Probe Current, Astigmatism, Specimen Preparation, Preparation for Topographic examination.

Unit 4: X-Ray Spectroscopy for Elemental Analysis (12 L)

Features of Characteristic X-Rays, Types of Characteristic X-Rays, Selection Rules, Comparison of K, L, and M Series, X-Ray Fluorescence Spectrometry, Wavelength Dispersive Spectroscopy, Analyzing Crystal, Wavelength Dispersive Spectra, Energy Dispersive Spectroscopy, Detector, Energy Dispersive Spectra, Advances in Energy,

Dispersive Spectroscopy, XRF Working Atmosphere and Sample Preparation, Energy Dispersive Spectroscopy in Electron Microscopes, Special Features, Scanning Modes, Qualitative and Quantitative Analysis, Qualitative Analysis, Quantitative Analysis, Quantitative Analysis by X-Ray Fluorescence, Fundamental Parameter Method, Quantitative Analysis in Electron Microscopy, Numerical.

Suggested Reading:

1. Yang Leng, Materials Characterization -Introduction to Microscopic and Spectroscopic Methods, Second Ed. Wiley-VCH,
2. R. D. Braun, Introduction to Instrumental Analysis, Second Ed.
3. Elaine A. Moore, Lesley E. Smart - Solid State Chemistry - an Introduction. Fourth Ed. CRC Press (2012)

Semester -II	**Paper – VIII**
Course Code: MSC-CH 218P	**Title of the Course:** **Elective Option -A: Analytical Chemistry Practical** **OR** **Elective Option B : Interpretation and Analysis of Spectra**
Credits: 2	**Total Lectures: 60Hrs**

Elective Option -A: Analytical Chemistry Practical

Course Outcome:

- This course is designed to give an idea about understanding the composition of mixture using TLC
- Student gets familiar with the Study of IR for analysis
- This course is designed to understand the quality checking process of water and evaluation of quality of water samples
- Student will get an idea about analysis of vitamins and adulteration of food products and their determination.
- Student understand the detail working and use of instruments like FES, Polarimeter, Colourimeter, Conductometer, pH meter for analysis of different samples

Detailed Syllabus:

Time allotted: One practical Session of 4 hours per week for one semester total **11** practical to be conducted.

1. Analysis of composition of mixtures of nitroanilines by TLC.
2. Study of characteristic infrared absorption frequencies.
3. Determination of buffering capacity of water by pH metry.
4. Determination of anionic detergents in water sample by methylene blue method.
5. Calibration of volumetric glasswares.
6. Spectrophotometric determination of iron in vitamin supplement/spinach leaves.
7. Determination of saponification value of oil.
8. Adulteration test for food and food products.
9. Determination of amount of glucose and sucrose in honey by polarimetry in honey sample.
10. Determination of ionisation constant of bromophenol blue.
11. Determination of percentage of hydrogen peroxide in ear drops by redox titration.
12. Determination of dissolved form of chromium in water sample by colorimetry.
13. Determination of calcium in dolomite sample by flame photometry.
14. Determination of nitrite in fertilizer/water sample spectrophotometrically.
15. Determination of molecular mass by viscometry measurements.
16. Determination of concentration of sulphuric acid, acetic acid and copper sulphate by Conductometric titration with sodium hydroxide.

Suggested Reading:

1. Vogels Textbook of inorganic quantitative analysis, A. I. Vogel, 3rd edition.
2. Standard methods of chemical analysis, Welcher.
3. An introduction to practical biochemistry, David T. Plummer, Tata McGraw-Hill Publishing Company Ltd.
4. Standard methods for the examination of water and waste water, 23rd Ed. Jointly published by.
5. American Public Health Association, American water work association, water environmental federation 2017.

Elective Option-B: Interpretation and Analysis of Spectra

Course Outcome:

After having completed the practical course, the student should be able to -

- Use of Woodward and Fieser rule, relationship between conjugation and λ_{max}, Effect of Chromophore, Extent of conjugation, Distinction between conjugated andconjugated compounds, Study of Geometric isomerism.
- Identification of functional groups or some significant bands in Infrared operator.
- Recognition of different protons and carbons, chemical shift position,

multiplicity ofthe signal and value of J, equivalent and non-equivalent protons.

- SEM and TEM analysis provides information surface morphology, crystalline structure, stress internal fractures,contaminants and more.
- Decomposition study of complexes by thermal method like TGA and DTA. Magnetic susceptibility measurement by Gouy method.

