MANGALAYATAN UNIVERSITY, ALIGARH

CENTRE FOR DISTANCE AND ONLINE EDUCATION

PROGRAMME PROJECT REPORT

MASTER OF SCIENCE (CHEMISTRY)

M.Sc. (Chemistry)

2023-24

Introduction

Master of Science in Chemistry (M.Sc. Chemistry) is a postgraduate program that delves into advanced chemical concepts and theories. This program is meticulously crafted to empower students with a profound comprehension of various chemical principles and their wide-ranging applications across various domains, including pharmaceuticals, materials science, environmental science, and chemical engineering. The comprehensive curriculum encompasses advanced topics such as quantum chemistry, chemical thermodynamics, spectroscopy, organic synthesis, and chemical kinetics, among others. Through M.Sc. Chemistry program, students not only acquire theoretical knowledge but also gain practical laboratory skills, enabling them to conduct cutting-edge research and contribute to advancements in the field of chemistry.

M.Sc. Chemistry students are encouraged to engage in independent research projects and collaborative endeavours, fostering the development of vital teamwork and communication abilities. They are introduced to state-of-the-art laboratory techniques and modern analytical instruments, which strengthen their capacity for problem-solving. Moreover, this program emphasizes the application of chemical knowledge in real-world scenarios, fostering the development of innovative solutions to complex challenges. Graduates of M.Sc. Chemistry program emerge as highly skilled chemists, well-prepared to pursue careers in academia, research and development, pharmaceuticals, chemical manufacturing and various other sectors where a profound understanding of chemistry is indispensable. This rigorous and fulfilling program offers students a solid foundation in chemistry, positioning them for a diverse array of exciting career prospects in the dynamic field of chemistry.

A. Programme's Mission and Objectives

Mission

- To cater and ensure excellent theoretical and practical training through teaching, counseling and mentoring with a view to achieve professional and academic excellence.
- To connect with industry and incorporating knowledge for research enhancement.
- To generate, disseminate and preserve knowledge for the benefit and betterment of society.

Objectives

M.Sc. Chemistry programme has a comprehensive set of objectives aimed to providing students with a deep and advanced understanding of the field. It seeks to instill a strong foundation in core chemical principles and theories while promoting critical thinking and analytical skills. Additionally, the programme aims to cultivate students' ability to conduct independent research, including honing skills in literature review, experimental design, data analysis and effective scientific communication. It aligns curriculum with the evolving needs of industries and academia to ensure that graduates are well-prepared for diverse career opportunities, spanning academia, research, pharmaceuticals, environmental science, and various other sectors. Ultimately, the programme contributes to the advancement of scientific knowledge and innovation within the realm of chemistry.

B. Relevance of the Programme with HEI's Mission and Goals

The vision and mission of HEI, Mangalayatan University, Aligarh are:

Vision:

To be an institution where the most formative years of a young mind are spent in the guided pursuit of excellence while developing a spirit of inquisitive questioning, an ability to excel in the pressure of a fast-changing professional world, and a desire to grow into a personality rather than a person, in an environment that fosters strong moral and ethical values, teamwork, community service and environment consciousness.

Mission:

- To be the enablers of the confluence of academic rigor and professional practicality

- To bring global best practices to students through widespread use of technology.
- To empower our faculty to constantly develop new skills and excel professionally.
- To provide the best campus environment to students and faculty with all facilities to nurture their interest.

M.Sc. (Chemistry) programme of the University strives to realize its vision and mission by rectifying student centric issues on priority and also to empower local community with the help of various social clubs running in University like NSS, KADAM and Alumni association. The University promotes multidisciplinary and allied research in various fields that supports and harnesses joyful learning environment. The goals of ODL (Open Distance Learning) program is to provide educational facilities to all qualified and willing persons who are unable to join regular courses due to personal or professional reasons. There are many potential learners who cannot afford to join regular courses due to professional responsibilities and personal commitments. For such cases M.Sc. (Chemistry) through ODL mode can be helpful in enhancing knowledge base and skill up-gradation.
The programme aims to provide alternative path to wider potential learners who are in need of refresher courses to update their skills.

C. Nature of Prospective Target Group of Learners

Distance Education of Mangalayatan University (MU) shall target the working professional's executives as well as those who cannot attend a full-time program due to prior occupation or other assignments. The candidates desirous of taking admission in M.Sc. (Chemistry) programme shall have to meet the eligibility norms as follows-

1. To obtain admission in M.Sc. (Chemistry) programme offered through ODL mode.
2. The learner must have completed graduation in science stream (PCM/ZBC).

