Curriculum & Syllabi

of

Master of Science

In

Chemistry

(w.e.f. 2018-19)

Vision
Mission
Program Educational Objectives
Program Outcomes
Program Specific Outcomes
Overall Credit Structure
Curriculum
Syllabus

Offered By

CHEMISTRY & ENVIRONMENTAL SCIENCE DEPARTMENT
M. M. M. UNIVERSITY OF TECHNOLOGY,
GORAKHPUR-273010, UP
August 2021

Department of Chemistry and Environmental Science

1. **Mission:**

    1. *To generate human resource of excellent quality, with high professional competence and research in the core and allied areas of basic sciences for the international and national needs.*
    2. *To generate and validate new scientific knowledge by engaging in cutting-edge research and to promote academic growth by offering state-of-the-art bachelor, master and doctoral programmes.*
    3. *To inculcate scientific skills for future needs.*
    4. *To enhance human skills to its fullest potential so that they may become intellectually capable and imaginatively gifted leaders in emerging range of professions.*

2. **Vision:**
   To foster excellence by nurturing scientific knowledge emerging out of experimentally/theoretically proven facts and tools in intellectual areas of engineering, and technology and to serve as an invaluable resource repository for industry, community and society.

3. ***M.Sc. Chemistry (Effective from the session 2020-2021)***

   The Objective of M.Sc. Chemistry program of this department is to create all possible Opportunities to the students for their close interaction with national/international research institutes and industries to provide high level training and teaching learning. Continuous up gradation of syllabi with due consultation of experts both from academia and Industries will be ensured, so that the students can cater the current needs of the Research Institutes and Industries.
   Collaborations will be done with a group of research institutions national/international and Industries for the placement of the students. Thus, the present program will prepare the younger generation to cope with the emerging scenario in the top-level industries, academic and research institutions. As per NEP-20 we are preparing the course program of multi exit level as per the employability of students in the field of Medicinal Chemistry, Polymer Chemistry, Solar energy, and Nuclear chemistry.

   Course Structure:

    1. *In the first semester there are four core theory papers out of which one is theory based practical, one core laboratory course and one audit course.*
    2. *In the second semester there are three core theory papers one core laboratory course, one course of programme electives and one audit course.*
    3. *In the third semester there are two core theory papers, one core laboratory course, two courses of programme elective and minor dissertation.*
    4. *In the fourth semester there is one core theory papers, one core laboratory course,*
       major dissertation.

4. *.Program Educational Objectives (PEO):*

*The program **educational** objectives (PEO) are the statement that illustrates the career and professional attainment after the agenda of studies (M.Sc. chemistry).*

1. *To have advance knowledge of chemistry domain.*
2. *To provide the professional services to industry, Research organization, institutes.*
3. *To provide the professional consultancy and research support for the relevant organization in the domain of super specialization.*
4. *To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.*
5. *To provide, value based and ethical leadership in the professional and social life.*
6. *To train PG graduates with higher qualifications for Industries and educational institutes.*
7. *To impart knowledge of industrial chemistry to students that comprises of good balance between pure and applied areas of chemistry along with subject of chemical engineering through classrooms teaching, self-study, group discussion, seminar, industrial visit, internship, dissertation, and practical training in laboratories.*
8. *To provide proper Industrial training and exposure to the students to real work environment of R&D, Quality Control and Production units of Chemical Industries such as Pharmaceutical, Paints, Polymers, Petrochemicals, Metal Refining Industries etc.*

5. *Programme Specific Outcome (PSO):*

1. *Have sound knowledge about the fundamentals and applications of chemical and scientific theories*
2. *Every branch of Science and Technology is related to Chemistry*
3. *Easily assess the properties of all elements discovered.*
4. *Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.*
5. *Will become familiar with the different branches of chemistry like analytical, organic, inorganic, physical, environmental, polymer and biochemistry*
6. *Helps in understanding the causes of environmental pollution and can open up new methods for environmental pollution control.*
7. *Develops analytical skills and problem-solving skills requiring application of chemical principles.*
8. *Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.*

6. ***Program Outcomes (POs):***

The program outcomes (POs) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the post-graduate will have by the end of program studies.

1. *In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.*
2. *Apply/implement interface between on the one hand, the history of chemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.*
3. *Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.*
4. *Skill in examining specific phenomena theoretically and/or experimentally.*
5. *Generation of new scientific insight sort the innovation of new applications of chemical research.*
6. *To possess requisite skills to be placed in Chemical Industries as well as Academic & Research Institutes.*
7. *To handle the problems of Chemical Industries through design & development of new protocols of new chemicals and products with better quality and lower cost.*
8. *To be hired for higher positions in Chemical Industries, R& D Labs, Research and Educational Institutes.*
9. *To acquire professional ethics, responsibilities, leadership qualities, and the importance of teamwork.*
10. *To communicate with others, make effective presentations, and write scientific reports and documents.*
11. *To handle general laboratory and sophisticated instruments used in chemical laboratories.*
12. *To have sufficient research aptitude to handle their future doctoral work as well as in industries or institutes.*

Department of Chemistry and Environmental Science
Madan Mohan Malaviya University of Technology
Gorakhpur-273010

Credit Structure

Category	I	II	III	IV	Total
Programme Core (PC)	20	16	11	7	**54**
Programme Electives (PE)		4	8		**12**
Dissertation (D)			4	12	**16**
Audit					
Total	**20**	**20**	**23**	**19**	**82**

Semester wise
Course Structure for M.Sc. Chemistry

Junior Year, Semester I

S. No.	Paper Code	Subject Name	L	T	P
Junior Year, Semester I (CoreandFoundationCourses)					
1.	MCY-101	Organic Chemistry I	3	1	0
2.	MCY-102	Inorganic Chemistry I	3	1	0
3.	MCY-103	Physical Chemistry I	3	1	0
4.	MCY-104	Molecular Spectroscopy	3	1	0
5.	MCY-105	Lab Coursework -I	0	0	9
6.	**Audit	Audit Subject	-	-	-

* *Offered by another department.

S. No.	Paper Code	Subject Name	PO1	PO2	PO3
Junior Year, Semester II (Core and Foundation Courses)			**L**	**T**	**P**
1.	MCY-106	Organic Chemistry II	3	1	0
2.	MCY-107	Inorganic Chemistry II	3	1	0
3.	MCY-108	Physical Chemistry II	3	1	0
4.	MCY-109	Lab Coursework -II	0	0	9
5.	MCY*	Program Elective 1	3	1	0
7.	**Audit	Audit Subject			

S. No.	Paper Code	Subject Name	L	T	P
Senior Year, Semester III (Core and Foundation Courses)					
1.	MCY-201	Instrumental method of analysis	3	1	0
2.	MCY-202	Organic Chemistry-III	3	1	0
3.	MCY-203	Lab Coursework -III	0	0	6
4.	MCY*	Program Elective 2	3	1	0
5.	MCY*	Program Elective 3	3	1	0
6.	MCY-350	Dissertation Part-1	0	0	8

S. No.	Paper Code	Subject Name	L	T	P
Senior Year, Semester IV (Core and Foundation Courses)					
1.	MCY-204	Heterocyclic Chemistry	3	1	0
2.	MCY-205	Lab Coursework -IV	0	0	6
3.	MCY-450	Dissertation Part-2	0	0	24

S. No.	Paper Code	Subject Name	L	T	P
Program Elective Courses (PC)					
1.	MCY-121	Polymer Chemistry	3	1	0

2.	MCY-122	Chemistry in Biology	3	1	0
3.	MCY-123	Photochemistry	3	1	0
4.	MCY-131	Environmental Chemistry	3	1	0
5.	MCY-132	Industrial Chemistry	3	1	0
6.	MCY-133	Pericyclic Reactions	3	1	0
7.	MCY-141	Medicinal Chemistry	3	1	0
8.	MCY-142	Material Chemistry	3	1	0
9.	MCY-143	Nuclear Chemistry	3	1	0

M.Sc. Chemistry
Course outcomes (COs)

Semester-I (Core and Foundation Courses)

MCY-101: Organic chemistry-I

Course outcomes (COs):

1. To describe the various types of reactive intermediates based on their generation, reactivity and stability.
2. To describe the Huckel's rule for aromaticity and describe the concept of anti-aromaticity and homoaromaticity.
3. To describe the concept of isomerism and classify the compound based on R/S and E/Z nomenclature. To describe the various types of aromatic and aliphatic electrophilic substitution reactions.
4. To differentiate between the various benzenoid and non-benzenoid compounds. To describe the various types of additions and eliminations reaction.

MCY-101 Organic Chemistry-I **4 Credits (3-1-0)**

UNIT-I **9**

Nature of Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Reactive Intermediates-Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes. Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule, energy of pi-molecular orbitals, annulenes, anti-aromaticity, homoaromaticity.