Detailed Syllabus:

Time allotted: One practical Session of four hour per week for a semester

Total 11 practical to be conducted

1. Comparison of calculated value with observed values of λ_{max} of differently substituted organic compounds.
2. Interpretation and Comparison of infrared spectrums of various known and unknown compounds.
3. Identification of proton and carbon magnetic resonance spectrum and its Interpretation.
4. Interpretation of mass spectrum and prediction of fragmentation in different compounds.
5. Use of two dimensional spectroscopy in determination of unknown compound.
6. Identification and Interpretation of Scanning electron microscopy micrograph.
7. Interpretation of Transmission electron microscopy image.
8. Separation and analysis study of mixture using Gas Chromatogram.
9. Decomposition study of complexes by the use of Thermogram from Thermo gravimetric analyser.
10. Analysis of Differential Thermal Analysis curve.
11. Surface topography by using atomic force microscopy images.
12. Study of changes in the nuclear environment of the atoms by Mossbauer spectrum.
13. Use of Gouy method is Magnetic Susceptibility measurement.
14. Study and importance of x-ray diffraction diagram to determine the complicated structure.
15. Electron Spin Resonance Spectroscopy of metal complexes or organic radicals.
16. Concentration study of metallic elements in different materials through the analysis of atomic Absorption/Emission spectra.

Suggested Reading:

1. Vogel's Textbook of Quantitative Chemical Analysis, Sixth edition – J Mendham, R C Denney, J D Barnes, M Thomas and B Sivasankar, Peterson.
2. Ultraviolet and Visible Spectroscopy – Michael Thomas, Wiley India Ed
3. Spectroscopy of Organic Compounds – P S Kalsi, New Age Int. Ltd.
4. Introduction to Instrumental Analysis – Robert D Braun.
5. Fundamentals of Molecular Spectroscopy – Colin N Banwell and Elaine M McCash.

Semester -II	Paper – IX
Course Code: MSC-CH 219T	Title of the Course: Organometallic and Inorganic Reaction Mechanism
Credits: 2	Total Lectures: 30Hrs

Elective Option-A: Organometallic and Inorganic Reaction Mechanism

Course Outcome:

At the end of course students will able to explain

- Valence electron count, back bonding in organometallics, spectral characterization of organometallic compounds.
- Catalytic reaction involving organometallic compounds and mechanism of these reactions
- Types of reaction involving organometallic compounds.
- Types of reactions in coordination compounds, inert and labile complexes, substitution reactions in coordination complexes and their mechanism, stereochemistry of reaction, kinetics of reactions.

Detailed Syllabus:

Unit 1: Organometallic Chemistry (10 L)

Introduction, Historical background, Organic ligands and nomenclature, 18 electron rule: counting electrons, Ligands in organometallic Chemistry – carbonyl complexes, ligands having extended pi system, bonding between Metal Atoms and organic pi systems: linear pi system, cyclic pi system, spectral analysis and characterization of organometallic complexes: IR and NMR, examples.

Unit 2: Organometallic Reactions and Catalysis (10 L)

Reactions involving gain and loss of ligands: ligand dissociation and substitution, oxidative addition, reductive elimination, nucleophilic displacement, reactions involving modification of ligands: insertion, carbonyl insertion, 1-2 insertion, hydride elimination, abstraction, organometallic catalysis: Hydroformylation, Monsanto acetic acid process, Wacker Process, Hydrogenation by Willkinsons catalyst, Olefin metathesis, heterogeneous catalysis: Ziegler Natta Polymerization, Water gas reduction.

Unit 3: Coordination Compounds: Reactions and Mechanism (10L)

History and principles, Substitution reactions: Inert and labile complexes, mechanism of substitution, Kinetics Consequences of reaction pathway: dissociation, interchange, association, experimental evidences in octahedral Substitution: dissociation, linear free energy relationship, associative mechanism, the conjugate base mechanism, the kinetic

chelate effect, stereochemistry of reactions: substitution in trans complexes, substitution in cis complexes, isomerisation of chelate rings, substitution reactions in square planar Complexes. Trans effect, explanations of the trans effect.

Suggested Reading:

1. Inorganic Chemistry: Gary Miessler and Donald A. Tarr, Fifth edition., Pearson.
2. Reaction Mechanism of Inorganic and Organometallic systems by Robert B. Jordan.
3. Inorganic and organometallic reaction mechanisms, Atwood J. D., 2nd edition.
4. Mechanisms of Inorganic and organometallic reactions by M. V. Twigg.
5. Inorganic Reaction Mechanisms by John Burgess, Vol 3.