D. Appropriateness of Programme to be conducted in ODL mode to acquire specific skills and competence

The University has identified the following **Programme Outcomes** and **Programme Specific Outcomes** as acquisition of specific skills and competence in M.Sc. (Chemistry) Programme.

Programme Outcomes (PO's)

After completing the M.Sc. (Chemistry) programme through ODL Mode, students will be able to:

a. PO1: Knowledge outcomes: Acquire knowledge and ability to develop creative solutions, and better understanding of the future developments of the subject. Also evolve analytical and logical thinking abilities.

b. PO2: Skill Outcomes: Learn and understand the new concepts and get prepared for placement by developing scientific skills. Further ability to communicate scientific information in a clear and concise manner.

c. PO3: General Competence: Be able to understand the role of science in solving real life problems and get an ability to participate in debates and discussions constructively.

d. PO4: Scientific Aptitude and Innovation: Know the recent developments, future possibilities and able to gather, assess, and make use of new information and applying this knowledge to find creative solutions.

Programme Specific Outcomes:

After completing the M.Sc. (Chemistry) programme through ODL Mode, students will be able to:

a. PSO1: Students will understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life. They will also be able to acquire knowledge about the fundamentals and applications of chemical and scientific theories.
b. PSO2: Helps in understanding the causes of environmental pollution and can open up new methods for environmental pollution control.
c. PSO3: Students will become familiar with the different branches of chemistry like analytical, organic, inorganic, physical, environmental, polymer and biochemistry. They will also learn to apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.
d. PSO4: Provide a systematic understanding of the concepts and theories of chemistry and their application in the real world – to an advanced level, and enhance career prospects in a huge array of fields.

E. Instructional Design

The programme is divided into four semesters and minimum credit requirement is 80 to get M.Sc. (Chemistry) degree in ODL mode from Mangalayatan University. Minimum time period for acquiring M.Sc. (Chemistry) degree will be two years and maximum time period to acquire is 4 years.

Evaluation Scheme

Semester-I							
S. No.	**Course Code**	**Course Name**	**Category**	**Credit**	**Continuous Assessment Marks**	**Term End Exam Marks**	**Grand Total**
					Max. Marks	**Max. Marks**	
1	CHM-6111	Inorganic Chemistry -I	DCC	4	30	70	100
2	CHM -6112	Organic Chemistry -I	DCC	4	30	70	100
3	CHM-6113	Physical Chemistry-I	DCC	4	30	70	100
4	CHM-6114	Analytical Chemistry -I	DCC	4	30	70	100
5	CHM -6115	Photochemistry and Pericyclic Reactions	DCC	4	30	70	100
6	CHM-6151	Chemistry Lab-I	DCC	4	30	70	100
Total				24	180	420	600

Semester-II							
S. No.	Course Code	Course Name	Category	Credit	Continuous Assessment Marks	Term End Exam Marks	Grand Total
					Max. Marks	Max. Marks	
1	CHM-6211	Inorganic Chemistry –II	DCC	4	30	70	100
2	CHM-6212	Organic Chemistry –II	DCC	4	30	70	100
3	CHM -6213	Physical Chemistry-II	DCC	4	30	70	100
4	CHM -6214	Analytical Chemistry -II	DCC	4	30	70	100
5	CHM-6215	Polymer Chemistry	DCC	4	30	70	100
6	CHM-6251	Chemistry Lab-II	DCC	4	30	70	100
Total				24	180	420	600

Semester-III							
S. No.	Course Code	Course Name	Category	Credit	Continuous Assessment Marks	Term End Exam Marks	Grand Total
					Max. Marks	Max. Marks	
1	CHM-7111	Bioinorganic and Biophysical Chemistry	DCC	4	30	70	100
2	CHM-7112	Organometallic Chemistry	DCC	4	30	70	100
3	CHM-7113	Organic Photochemistry	DCC	4	30	70	100
4	CHM-7114	Research Methodology	GE	4	30	70	100
5	CHM-7151	Chemistry Lab -III	DCC	2	30	70	100
Total				18	150	350	500

Semester-IV							
S. No.	Course Code	Course Name	Category	Credit	Continuous Assessment Marks	Term End Exam Marks	Grand Total
					Max. Marks	Max. Marks	
1		Elective -1	Elective	4	30	70	100
2		Elective -2	Elective	4	30	70	100
4	CHM-7251	Chemistry Lab -IV	DCC	2	30	70	100
4	CHM-7291	Project	DCC	4	0	100	100
Total				14	90	310	400

List of Elective Papers

CHM-7211	Supramolecular Chemistry	Elective
CHM-7212	Green and Environmental Chemistry	Elective
CHM- 7213	Chemistry of Natural Product	Elective
CHM- 7214	Solid State Chemistry	Elective

Total credit of M.Sc. (Chemistry) program Semester wise

Semester	Credit
I	24
II	24
III	18
IV	14
TOTAL	**80**

MOOCs

The University shall give flexibility in opting for MOOCs (Massive Online Open Courses) by the students pertaining to the prescribed curriculum and also the credits earned in the MOOCs may be dealt as part of the evaluation scheme as per UGC (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020.