UNIT-II **9**

Stereochemistry:

Concept of Chirality and molecular dissymmetry, R and S nomenclature, Geometrical isomerism

E and Z Nomenclature, Fischer projections, Sawhorse projections and Zig-zag notation and interconversion, chirality without chiral centres. Stereospecific and stereoselective synthesis, asymmetric synthesis. Racemic modifications and their resolution, enantiomeric excess (ee), Conformational analysis of cyclohexanes and decalins.

UNIT-III **9**

Aromatic Electrophilic Substitution:
The Arenium ion mechanism, orientation and reactivity in monosubstituted benzene rings, ortho/ para ratio. Ipso substitution Aliphatic Electrophilic Substitution: Bimolecular mechanisms - SE2 and Sei. SE1 mechanism. Halogenations of aldehydes, ketones, acids and acyl halides. Effect of substrates, leaving group and the solvent system on reactivity. Acylation at aliphatic carbon, alkylation of alkene Free radical reactions: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance, Reactivity in aliphatic and aromatic substrates at a bridgehead and attacking radicals. Effect of solvents on reactivity.

UNIT-IV **9**

Additions:
Addition to carbon-carbon multiple bonds, HX, X_2, stereo chemistry of addition, formation and reaction of epoxides, syn and anti hydroxylation, and hydrogenation,
Eliminations: Types of elimination reactions, mechanisms, stereochemistry and orientation, Hofmann and Saytzeff's rules. Competitions between elimination and substitution. Dehydration, dehydrogenation, decarboxylative elimination, pyrolytic elimination, molecular rearrangement during elimination.

Books and References

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall.
4. Modern Organic Reactions, H.O. House, Benjamin.
5. 6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

MCY-102:Inorganic chemistry-I

Course outcomes (COs):

1. To describe the concept of various types of symmetry, operations and symmetry classification in inorganic compounds.
2. To study the concept of stereochemistry and bonding in main group compounds based on theories, spectrochemical factors and Energy level diagrams. To study the concept of CFT, LFT, Nephelauxetic effect, Term symbols, structural effects for transition elements.
3. To describe the electronic spectra and magnetic properties of transition metal complexes and their applications.
4. To study the concept of catenation, heterocatenation, isopolyanions, heteropoly anions and various inorganic rings and cages compounds.

MCY-102 Inorganic Chemistry-I 4 Credits (3-1-0)

UNIT-I **9**

Stereochemistry and Bonding in Main Group Compounds VSEPR theory & drawbacks, Bent rule, MO theory, Energy level diagram for F_2, O_2, CO, NO. Walsh diagram (triatomic and pentatomic). Symmetry and Structure: Symmetry elements and operations; equivalent symmetry elements and equivalent atoms; symmetry point groups with examples from inorganic compounds; groups of very high symmetry; molecular dissymmetry and optical activity; systematic procedure for symmetry classification of molecules and illustrative examples.

UNIT-II **9**

Chemistry of Transition Elements: CFT, LFT, Nephelauxetic effect, Term symbols for metal ions; Structural effects: ionic radii and Jahn-Teller effect; octahedral vs. tetrahedral coordination, Chemistry of f-block element Optical and magnetic properties of Lanthanides and Actinides and splitting of f-orbitals in octahedral field.

UNIT-III **9**

Electronic spectra and magnetic properties of Transition Metal Complexes : Electronic absorption spectra of octahedral and tetrahedral complexes, Orgel diagrams, Tanabe-Sugano diagrams, calculation of Dq, B and β values, selection rules, band intensities and band widths, spectra of high-spin octahedral and tetrahedral complexes of d 1 to d 9 systems, Spectrochemical series; Adjusted crystal field theory. Molecular orbital theory of octahedral and tetrahedral complexes.

UNIT-IV **9**

Inorganic Rings, Chains and Cages: Chains: Catenation, heterocatenation, isopolyanions and heteropoly anions; Rings: Borazines, Phosphazenes; Cages: Cage compounds having phosphorus, oxygen, nitrogen and sulphur: Boranes, Carboranes.

Books and References

1. J. E. Huheey, E. A. Keiter, R. L. Keiter & amp; O. K. Medhi. Principles of Structure and Reactivity (1st impression), Pearson Education (2006).
2. F. A. Cotton. Chemical Applications of Group Theory, (3rd edn.), John Wiley & Sons (1999).
3. P. Atkins, T. Overton, J. Rourke, M. Weller & F. Armstrong, Shriver and Atkins Inorganic Chemistry, Oxford University Press (2006).
4. N. N. Greenwood & A. Earnshaw. Chemistry of the Elements, Pergamon Press (1984).
5. F. Basolo & amp; R. G. Pearson, Mechanism of Inorganic Reactions, Wiley Eastern (1967).
6. F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann. Advanced Inorganic Chemistry (6th edition), John Wiley (1999).
7. S. F. A. Kettle, Physical Inorganic Chemistry, Spectrum (1996).

8. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of Inorganic Chemistry (3rd edn.), John Wiley & Sons (1994).

MCY-103:Physical chemistry-I

Course outcomes (COs):

1. To study the concept of electrodes with classification, electrode potentials, types of electrochemical cells/galvanic cells and their applications.
2. To study the kinetics of various order reactions, kinetics theory and photophysical process.
3. To study the basic principle of quantum chemistry and their applications.
4. To study the concept of unit cell, crystal defect, symmetry in crystals, and their classification.

MCY-103: Physical Chemistry- I **4 Credits (3-1-0)**

UNIT-I **9**

Quantum Chemistry:

Basic Principle of Quantum Chemistry. Quantum Mechanical Concepts and Concepts of wave functions. Operators, Particle in box, Harmonic Oscillator. Hydrogen atom and Rigid Rotor. Angular Momentum, Tunnelling, Variation Principle, Perturbation. Molecular Orbital Theory, Valence Bond Theory. Huckel Molecular Orbital Theory, Atomic structure.

UNIT-II **9**

Solid State Chemistry:

Atoms, voids per unit cell, molecular formula calculation symmetry in crystals. Packing fraction density, coordinate system and relation between edge length, radius and Nearest neighbor distance. Structure of ionic solids. Miller Indices, Bragg's Equations and Interplanar spacing. Structure Factors. Band Theory. Crystal Defect.

UNIT-III **9**

Chemicals kinetics:

Kinetics of different order reactions. Kinetics of reversible, parallel and series reactions. Arrhenius Equation. Collision Theory, Activated Complex Theory and Theory of Unimolecular reactions. Kinetics of Photophysical process. Enzymes catalysis.

UNIT-IV **9**

Electrochemistry:

Electrochemistry of solutions: Ion-solvent interactions, ion-ion interactions, ionic migration and diffusion. Thermodynamics of galvanic cells: Equilibrium electrode potentials, IUPAC convention for electrode potentials, classification of electrodes. Origin of emf and classification of electrochemical cells. Electron transfer at the electrode-solution interface, Voltammetry, fuel cells.

Books and References

1. Chemical Kinetics : K. J. Laidler
2. Kinetics and Mechanism of Reaction Rates: A. Frost and G. Pearson.
3. Modern Chemical Kinetics: H. Eyring
4. Fast Reactions: J. N. Bradly
5. Fast Reactions in Solutions: Caldin
6. Basic Principles of Spectroscopy: R. Chang
7. NMR and Chemistry: J.W. Akit
8. Physical Chemistry: P.W. Atkins

MCY -104: Molecular spectroscopy
Course outcomes (COs):

1. Explain what it means to use spectroscopic methods for qualitative and quantitative analysis. Identify the terms in and describe deviations to Beer's Law. Understand principle, instrumentation and applications of UV-Visible spectroscopy and fluorimetry.
2. Understand Theory, Instrumentation and Applications of Infra-red and Raman Spectroscopy towards determination of molecular structure. Quantitative determination using Infra-red and Raman Spectroscopy.
3. Understand Theory, and various concepts like chemical shift, spin-spin coupling, NOE effects of ^{1}HNMR and ^{13}CNMR spectroscopy. Instrumentation and Applications of ^{1}HNMR and ^{13}CNMR towards determination of molecular structure.
4. Understand Theory, and various concepts like isotope abundance, molecular ion, fragmentation processes of Mass Spectrometry. Instrumentation and Applications of Mass Spectrometry towards determination of molecular structure.

MCY-104 Molecular Spectroscopy **4 Credits (3-1-0)**

UNIT-I **9**

UV-Visible spectroscopy:

Basics of photometry, Lambert beer's law, Woodward-Fisher rule and applications. Molecular Luminescence: Fluorimetry and Phosphorimetry Fluorimetry: Theory and basic principle; Quenching; Spectrofluorimeters and applications.