Faculty of Science and Technology

Master of Science (M.Sc.)

Rules and regulation

1. The M. Sc. programme is for 2 academic years and 4 semesters. The minimum total number of credits requirements for each programme is 88 credits and 12 additional credits for grades.
2. The M.Sc. The degree will be awarded to the students who complete a total of 88 credits in a minimum of two years by completing an average of 22 credits per semester and 12 additional grade-based credits
3. Each theory credit is equivalent to 15 clock hour of teaching and each practical credit is equivalent to 30 clock hour of teaching in a semester.
4. Semester GPA will be calculated based on 22 credits and Final CGPA will be calculated on the basis of 88 credits of all the four semesters.
5. The duration of each theory semester is 15-18 weeks in which at least 12-week classroom teaching and 03 weeks of continuous internal assessment is must.
6. The duration of each practical semester is 15 to 18 weeks in which at least 14-week laboratory session and one week of internal evaluation including viva and journal certification is must.
7. The student can complete the two-year degree programme in maximum four years by completing less number of credits in each semester. This rule is not applicable to practical courses, as student need to opt practical courses in the two years of degree programme.

8. Discipline Specific Core Courses (DSCC) are compulsory in nature.
9. Students are allowed to opt the Discipline specific elective and project credits from another department then where he/she is registered for M.Sc. Students are also allowed to take all the courses/credits from parent department.

Distribution of credits

Type of Courses	**Total Credits**	**Credits/ semester**
Discipline Specific Core Courses (DSCC)	64/62	16
Discipline Specific Elective Courses (DSCE	16	04
Generic Elective	06	02 (only I, II and III)
Project Work/ Internship (DSCC)	02	02 (IV Semester)
Total	88	22

Master of Science (M.Sc.) Course Distribution

Class	**Semester**	**Subjects**	**Courses**	**DSCC**		**DSEC**		**GE**	**Project**	**Total Credits**
				T	P	T	P	T or P		
M.Sc. I	I	01	09	03	03	01	01	01		22
M.Sc. I	II	01	09	03	03	01	01	01		22
M.Sc. II	III	01	09	03	03	01	01	00	01	22
M.Sc. II	IV	01	09	03	03	01	01	00	01	22
M.Sc. II	IV*	01	Internship/ Industrial Project							22

Master of Science (M.Sc.) Credit Distribution

Class	**Semester**	**Subjects**	**Courses**	**DSCC**	**DSEC**	**GE**	**Project**	**Total Credits**

				T	P	T	P	T	P		
M.Sc. I	I	01	09	09	06	03	02	02	00	00	22
M.Sc. I	II	01	09	09	06	03	02	02	00	00	22
M.Sc. II	III	01	09	09	06	03	02	02	00	00	22
M.Sc. II	IV	01	09	09	06	03	02	00	00	02	22
M.Sc. II	IV*	01	Internship/ Industrial Project								22

Distribution of Credits

Class	Semester	Course and their credits in Bracket			
		DSCC	DSEC	GE	Project
M.Sc. I	I	DSCC-01 (04)	DSEC -01 (02)	GE-01(02)	NA
M.Sc. I	I	DSCC-02 (04)	DSEC-02 (02) P		
M.Sc. I	I	DSCC-03 (02)			
M.Sc. I	I	DSCC-04 (02) P			
M.Sc. I	I	DSCC-05 (02) P			
	I	DSCC-06 (02) P			
M.Sc. I	II	DSCC-07 (04)	DSEC -03 (02)	GE-02(02)	NA
M.Sc. I	II	DSCC-08 (04)	DSEC-04 (02) P		
M.Sc. I	II	DSCC-09 (02)			
M.Sc. I	II	DSCC-10 (02) P			
M.Sc. I	II	DSCC-11 (02) P			
M.Sc. I	II	DSCC-12 (02) P			
M.Sc. II	III	DSCC-13 (04)	DSEC -05 (02)	GE-03(02)	NA
M.Sc. II	III	DSCC-14 (04)	DSEC-06 (02) P		
M.Sc. II	III	DSCC-15 (02)			
M.Sc. II	III	DSCC-16 (02) P			
M.Sc. II	III	DSCC-17 (02) P			
M.Sc. II	III	DSCC-18 (02) P			
M.Sc. II	IV	DSCC-19 (04)	DSEC -07 (02)	NA	Project (02)