UNIT-II **9**

Infra-red spectroscopy:

Applications of FT-IR in structural determination. Raman Spectroscopy: Theory, Instrumentation and Applications of Raman Spectroscopy.

UNIT-III **9**

NMR Spectroscopy:

^{1}H NMR: Instrumentation, Magnetic and non-magnetic nuclei, Larmor frequency, absorption of radiofrequency, chemical shift and its measurement, factors influencing chemical shift, deshielding, anisotropic effect, spin-spin coupling, factors influencing coupling constant, NOE effects AB, AX and ABX systems.

^{13}C NMR:

Introduction, chemical shifts, Off-resonance coupled and decoupled spectra. Two dimensional NMR spectroscopy. Spectral Interpretation of compounds based on NMR spectroscopy.

UNIT-IV **9**

Mass Spectrometry:

Basic principles, ionization techniques, isotope abundance, molecular ion, fragmentation processes of organic molecules, McLafferty rearrangement, deduction of structure using mass spectral fragmentation, FAB-Mass, high resolution MS, soft ionization methods, EI-MS and MALDI-MS. Structure elucidation of simple molecules using structural data including C, H, N, S O percentage, spectral data (UV, IR, NMR, MS etc).

Books and References:

1. Skoog, D. A.; Holler, F. J.; Nieman, T. A. Principles of Instrumental Analysis, 5th Ed., Thomson Brooks/Cole, 1998.
2. Strobel, H. A.; Heineman, W. R. Chemical Instrumentation: A Systematic Approach, 3rd Ed., John Wiley and Sons, 1989.
3. Willard, H. H.; Merritt, Jr., L. L.; Dean, J. A.; Settle, Jr., F. A. Instrumental Methods of Analysis,7th Ed., Wadsworth, 1988.
4. Ewing, G. W. Instrumental Methods of Chemical Analysis, 5th Ed., Mcgraw-Hill, 1985.
5. Banwell, C.N. and Mc Cash, E. L. M.,"Fundamentals of Molecular Spectroscopy", 4th Ed. McGraw-Hill N. Y. 1999
6. Slichter, C.P., " Principles of Magnetic Resonance", Springer Verlag. 1981
7. Graybeal, J.D., "Molecular Spectroscopy", McGraw-Hill. 1988
8. Spectroscopic Identification of Organic Compounds- R. M. Silverstein and G. C. Bassler
9. Applications of Spectroscopic Techniques in Organic Chemistry- P. S. Kalsi

MCY -105:Laboratory coursework-I
Course outcomes (COs):

1. Brief introduction on safety, laboratory equipments and apparatus.
2. To study the complexometric titrations and preparation of inorganic complexes. Quantitative and qualitative estimation of pair of metal ions and insoluble sulfates.
3. To estimate the organic compounds via chromatography methods. Synthesis and purification of organic molecules via several synthetic techniques.
4. To study the physical and chemical properties of solvents and solutions through advance volumetric and techniques.

MCY-105 Lab. Coursework -I **Credits 3 (0-0-9)**
1. Introduction to laboratory equipments, apparatus and safety:

Use of common laboratory equipments like fume hoods, vacuum pumps, weighing balance etc. to be explained to the students.
Introduction to various types of quick fit joints and apparatus to the students.
Discussion of Safety Techniques: i) Disposal of chemicals, ii) Usage of protective equipments, iii) First aid, iv) Fire extinguishers, types of fire, Hazards of chemicals.

2. List of Experiments

a. Inorganic Chemistry (Any 3)

1. Quantitative separation and determination of pairs of metal ions using volumetric analysis.
2. Quantitative separation and determination of pairs of metal ions using gravimetric methods.
3. Qualitative and quantitative analysis of insoluble-oxides, sulphates and halides
4. Complexometric titrations.
5. Preparation, purification and structural elucidation of some of the complexes from the following by available phyco-chemical and spectral methods:

a. $Mn(acac)_3$
b. $[Co(Py)_2\ Cl_2]$
c. $[Ni(NH_3)_6]Cl_2$
d. $Ni(dmg)_2$
e. $[Cu(NH_3)\ 4]SO_4.H_2O$

b. Organic Chemistry

1. Identification of compounds of by thin layer chromatography.
2. One step synthesis of the following: (any two)

a. ortho-benzoyl benzoic acid from phthalic anhydride
b. para-nitrobenzoic acid from paranitro toluene
c. Anthraquinone from anthracene
d. Benzhydrol from benzophenone
e. Synthesis of polyacrylic acid.
f. Synthesis of porphyrin.

3. Separation /Purification techniques -crystallization, distillation methods (atmospheric/vacuum).

c. Physical Chemistry (Any 3)

1. Determination of surface tension and viscosity.
2. Verification of the limit of Beer-Lambert's law using potassium permanganate solution.
3. Preparation of buffer solutions and determination of their pH values.
4. Determination of the primary salt effect on the kinetics of ionic reaction and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion)
5. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.
6. Determination of pKa of an indicator.
7. Determination of molecular weight of a polymer using Ubelohyde viscometer.
8. Adsorption: study of surface tension – concentration – relationship for solutions (Gibbs equation)

Books and References

1. Inorganic Experiments, J. Derek Woolins, VCH

2. Findley's Practical Physical Chemistry, revised B.P. Levitt, longmann
3. Vogels Text book of Practical Organic Chemistry, Pearson education.
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand
5. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin
6. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett
7. Small Scale Organic Preparation, P.J. Hill
8. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill Interscience

Semester-II (Core and Foundation Courses)

MCY -106: Organic Chemistry-II
Course outcomes (COs):

1. To describe and classify the various selective name reactions involved addition, substitution, condensation, coupling and redox reaction.
2. To explain the various type of rearrangement reactions along with stereo aspect.
3. To describe the various type of oxidizing and reducing reagent for organic synthesis and its applications
4. Brief description of UV, IR and NMR spectroscopy for various organic/inorganic molecule detections.

MCY-106 Organic Chemistry-II **4 Credits (3-1-0)**

UNIT-I **9**

Selective Name Reactions:
Reimer-Tiemann, Cannizaro, Diels-Alder, Knovengeal, Baylis-Hilman, Shapiro reaction, Perkin, Reformatsky, Grignard, Chichibabin, Michael, Mannich, Stork-enamine, Ene and Barton Reaction. Stobbe, Dieckmann, Benzoin and Aldol condensation. Robinson Annelation and Sharpless Asymmetric Epoxidation.

UNIT-III **9**

Rearrangements:
Stevens, Wittig, Cope, Wagner-Meerwein, Pinacol, Claisen, Wolff, Hofmann, Curtius, Schmidt, Lossen, Beckmann, Baeyer-Villiger, Favorskii, and Benzilic acid.

UNIT-III **9**

Reagents in Organic Synthesis:
Jones reagent, Collins reagent, Gilman's reagent, Wittig reagent, Lithium dimethyl cuprate, DDQ, SeO_2 , Crown ethers, chromic acid, sodium dichromate, potassium dichromate DIBAL-H, LDA, DCC

, 1,3-propane-dithiane, Trimethyl-silyl iodide, Tri-n-butyl-tin-hydride, Birch reduction, Wolf-Kishner reduction, Clemmensen reduction, Mozingo reduction, Meerwein-Pondorf-Verley reduction, Oppenauer oxidation.

UNIT-IV **9**

UV spectroscopy: Woodward-Fisher rules for conjugated dienes and carbonyl compounds, applications of UV.
IR Spectroscopy: Characteristics vibrational frequencies of aromatic and aliphatic compounds. Effect of hydrogen bonding and solvent effect on vibrational frequencies.
NMR Spectroscopy: Chemical shift, factors influencing chemical shift, shielding-deshielding, spin-spin coupling (n+1) rule.

Books and References

1. Organic Chemistry by Stanley H. Pine.
2. Advance Organic Chemistry: Reactions, Mechanisms and Structure by Jerry March.
3. Organic Chemistry by Clayden, Greeves, Warren & Wothers.
4. Organic Chemistry by Morrison and Boyd.
5. Spectroscopy of Organic compounds by P. S. Kalsi
6. Stereochemistry of Carbon Compounds by E. L. Eliel.
7. Stereochemistry of Organic compounds by D. Nasipuri.

MCY -107: Inorganic chemistry-II
Course outcomes (COs):

1. To describe the structure, bonding and ligand heptacity in inorganic complexes. To study the basic concept of catalysis in organometallic chemistry incuding metal Carbonyls.
2. To describe the preparation, structure, heptacity, catalysis and spectral analysis of different metal carbonyls.
3. To describes the substitution and anation reaction mechanism of inorganic complexes. To study the effect of acid and base in substitution reaction kinetics.
4. To study the chemistry of non-aqueous solvents, describe the solvent and solution in aqueous medium and its titrations.

MCY-107 Inorganic chemistry – II **4 Credits (3-1-0)**

UNIT-I **9**
Organometallic Chemistry:
Ligand hapticity, synthesis, structure and bonding organometallic compounds, organometllic compounds in organic synthesis, homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation and polymerisation), transition metal pi-complexes.

UNIT-II **9**
Metal Carbonyls and Related Compounds:
Preparation, structure, and properties: bonding in metal carbonyls, variants of CO bridging, vibrational spectra of metal carbonyls, principal reaction types of metal carbonyls.

UNIT-III **9**

Kinetics and Mechanism of Substitution Reactions:

Nature of substitution reactions: prediction of reactivity of octahedral, tetrahedral and square-planar complexes in terms of crystal field stabilization energy and structure preference energy; rates of reactions; acid hydrolysis, base hydrolysis and anation reactions.

UNIT-IV **9**

Chemistry of Non-Aqueous Solvents:

Classification of solvents, properties, levelling effect, type of reactions in solvents, chemistry of liquid ammonia and liquid acetic acid with respect to properties, solubility and reactions.

Books and References

1. Inorganic Chemistry- Principles, structure and reactivity, J. H. Huheey, Harper and Row Publisher, Inc. New York (1972)
2. Concise Inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London
3. Theoretical Inorganic Chemistry, M.C. Day and J. Selbin, Reinhold, EWAP
4. Organometallic Chemistry, T. S. Swain and D. S. T. Black.
5. Advanced Inorganic Chemistry- F. A. Cotton, R. G. Wilkinson.
6. Organometallic Chemistry- P. L. Pauson.
7. Inorganic Chemistry- Gary L. Miessler and Donald A. Tarr.

MCY -108:Physical chemistry-II

Course outcomes (COs):

1. Explain the concept of phase rule and its applications.
2. To describe the basic concept of thermodynamics, free energy, and molal quantities.
3. Brief description of fugacity. Explain the law of thermodynamics and its applications.
4. To describe Nernst heat theorem, and Distribution law. Brief description of non-equilibrium thermodynamics. Brief description of chemical equilibrium.

MCY-108: Physical Chemistry-II **4 Credits (3-1-0)**

UNIT-I **9**

Thermodynamics-I: Basic concept of thermodynamics, Gibb's and Helmholtz free energy functions and their significance, Partial molal quantities, Thermodynamic criteria for the fugacity of the process in terms of entropy change, internal energy change, enthalpy and free energy change.

UNIT-II

9

Thermodynamics-II: Nernst heat theorem, Third law of thermodynamics and its application, Thermodynamic derivation of phase rule and its application, Distribution law, its thermodynamic derivation and application, Zeroth law of thermodynamics.

UNIT-III **9**

Chemical equilibrium: Chemical potential in case of ideal gases, Chemical equilibrium constant and

its temperature dependence, Law of chemical equilibrium and its application, Clausius and Clapeyron equation and its application, Determination of molecular weight of non-volatile solutes from colligative properties, Relationship between relative lowering of vapour pressure and osmotic pressure, Van't Hoff equation for dilute solutions and its application.

UNIT-IV **9**

Non–Equilibrium Thermodynamics: Basic principles of non-equilibrium thermodynamics, Rate laws, second law of thermodynamics for open system, law of conservation of mass, charge and energy, Phenomenological equations for single and coupled flows, Curie-Prigogine principle, Applications of non-equilibrium thermodynamic.

Books and References

1. Thermodynamics for Chemists: S. Glasstone
2. Physical Chemistry: G.M. Barrow
3. Non -equilibrium Thermodynamics: C. Kalidas
4. Non -equilibrium Thermodynamics: I. Prigogene
5. Electrochemistry: S. Glasstone
6. Electrochemistry: P.H. Reiger

MCY -109:Laboratory coursework-II

Course outcomes (COs):

1. To estimate the alloy and ores via gravimetrically and volumetrically methods.
2. To synthesize and characterization of metal complexes. Qualitative and quantitative analysis of soil and water.
3. To perform distillation, crystallization, sublimation and chromatography of organic solvents, solute and mixtures respectively. To prepare of organic molecules through one pot synthesis and its applications.
4. To determine the colligative, calorimetric, colorometric, adsorption, volumetric and adsorption properties, kinetics molecular weight and pH of various types of solutions and reactions.

MCY-109 Lab. Coursework -II **Credits 4 (0-0-9)**

List of Experiments

a. Inorganic Chemistry (Any 3)

1. Analysis of ore (Any one)

i) Pyrolusite ore - Estimation of silica gravimetrically and Manganese volumetrically.
ii) Chromite ore – Estimation of Iron gravimetrically and Chromium volumetrically

2. Analysis of Alloy

Solder alloy – Estimation of Tin gravimetrically and Lead volumetrically

3. Preparation and purity determination (Any one)

i) Potassium trioxalato chromate (III).

ii) Tris (acetylacetanato) Iron (III).
iii) Bis(ethylene diamine) copper (II) sulphate.

4. Characterization of soil and water.

b. Organic Chemistry

1. Techniques: (At least Two Practicals)
Crystallization, Sublimation, Distillation, Steam Distillation, Vacuum Distillation, Column Chromatography, Thin Layer Chromatography.
2. Preparation of Derivatives: (Any 3 derivatives)

Oxime, 2, 4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid.

3. Preparations: Single Stage (Any 4)

i) Cyclohexanone to Adipic acid
ii) Acetylation of ferrocene
iii) Chlorobenzene to 2,4-Dinitrochlorobenzene
iv) 2,4-Dinitrochlorobenzene to 2,4-Dinitrophenol
v) Acetoacetic ester to 1-Phenyl-3-methyl-5 pyrazolone
vi) Benzaldehyde to Cinnamic acid
vii) 4-Chlorobenzaldehyde to 4-Chlorobenzoic acid + 4-Chlorobenzyl alcohol
viii) p-Nitrotoluene to p-Nitrobenzoic acid
ix) Benzene to β-Benzoyl propionic acid
x) Benzaldehyde to Dibenzylidene acetone
xi) Phthalic anhydride to phthalimide
xii) Phthalimide to Anthranilic acid
xiii) Acetanilide to p-Bromoacetanide
xiv) p-Bromoacetanide to p-Bromoaniline

c. Physical Chemistry (Any 3)

Students are expected to perform atleast 6 experiments of 3-4 hours duration each.

1. Determination of molecular weight of high polymer by viscometry.
2. Determination of hydrolysis constant of sodium acetate conductometrically (or NH4Cl).
3. To determine the equivalent conductance of weak electrolyte at infinite dilution using Kohlrausch law.
4. To determine dissociation constant of an indicator (phenolphthalein) coluromitrically.
5. Determination of molecular radius of molecule (organic liquids) using refractometer.
6. Determination of partial molar volume of ethanol and of water in aqueous solutions at room

temperature.

7. Study of the kinetics of zero order reaction.
8. To determine the integral heat of solution of a salt using Dewar's Flask as calorimeter.
9. Determination of transition temperature of sodium sulphatedecahydrate by thermometric method.
10. To investigate the adsorption of oxalic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuirs adsorption isotherms.
11. Determination of pH values of various mixtures of sodium acetate and acetic acid in aqueous solutions and hence dissociation constant of an acid.
12. Determination of molecular weight of organic compounds using Freezing-point technique.

Books and References

1. Inorganic Experiments, J. Derek Woolins, VCH
2. Findley's Practical Physical Chemistry, revised B.P. Levitt, Longmann
3. Vogels Text book of Practical Organic Chemistry, Pearson education.
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand
5. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin
6. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett
7. Text Book of Quantitative Inorganic Analysis, by A. I. Vogel.
8. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill Interscience
9. Advanced Physical Chemistry Experiments, by Shoemaker and Gerland.

Semester-III (Core and Foundation Courses)

MCY-201 Instrumental Methods of Analysis:
Course outcomes (COs):

After completing the course students will be able to...

1. Explain the principle, instrumentation and identification of elements present in a given sample by Atomic Absorption Spectroscopy
2. Explain the principle, working, instrumentation and application of thermogravimetric analysis (TGA), Differential thermal Analysis (DTA) and Differential scanning calorimetry (DSC).
3. Explain the principle, instrumentation, working, and applications of Gas Chromatography (GC) technique for separation and identification of organic compounds.
4. Explain the principle, instrumentation, working, and applications of High Performance Liquid Chromatography (HPLC) technique for separation and identification of organic compounds.