M.Sc. II	IV	DSCC-20 (04)	DSEC-08 (02) P		
M.Sc. II	IV	DSCC-21 (02)			
M.Sc. II	IV	DSCC-22 (02) P			
M.Sc. II	IV	DSCC-23 (02) P			
M.Sc. II	IV	DSCC-24 (02) P			
M.Sc. II	IV	Internship or Industrial Training (22)			

1. The students need to complete the DSCC and DSEC credit from parent department and Generic Elective and Projects/ Internship credits can be earned from any department from the college or industry.

Structure of CGPA and Marking Scheme of CBCS for Postgraduate Science Programmes

Semester -I

Semester	Course Code	Type of Course	Course Name	Credits	Maximum Internal Marks	Maximum External Marks	Total
I	DSCC-01 (04)	Theory	X	04	30	70	100
I	DSCC-02 (04)	Theory	X	04	30	70	100
I	DSCC-03 (02)	Theory	X	02	15	35	50
I	DSCC-04 (02) P	Practical	X	02	15	35	50
I	DSCC-05 (02) P	Practical	X	02	15	35	50
I	DSCC-06 (02) P	Practical	X	02	15	35	50
I	DSEC-01	Theory	X	02	15	35	50
I	DSEC-02	Practical	X	02	15	35	50
I	GE-01	Theory	X	02	15	35	50
	Semester Total			22	165	385	550

Semester -II

II	DSCC-07 (04)	Theory	X	04	30	70	100
II	DSCC-08 (04)	Theory	X	04	30	70	100
II	DSCC-09 (02)	Theory	X	02	15	35	50

II	DSCC-10 (02) P	Practical	X	02	15	35	50
II	DSCC-11 (02) P	Practical	X	02	15	35	50
II	DSCC-12 (02) P	Practical	X	02	15	35	50
II	DSEC-03	Theory	X	02	15	35	50
II	DSEC-04	Practical	X	02	15	35	50
II	GE-02	Theory	X	02	15	35	50
Semester Total				22	165	385	550

Semester -III

III	DSCC-13 (04)	Theory	X	04	30	70	100
III	DSCC-14 (04)	Theory	X	04	30	70	100
III	DSCC-15 (02)	Theory	X	02	15	35	50
III	DSCC-16 (02) P	Practical	X	02	15	35	50
III	DSCC-17 (02) P	Practical	X	02	15	35	50
III	DSCC-18 (02) P	Practical	X	02	15	35	50
III	DSEC-05	Theory	X	02	15	35	50
III	DSEC-06	Practical	X	02	15	35	50
III	GE-03	Theory	X	02	15	35	50
	Semester Total			22	165	385	550

Semester -IV

IV	DSCC-19 (04)	Theory	X	04	30	70	100
IV	DSCC-20 (04)	Theory	X	04	30	70	100
IV	DSCC-21 (02)	Theory	X	02	15	35	50
IV	DSCC-22 (02) P	Practical	X	02	15	35	50
IV	DSCC-23 (02) P	Practical	X	02	15	35	50
IV	DSCC-24 (02) P	Practical	X	02	15	35	50
IV	DSEC-07	Theory	X	02	15	35	50

IV	DSEC-08	Practical	X	02	15	35	50
IV	Project	Practical	X	02	15	35	50
Semester Total				22	165	385	550
Total				88	660	1540	2200

1. Mechanism for workload computation:
   a. 01 credit is equivalent to 01-hour theory lecture per week
   b. 01 credit is equivalent to 02-hour practical session per week

Additional Credits for All PG programmes

Sr. No.	Title	Credits	Remark
1.	Constitution of India / Ethics and Values	02	Compulsory
2.	Human Right	02	Compulsory
3.	Cyber Security	02	Compulsory
4.	Intellectual Property Rights	02	Compulsory
5.	Completion of SWAYAM/MOOC Course	02	Optional
6.	Completion of skill-based certificate course at College level	02	Optional
7.	State/ National Level Medal/Award for curricular /Extracurricular/ Cultural/ Sports and games activities	04	Optional
8.	Prize in curricular/ extracurricular/ cultural activities at college level/University level	02	Optional
9.	The courses of 02 credits opted from other departments / disciplines	02	Optional
10.	Book Review on book suggested by academic Council	02	Optional