MCY-201 Instrumental Methods of Analysis **4 Credits (3-1-0)**

UNIT-I **9**

Atomic Absorption Spectroscopy (AAS): Basic Principle, difference between FES and AAS, Standard instruments used, Experimental Procedure, Application of AAS, interferences and remedial measures, comparative study between AAS and FES, sensitivity of Instruments.

UNIT-II **9**

Thermogravimetric analysis (TGA): Principle, instrumentation, factors affecting TGA curve, derivative thermogravimetric analysis (DTGA) and application of thermogravimetric analysis, Differential thermal Analysis(DTA), instrumentation of DTA and application of DTA, Simultaneous study of TGA, DTA with examples. Differential scanning calorimetry (DSC).

UNIT-III **9**

Chromatography:
General introduction, principles and types of chromatography, physical sate of mobile phase, mechanism of separation and techniques involved.

Gas Chromatography (GC):
Principle, instrumentation, column efficiency, solid supports, liquid phase, column temperature, detectors, chromatographic identification, multi-dimensional GC, fast GC, applications.

UNIT-IV **9**

High Performance Liquid Chromatography (HPLC)
Principle, instrumentation, identification of peaks, effect of temperature and packing material, types of HPLC: partition, adsorption, ion-exchange, size-exclusion or gel; derivatization in HPLC: post and pre-columns, applications.

Books and References

1. Instrumental Method of Analysis by H. Willard, L. Merritt, J. Dean & F. Settle
2. Analytical Chemistry (Theory and Practical) by U.N. Dash
3. Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes
4. Leon Reubsaet, Tyge Greibrokk, John Wiley and Sons
   Introduction to Modern Liquid Chromatography by Lloyd R. Snyder, Joseph J. Kirkland and J. Wiley
5. Practical HPLC Method Development by Lloyd R. Snyder, Wiley-Interscience
6. Principles & Practices of Chromatography by R. P. W. Scott, Library for Science
7. Fundamentals of Analytical Chemistry, VIII Edn., D.A. Skoog, D.M. West, F. J. Holler and S.R. Crouch, Thomson Brooks/Cole Publishers.
8. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and T.A. Nieman, 5th Edition,

Harcourt Brace & Company, Florida.
9. Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, Meerut.
10. Instrumental Methods of Chemical Analysis, Chatwal and Anand, Himalaya Publishing House, Meerut.

MCY-202: Organic Chemistry-III
Course outcomes (COs):

1. Describes general principles and mechanistic studies of various name reactions.
2. Describe the importance and properties of various catalysts.
3. Describe the method of preparation of examines in condensation of secondary amines aldehydes and ketones. Studies of stereochemistry aspects.
4. Classify the carbohydrates and determine the momomeric units. Explain basic concept of amino acids and classify it.

MCY-202 Organic Chemistry-III **4 Credits (3-1-0)**

UNIT-I **9**

Metal catalyzed organic reactions
Cross-coupling reaction, Sonogashira coupling reaction, Suzuki coupling reaction, Buchwald-Hartwig Reaction, Heck coupling reaction, cross coupling reaction, Tsuji-Trost Reaction, Willkinson catalyzed reaction, Wacker process, Ring closing metathesis by grubbs catalyst, pauson-khand reaction. Buchwald

UNIT-II **9**
Enamines and ylides
Methods of preparation of enamines: condensation of secondary amine and aldehyde or ketone, reaction between alkynes and secondary amines. Comparison of reactivity of enamines and enolates. Phosphorus, sulfur and nitrogen ylides: Preparation, structure and comparison of reactivity. Reactions of phosphorus sulfur and nitrogen ylides with carbonyl compounds, including mechanism and stereochemistry. Wittig reaction, Wittig-Horner reaction.

UNIT-III **9**
Carbohydrates
Classification, epimers, redox reaction of carbohydrates, osazone formation, chain elongation, chain shortening, cyclization of monosaccharides, ether formation determination of ring size, anomeric effect, reducing and non-rducing sugar, protection of 1, 3-diols, determination of isoprene units.

UNIT-IV **9**
Amino acids
Basic concept of amino acids, classification of amino acids, zwitter ion, isoelectronic point, synthesis of amino acids, protecting and deprotecting group of amino acids, peptides, sequence determination of amino acids, enzymetic hydrolysis of amino acids.

Books and References

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M. B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis, (2007), Freeman and Company, New York.
4. S. M. Mukherjee and S. P. Singh, Reaction Mechanism in Organic Chemistry, 1st Edition 1990), Macmillan India Ltd., New Delhi.
5. S. M. Mukherjee and S. P. Singh, Pericyclic Reactions, MacMillan India, New Delhi.
6. Jagdamba Singh and L D S Yadav, Advanced Organic Chemistry /Organic Synthesis, Pragati Prakashan, 2011.

MCY-203:Laboratorycoursework-III

Course outcomes (COs):

1. To apply previous knowledge for performing experiment scientifically and safety.
2. To perform quantitative separation and determination of pair metal ions by different techniques of volumetric and gravimetric.
3. To estimate distribution coefficient between two immiscible solvents.
4. To perform saponification and conductrometric via different methods.

MCY-203

Lab. Coursework -III **Credits 3 (0-0-6)**

1. Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods:
    a. Cu^{2+} (gravimetrically) and Zn^{2+} (Volumetrically)
    b. Fe^{3+} (gravimetrically) and Ca^{2+} (Volumetrically)
    c. Ni^{2+} (gravimetrically) and Ni^{2+} (Volumetrically)
2. Separation of a mixture of cations/anions by paper chromatographic technique using aqueous/non-aqueous media.
    a. Co^{2+} and Cu^{2+} (non-aqueous medium)
    b. Cl^{-} and I^{-} (aqueous-acetone medium)
3. Separation and Identification of compounds having one or more functional groups.
4. Distribution coefficient of I_2 between two immiscible solvents.
5. Saponification of ethyl acetate with sodium hydroxide by chemical method.
6. Conductometric titration of a polybasic acid.

Books and References

1. Inorganic Experiments, J. Derek Woolins, VCH
2. Findley's Practical Physical Chemistry, revised B.P. Levitt, Longmann
3. Vogels Text book of Practical Organic Chemistry, Pearson education.
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand
5. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin
6. Text Book of Quantitative Inorganic Analysis, by A. I. Vogel.
7. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill Interscience
8. Advanced Physical Chemistry Experiments, by Shoemaker and Gerland.
9. General Chemistry Experiments Revised Edition, A. J. Elias, Sangam Books Ltd.

Semester-IV(Core and Foundation Courses)
MCY-204: Heterocyclic Chemistry
Course outcomes (COs):

1. Describe the types of strains, physic-chemical interaction and conformational aspects. Describes general principles and classification preparation of non-aromatic heterocyclic compounds.
2. Describes general principles and classification preparation of five and six membered heterocyclics with one heteroatoms.
3. Describes general principles and synthesis of five and six membered heterocyclics with two heteroatoms.
4. Describes general principles, synthesis, reactivity and importance of various heterocyclic compounds with more than two heteroatoms.

MCY-204 Heterocyclic Chemistry **4 Credits (3-1-0)**

UNIT-I **9**

Non-aromatic Heterocyclics: Various types of strains, interactions and conformational aspects of nonaromatic heterocycles. Synthesis, reactivity and importance of the following ring systems, Azirines, Aziridines, Oxiranes, Thiiranes, Diazirenes, Diaziridines, Oxaziridines, and Azetidines

UNIT-II **9**

Five and six member heterocyclics with one heteroatoms: Introduction, resonating structure, electrophilic substitution reaction, synthesis of pyrrole, furan, and thiophene. Pyridine: resonating structure, electrophonic substitution reaction, nucleophilic substitution reaction, synthesis of pyridine. Synthesis of indole and quinoline.

UNIT-III **9**

Five and six member heterocyclics with two heteroatoms: Synthesis, reactivity, aromatic character

and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Isoxazole, Isothiazole, Pyridazine, Pyrimidine. Pyrazine, Oxazine, thiazine, benzimidazole, benzoxazole and benzthiazole.

UNIT-IV **9**

Heterocyclics with more than two heteroatoms: Synthesis, reactivity, aromatic character and importance of the following Heterocycles: 1,2,3-triazoies,1,2,4-triazoles,Tetrazoles, 1,2,4-oxadiazole, 1 ,3,4-oxadiazole, 1,2,5- oxadiazole, 1,2,3-thiadiazoles, 1,3,4- thiadiazoles, 1,2,5- thiadiazoles, 1,2,3-triazine, 1,2,4- triazine, 1,3,5- triazine, tetrazines. Synthesis and importance of purines and pteridines. Syntheis of Caffeine, theobromine and theophylline.

Books and References

1. T. Gilchrist, Heterocyclic Chemistry
2. R. M. Acheson, An introduction to the Chemistry of heterocyclic compounds
3. J. A. Joule & K. Mills, Heterocyclic Chemistry.
4. A. Paquette, Principles of Modern Heterocyclic Chemistry
5. J. A. Joule & , Heterocyclic Chemistry
6. A. R. Katritzky, Handbook of Heterocyclic Chemistry
7. Modern Heterocyclic Chemistry by Julio Alvarez-Builla, Juan Jose Vaquero, Wiley-VCH

MCY-205: Lab coursework-IV

Course outcomes (COs):

1. To study the multistep synthesis of organic compounds.
2. To determine the degree of hydrolysis and equilibrium constant by kinetics and distribution methods.
3. To understand the working mechanism and application of adsorption isotherm.
4. To study the quantitative analysis of salt and solute in various application through pH meters.

MCY-205

Lab. Coursework -IV **Credits 3 (0-0-6)**

1. Preparation and characterization of two and three steps organic compounds.
2. Degree of hydrolysis of urea hydrochloride by kinetics method.
3. Equilibrium constant of $KI + I_2 \rightleftharpoons KI_3$ by distribution method.
4. Adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
5. Determination of Na_2CO_3 content (in %) of washing soda using a pH meter.
6. Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators.

Books and References

1. Inorganic Experiments, J. Derek Woolins, VCH
2. Findley's Practical Physical Chemistry, revised B.P. Levitt, Longmann
3. Vogels Text book of Practical Organic Chemistry, Pearson education.
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand
5. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin
6. Text Book of Quantitative Inorganic Analysis, by A. I. Vogel.

7. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill Interscience
8. Advanced Physical Chemistry Experiments, by Shoemaker and Gerland.

Program Elective Courses:

MCY 122: Chemistry in Biology
Course outcomes (COs):

1. To understand the role of metal ions in biological systems at a molecular level and understanding the basic chemical principles that promote their reactivity.
2. To study the catalytic reaction of various biological cycles, enzyme kinetics, transport reaction from biological membrane and photosystems. To study the biological systems mechanism, how its work.
3. To study the role of metal and metal complex in enzymes, photosystems, transport mechanism and in medicine.
4. To analyze Molecular, Recognition, Organization, Chirality and Role of Sugar in Biological Recognition.

MCY-122 Chemistry in Biology **4 Credits (3-1-0)**

UNIT-I **9**

Biomolecules: Amino acids and proteins, Carbohydrates-polysaccharides, lipids, cell-membranes and nucleic acids. Structure and function: Protein structure, Ramach and ran-plot, protein folding: DNA/RNA structures, various forms (a, b, c, z) of DNA, t-RNA structure, transcription and translation.

UNIT-II **9**

Metabolism and Energetics: Glycolysis, Citric Acid Cycle, Oxidative Phosphorylation and Transport through Membranes. Photosystems, Porphyrins, Enzyme Kinetics & Inhibition

UNIT-III **9**

Metalloenzymes Containing Magnesium, Molybdenum, Iron, Cobalt, Copper and Zinc. Oxygen Transport, Electron- Transfer Reactions; Nitrogen Fixation, Metal Complexes in Medicine.

UNIT-IV **9**

Molecular Recognition: Molecular Organization, Chiral Recognition and Role of Sugar in Biological Recognition.

Books and References

1. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman &Co. New York.
2. D.L. Nelson and M.M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002) Mc. Millan North Publication.
3. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.
4. I. Bertini, H. B. Gray, S. J. Lippard, J.S. Valentine, 1st South Asian Edn., (1998) Viva Books Pvt. , New Delhi.
5. M. B. Smith, Organic Synthesis, (1998) Mc Graw Hill Inc, New York.

MCY 123: Photochemistry
Course outcomes (COs):

1. To study the principle and application of light reaction in different reaction mechanism.
2. To study the concept of light reaction in different rearrangement reaction.
3. To study the redox reaction.
4. To study the principle and application of light reaction in natural products.

MCY-123 Photochemistry **4 Credits (3-1-0)**

UNIT – I **9**

Basic Principles of Photochemistry

Jablonski diagram. α–Cleavage or Norrish Type I process, Norrish Type I process given by acyclic saturated ketones, Norrish Type I reaction of saturated cyclic ketones, and Norrish Type I process given by cyclopentanones.

UNIT – II **9**

Photochemistry of Cyclic Compounds

α–Cleavage given by cyclobutanones, and β–Cleavage reaction. Photo-cycloaddition reaction (Paterno-Buchi reaction), Barton reaction, Hofmann Loffler Freytag reaction, Group transfer reaction.

UNIT – III **9**

Photo-rearrangements

Photo-rearrangement of cyclopentenone, Cyclohexanone rearrangements, Lumiketone rearrangement, Di-π- Methane type rearrangement, Rearrangement of dienones, Photo rearrangements of β, ϒ-unsaturated ketones, 1,2–Acyl shift (Oxa–Di-π-methane rearrangement), 1,3–Acyl shift, Aza–Di-π-methane rearrangement, Di-π-methane (DPM) rearrangement and Rearrangements in aromatic compounds

UNIT – IV **9**

Photo Reduction and Photo Oxidation

Photo-reduction of carbonyl compounds, photo-reduction of aromatic hydrocarbons, photochemical oxidations, and photo-oxidation of alkenes and polyenes

Books and References

1. Organic Photochemistry and Pericyclic Reactions 1st Edition by Kalaivani
2. Principles and Applications of Photochemistry 1st Edition by Brian Wardle
3. Applied Photochemistry by Rachel C. Evans, Peter Douglas and Hugh D. Burrow(2013)
4. Modern Molecular Photochemistry of Organic Molecules1st Edition by Nicholas J. Turro, J.C. Scaiano, and V. Ramamurthy.
5. Photochemistry and Pericyclic Reactions by Jagdamba Singh and Jaya Singh (2009).
6. Problems in pericyclic reactions and photochemistry by V. K. Selvaraj (2013).
7. Organic chemistry, Jonathan Clayden, Nick Greeves and Stuart Warren

MCY-131: Environmental Chemistry
Course outcomes (COs):

1. Explain basic concept of environmental chemistry.
2. Describes general principles and preparation of buffer solution for acid base chemical reactions.
3. Describes general principles of atmospheric chemistry.
4. Describes general principles of solar chemical reaction for various atmospheric chemical reactions. Describes the formation of soils and its physic-chemical properties such as soil-texture, bulk density, anion exchange capacity and so on. Describes and classify the hazardous materials.

MCY-131 Environmental Chemistry **4 Credits (3-1-0)**

UNIT – I **9**
Basic Chemistry: Compounds, Molecules, Chemical bonding, preparation of buffer solutions, acid base chemical reactions- pH and pOH, hydrolysis, chemical equilibrium, oxidation and reduction, solubility and solubility product, and concept of green and sustainable chemistry.

UNIT – II **9**
Atmospheric Chemistry: Chemical concentration of the atmosphere; Chemical and solar light chemical reactions in the atmosphere - formation of smog, acid rain, and ozone chemistry, Indoor Air quality, effect of greenhouse gases and their environmental significance.

UNIT – III **9**
Soil Chemistry: Formation of Soil and its Profile, Chemical & Mineralogical composition of soil, organic and inorganic components in soil. Physical properties of soil–texture, bulk density, permeability; Chemical properties–Cation Exchange Capacity and Anion Exchange Capacity, macro-nutrients are nitrogen (N), phosphorus (P) and potassium (K) or NPK in soils.

UNIT – IV **9**
Chemistry of pollutants: Hazardous waste and their environmental effects, Heavy metals and biochemical impacts of various metals-Lead, Arsenic, Mercury, Cadmium, Selenium, Chromium, Chemistry of Persistent organic pollutants (POPs), chlorofluorocarbons (CFC), Environmental Standards, Pesticides and Chemical fertilizers.

Books and References

1. Banerji, S. K. Environmental Chemistry. 2nd ed. Prentice-Hall, New Delhi, India. 1999.
2. De, A. K. Environmental Chemistry. 4th ed. New Age International (P) Ltd., New Delhi, India. 2000

3. Harrison, R. M. and de Mora, S. J. Introductory Chemistry for the Environment Science. 2nd ed. Cambridge University Press, New Delhi. 1996.
4. Hobbes, P.B. Introduction to Atmospheric Chemistry. Cambridge University Press, UK. 2000.
5. Kothandaraman H. and Swaminathan, G. Principles of Environmental Chemistry. B.I. Publications, Chennai, India. 1997.
6. Mahan, B. M. and Myers, R. J. University Chemistry. 4th ed. International Students. Benjamin / Cummings Publishing Co., USA. 1987.

MCY-132: Industrial Chemistry
Course outcomes (COs):

1. Understand about the raw materials required, synthetic procedures and applications of various modern agrochemicals available in market.
2. Understand the basics about the raw materials required, synthetic procedures, and applications of various Dyes, Pigments and soaps manufactured by industry.
3. Understand about the raw materials required, synthetic procedures, and applications of a variety of Cement, Glasses and Refractory materials manufactured by industry.
4. Understand about the raw materials required, synthetic procedures, and applications of a variety of Cosmetics, Compounds used for different perfumes, and Essential oils manufactured by industry.

MCY-132 Industrial Chemistry **4 Credits (3-1-0)**

UNIT – I **9**

Agrochemicals:
Organo phosphorus pesticides: Malathion, Monocrotophos, dimethoate,chloropyriphos, Dichlorpyriphos, Dichlororous, phenthoate.
Carabamates: Carbonyl, Bygon, Zirman, Zineb, Maneb, Alaicarb. Pyrenthroids: Natural pyrenthrins, Isolationand structures, synthetic Pyrethroids; Allethrin, cypermethrin.
Repellents: N, N-Diethyl-3methyl Benzamide, N, N-Diethyl toluamide, 2–Ethyl-1,6-hexanedial, Butopytranexyl, Dimethylcabonate, Dimethyl terphthalate, Use Pheromones in pest management.

UNIT – II **9**

Dyes and Pigments: Classification of Dyes, Methods of preparation of commercial dyes of different classes with suitable examples. Typical manufacturing processes of few dyes
Fluorescent brightening agents, Photosensitive dyes, dyes as food additives, natural dyes.
Oils, Soaps and Detergents: Refining of edible oils, Manufacturing of soaps, Detergents, Liquid Soaps. Manufacturing of fatty Acids and glycerol, greases from fatty acids, turkey –red oil.

UNIT – III **9**

Cement: Types and properties, manufacture of Portland cement, chemical constitution of Portland cement and their characteristics, special cements and their uses, setting and hardening of cement, raw materials, reaction in the kiln, mixing of additives, corrosion of cement stone, manufacturing of lime; gypsum, plaster of Paris, estimation of silica, alumina, calcium oxide and sulphate in Portland cement.

Glass and Refractory materials: Raw materials, Soda glass, borosilicate glass, Lead Glass, Colored Glass.
Refractories: Classification, properties, manufacturing, fire clay bricks, high alumina, sillimanite and magnesite refractories, silica bricks, super refractories, graphite refractories, insulating and pure oxide refractories, modern ceramics.

UNIT – I V **9**

Cosmetics
Introduction, manufacturing process of powder, cream and lotion, lipstick and nail polish, shampoo and hair dyes, tooth paste.
Perfumery
Compounds used for different perfumes, Essential oils, Preparation of phenyl ethanol, Yara-Yara, β-ionone, musk ketone, musk ambrette, musk xylene, phenyl acetic acid and its' esters, benzyl acetate, synthetic musk, jasmine.

Books and References

1. N. N. Melnikow: Chemistry of Pesticides, Springer
2. M. B. Green, G.S. Hartley West: Chemicals for Crop Protection and Pest Management, Pergamon.
3. K. Venkatraman: The Chemistry of Synthetic Dyes Vol. 1-7 (A.P)
4. Abranart: Dyes and Their intermediates (Pergaman).
5. Beech: Fiber reactive Dyes (Logos Press).
6. Frig and David – Dyes intermediate.
7. Allan: Color Chemistry
8. Kent-Riegels: Industries Chemistry.
9. M Ash & I Ash: A formulary of paints & other coatings.
10. L. W. Aurand, A. E. Woods, Food Chemistry, AVI Publishing Inc.
11. R.W. Thomas and P. Farago: Industrial Chemistry (HEB).
12. C.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut, 2011

MCY 133: Pericyclic Reaction
Course outcomes (COs):

1. To study the types of pericyclic reactions and their reaction conditions.
2. To learn the concept of frontier orbitals, correlation diagram and woodward – Hoffmann rules for cycloaddition reactions.
3. To study the alkenes and conjugated systems of electrocyclic reactions, photochemical and thermal Electrocyclic reactions.
4. To understand the concept of transfer reaction mechanism of diimide and related compounds, retro ene reactions.

MCY-133:Pericyclic Reactions **Credits 4 (3-1-0)**

UNIT – I **9**

Introduction of Pericyclic Reaction: The nature of Pericyclic reactions, Cycloaddition reaction, Diels-Alder reaction, 1, 3-Dipolar Cycloaddition reaction, Stereochemistry of Cycloaddition reaction and Cheletropic reactions.

UNIT – II **9**

The woodward – Hoffmann rules and molecular orbitals: frontier orbitals, Orbital correlation diagram and woodward – Hoffmann rules for cycloaddition reactions.

UNIT – III **9**

Electrocyclic reactions: neutral polenes, ionic conjugated systems, woodward – Hoffmann rules for electrocyclic reactions, photochemical and thermal electrocyclic reactions.

UNIT – IV **9**

Sigmatropic rearrangement: - Suprafcial and antarafacial [m,n] rearrangement.
Group transfer reactions: Diimide and related compounds, retro ene and thermal elimination reactions.

Books and References:

1. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis, (2007), Freeman and Company, New York.
2. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1st Edition (1990), Macmillan India Ltd., New Delhi.
3. T.H. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc. (IS Edition).
4. S.M. Mukherjee and S.P. Singh, Pericyclic Reactions, MacMillan India, New Delhi.
5. Jagdamba Singh and L D S Yadav, Advanced Organic Chemistry / Organic Synthesis, Pragati Prakashan, 2011.
6. I. Fleming, Pericyclic Reactions, Oxford University Press, Oxford (1999).

MCY-141:Medicinal chemistry
Course outcomes (COs):

1. Write structure activity relationship and mechanism of action of various drugs.
2. Perform synthesis of various types of drugs
3. Classify anti-cancer agents
4. Explain and relate physic-chemical properties with drug actions. Classify the drugs on the basis of five and six membered heterocyclic rings.

MCY-141 Medicinal Chemistry **4 Credits (3-1-0)**

UNIT – I **9**

Synthetic drug: A general study of important synthetic drug of the following types: Sulpha drug: Sulphanilamide derivative, sulphathiazole, sulphathalidine, sulphasuccidine, sulphaguanidine, sulphadiazine. Antimalarials: 4- Aminoquinoline derivative, chloroquine, santoquine, pamaquine, 8-aminoquinoline.

UNIT – II **9**

Drugs based on five membered heterocycles: Tolmetin, spiralpril, oxaprozine, sulconazole, nizatidine, imolamine, isobuzole. Drugs based on six membered heterocycles: Warfarin, quinine, norfloxacin and ciprofloxacin, methylclothiazide, citrine, terfenadine.

UNIT – III **9**

β-Lactam antibiotics: Penicillin, cephalosporin. Drugs based on five membered heterocycles fused to six membered rings: Acyclovir, methotrexate. Anti- cancer agents: Nitrogen mustards, antimetabolites in cancer chemotherapy. Psychopharmacological agents: Reserpine, promazine, chlorpromazine, mepazine

UNIT – IV **9**

Drugs based on seven membered heterocyclic rings fused to benzene: Chlordiazepoxide, diazepam, diltiazem. Drugs based on heterocycles fused to two benzene rings: Quinacrine, tacrine. Antibiotics: Synthesis of penicillin -G, penicillin -V, ampicillin, chloramphenicol, streptomycin and cephalosporin-C

Books and References

1. A. Burger, Medicinal Chemistry, Vol. I-III, (1995) Wiley Interscience Publications, New York.
2. W. O. Foye, Principles of Medicinal Chemistry, 3rd Edition (1989), Lea & Febiger/ Varghese Publishing House, Bombay.
3. D. Lednicer and L. A. Mitscher, The Organic Chemistry of Drug Synthesis, Vol. I-III, Wiley Interscience.
4. A. Kar, Medicinal Chemistry, (1993) Wiley Eastern Ltd., New Delhi.
5. N. K. Terrett, Combinatorial Chemistry, (1998) Oxford Univ. Press, Oxford.
6. Daniel Lednicer Stretegies for organic drug synthesis and design, John Wiley & Sons, New York.

MCY 142: Material Chemistry

Course outcomes (COs):

1. To study the background and origin of materials, classification and their applications.
2. To study the preparation, characterization, properties and applications of nanomaterials.
3. To study the preparation, characterization, properties, classification and applications of polymer & composites.
4. To study the Scope and methods used for materials characterization based on molecular and photometric spectroscopy.

MCY-142: Material Chemistry **Credits 4 (3-1-0)**

UNIT – I **9**

Introduction: Historical perspective, importance of materials, materials for future. Crystalline and non-crystalline materials, Intrinsic and extrinsic semiconductors. Intrinsic carrier concentration. Carrier mobility. Impurity conduction. Elemental, compound (II-VI, III-V) and amorphous semiconductors. Magnetic properties: Types of Magnetism. Ferromagnetic domains. Measurement of magnetic susceptibility. Applications of magnetic materials.

UNIT – II **9**

Nano Materials

Preparation methods: Thermal and ultrasound decomposition methods. Reduction methods. Co-precipitation, spray drying, sol-gel and hydrothermal methods. Properties: Quantum wells, wires and dots. Size and dimensionality effects. Single electron tunneling. Applications in infrared detectors and quantum dot lasers. Magnetic properties of nanocrystalline materials. Nanostructured ferroelectric materials and their properties. Carbon clusters compounds, Preparation and properties of carbon nanotubes. Inorganic nanotubes and nanorods, nanoporous materials.

UNIT – III **9**

Polymer and Composites

Polymers and chemical bonding. Polymerization mechanism. Addition and Condensation polymerization. Chain transfer reaction. Co-polymerization. Polymerization by coordination catalyst. Ring opening polymerization. Molecular weights and their distribution. Microstructure of polymer chains. Configuration and conformation. Crystallinity and melting. Glass transition. Physical states of polymers and mode of motions of polymer chain. Measurement of viscosity. Compatibility and solubility parameters. Polymer additives, blends and composites. Conducting, bio-natural and advanced polymers.

UNIT – IV **9**

Material Characterization

Scope and methods used for materials characterization. Transmission electron microscopy: Description of TEM. Formation of images and selected area diffraction patterns. Interpretation of electron diffraction patterns. Specimen preparation. Scanning electron microscopy: Description of SEM. Image formation methods in SEM. Scanning probe microscopy: STM and AFM. techniques. Principle of EDAX, XPS, TGA, DSC and XRD.

Books and References

1. Principles of Polymerization, Fourth Edition, George Odian, 2004 John Wiley & Sons, Inc.
2. Polymer Science, Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, 2019, New Age International Publication.
3. Text Book of Polymer Science, 3rd Edition (1984), F. W. Billmayer, Jr., Willey-Interscience, New York.
4. Introduction to Materials Chemistry, 2nd Edition, Harry R. Allcock, 2019, John Wiley & Sons, Inc.
5. Essentials of Materials Science and Engineering Second Edition, SI, 2010, Cengage Learning.
6. Nanomaterials and Nanochemistry, C. Brechignac P. Houdy M. Lahmani, 2006, Springer.
7. Handbook of Materials Characterization, S. K. Sharma, 2018, Springer.

MCY-121: Polymer Chemistry
Course outcomes (COs):

1. To gain knowledge about polymer science with respect to Classification of polymers, Structure of polymers, Chemistry of polymerization, molecular weight & polydispersity, glass transition temperature (Tg) & crystallinity of polymers stereochemistry of polymers.

2. To understand the mechanism and kinetics of step-growth and chain-growth polymerization. To understand the advanced techniques of controlled polymerization like living polymerization.

3. To understand the properties and behaviour of polymer solutions: Flory-Huggins theory of polymer solutions, nature, size and shape of macromolecules in solution. To gain knowledge about speciality polymers like Liquid crystalline polymers, conducting polymers, electroluminescent polymers, inorganic polymer, nanocomposites of polymers, biomedical polymers.
4. To understand the Analytical Techniques used for the characterization of polymer samples viz. differential thermal analysis (DTA), and differential scanning calorimeter (DSC) techniques, thermogravimetric analysis (TGA). To gain knowledge about the experimental determination of the molecular weight and structure of polymers.

MCY-121 Polymer Chemistry **3 Credits (2-1-0)**

UNIT – I **9**

Polymers: Monomers, Functionality, Classification of polymers, Structure of polymers, Chemistry of polymerization, molecular weight & amp; polydispersity, Crystallinity and glass transition temperature (Tg) & amp; crystallinity of polymers, Types: Chain and step growth polymerization, mechanism of free radical, cationic, anionic and coordination polymerization, stereochemistry of polymers.

UNIT – II **9**

Mechanism and kinetics of step-growth and chain growth polymerization: Radical, cationic, anionic and condensation polymerization, copolymerization, reactivity ratios, thermodynamic aspects of polymerization, mechanism of living radical polymerizations: nitroxide mediated polymerization (NMP), metal-catalyzed living radical polymerization, reversible addition-Fragmentation Chain Transfer (RAFT) radical polymerization, coordination polymerization, ring opening polymerization, click chemistry.

UNIT – III **9**

Polymer solutions: Flory-Huggins theory of polymer solutions, nature, size and shape of macromolecules in solution. Specialty polymers: Liquid crystalline polymers, conducting polymers, electro-luminescent polymers, inorganic polymer, nanocomposites of polymers, biomedical polymers.

UNIT – IV **9**

Analytical Techniques: Thermal Analysis: Thermal transitions and their classification in polymers, glass transition temperature and its mechanism, melting point of semi crystalline polymers, characterizing polymer and polymer blends using differential thermal analysis (DTA), and differential scanning calorimeter (DSC) techniques, thermogravimetric analysis (TGA) Molecular weight determination: Basic concepts of end group analysis, colligative properties, osmometry, light

scattering, and gel permeation chromatography, Viscosity of polymers solutions, size of the polymer molecules.

Books and References

1. R.B. Seymour, C.E. Carraher, Polymer Chemistry, CRC Press, 7th edition, 2008, Boca Raton.
2. J R Fried, Polymer Science and technology, Prentice Hall of India New Delhi2nd edition2005.
3. F W Billmeyer, Text book of Polymer Science , Willey -Inter science New York,4th Ed. 1981.
4. B. Vollmert, Polymer Chemistry, Springer-Verlag, Berlin.
5. George Odian , "Principles of polymerisation", Seymor Robert
6. V.R. Gowariker, "Polymer Science" – New Age International (P) Ltd, Publishers

MCY-143: Nuclear Chemistry

Course outcomes (COs):

1. Write nuclear structure and stability.
2. Describes general principles of binding energy
3. Explain the nuclear reaction. Describes and classify the reactor theory
4. Explain the various types of materials, which is use in reactors. Describe the elements of radiation chemistry.

MCY-143 Nuclear Chemistry **4 Credits (3-1-0)**

UNIT – I **9**

Nuclear Structure and Stability Binding energy, empirical mass equation, The nuclear models, the liquid drop model, the shell model, the Fermi gas model & collective nuclear model, nuclear spin parity & magnetic moments of odd mass numbers nuclei.

UNIT – II **9**

Nuclear reaction

Introduction, Production of projectiles, nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, Coulomb scattering, potential barrier, potential well, formation of a compound nucleus, Nuclear reactions, direct Nuclear reactions, and heavy ion induced nuclear reactions, photonuclear reactions.

Nuclear fission

Liquid drop model of fission, fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and Asymmetric fission, decay chains and delayed neutrons.

UNIT – III **9**

Reactor Theory -

Nuclear fission as a source of energy, Nuclear chain reacting systems, critical size of a reaction, research reactors, graphite moderated, heterogeneous, enriched uranium reactors, light water moderated, heterogeneous, enriched uranium reactors, water boilers enriched aq. Homogeneous reactors, Thermonuclear reactors, gamma interactions,shielding and health protection. Reactors in India.

Nuclear Resources in India

Uranium and Thorium resources in India and their extractions, Heavy water manufacturing in India.

UNIT – IV **9**

Elements of Radiation Chemistry

Radiation Chemistry, Interaction of radiation with matter, Passage of neutrons through matter, Interaction of gamma radiation with matter, Units for measuring radiation absorption, Typical reactions involved in the preparations of isotopes. radiochemical principles in the use of tracers, typical application of radioisotopes as tracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity

Books and References

1. Friedlander, Kennedy and Miller, Nuclear and Radio Chemistry: John Wiley
2. B.G. Harvey, Nuclear Chemistry
3. Hassinsky: Translated by D.G. Tuck, Nuclear Chemistry and its application: Addison Wiley
4. B.G. Harvey, Introduction to Nuclear Physics and Chemistry
5. Maeclefort: Nuclear Chemistry: D.Van Nostrand
6. An N.Nesmeyannoy: Radiochemistry: Mir
7. Jacobs et al: Basic Principles of nuclear Science and Reactors, V.Nost & EWAP
8. N.Jay: Nuclear Power Today Tomorrow: ELBS
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Essentials of Nuclear Chemistry, H.J. Arnikar, John Wiley
11. Nuclear and Radiation Chemistry: B.K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri

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