Syllabi and Course Materials

Syllabi, PPR and self-learning materials are developed mostly by experienced faculty members of Mangalayatan University in consultation with contents experts and the same will be forwarded to CIQA and BoS/Academic Council/ Executive Council for further suggestions and approval.

SEMESTER: I

Course Code: CHM-6111 **Credits: 4**

Course Name: Inorganic Chemistry- I

Course Objectives:

The objective of this course aims to explain the general characteristics of s and p-block elements and their variation in the periodic table is also explained in this course. The chemistry of phosphorous related compounds also discussed in this course.

Block I: Non-transition elements

Unit 1: Chemistry of Non-Transition Elements

Introduction to s-and p-block elements, General Trends in s-block elements, General Trends in p-block elements, Stereochemistry, Bonding

Unit 2: Quantitative Difference between Physical and Chemical Properties

Physical properties of s-and p-block elements, Chemical properties of s and p-block elements

Unit 3: Organometallic Compounds of Non-Transition Elements and their Importance

Introduction to Organometallic compounds, s-and p-block organometallic compounds and their synthesis and importance

Block II: s and p-Block elements: Group 1, 2, 13, 14 and 15

Unit 4: General Properties of p-Block Elements

Metal complexes and Clusters

Unit 5: Chemistry of Alkali and Alkaline Earth Metals

Alkali metals, Alkaline earth metals, General Characteristics of Alkaline earth metals

Unit 6: Chemistry of Group 13, 14, 15, And 16 Elements.

Boron Family and their compounds, Carbon Family and their compound, Nitrogen Family and their compounds, Oxygen Family and their compounds

Block III: Halogen Family

Unit 7: Chemistry of Halogen Compounds

Halogen Family, General properties of Halogens, Halogen Oxoacids, Applications

Unit 8: Polyhalogen and Interhalogen Compounds

Polyhalogen Compounds, Interhalogen Compounds and their Applications

Unit 9: Compounds of Halogens and Oxygen

Halogen Family, General properties of Halogens, Halogen Oxoacids, Applications

Block IV: Noble Gases

Unit 10: Chemistry of Noble Gasses

Chemistry of noble gases, Xenon compounds, Applications

Unit 11: Catenation between Heavier Elements

Occurrence, RE=ER (E = P, As, Sb, Bi), $R_2E=ER_2$ and R2E (E = Si, Ge, Sn, Pb) systems, Applications

Unit 12: Multiple Bonding between Heavier Elements

Nature of Bonding, Multiple bonding

Block IV: Phospha-Alkynes and Phospha-Alkenes, Chemistry of Alkali and Alkaline Earth Metals and Main Group Organometallic Chemistry

Unit 13: Phospha-Alkynes and Phospha-Alkenes.

Phospha-alkynes, Phospha-alkenes

Unit 14: Chemistry of Alkali and Alkaline Earth Metals

Chemistry of alkali and alkaline earth metals, their uses in homogeneous catalysis and material chemistry.

Unit 15: Main Group Organometallic Chemistry

Variable oxidation states of main group elements with special emphasis on recently developed Al(I) and Si(II)-silylene chemistry.

Books Recommended/Suggested Reading:

1. *Basic Inorganic Chemistry, F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.*
2. *Concise Inorganic Chemistry, J. D. Lee, 5th Edition (1996), Chapman & Hall, London.*
3. *Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970*
4. *Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.*
5. *Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.*
6. *Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.*
7. *Shriver & Atkins, Inorganic Chemistry 5th Ed.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain non-transition elements.
2. Define s-and p-block elements.
3. Interpret halogen and inter halogen compounds.
4. Illustrate Noble gases.
5. Identify Phospha-alkynes and phospha-alkenes

Course Code: CHM-6112 **Credit: 4**

Course Name: Organic Chemistry- I

Course Objectives:

The objective of this course is to explain the concept of optical isomerism and stereochemistry of bridged, caged, cyclic compound, reaction mechanism and intermediates.

Block I: Stereoisomerism: Optical Isomerism

Unit 1: Chiral Molecules with One Stereogenic Centre

Stereoisomers, symmetry elements, chiral molecules with one stereogenic centre, optical activity, sequence rules, absolute configuration, enantiomeric excess.

Unit 2: Two (or More) Stereogenic Centres

Molecules with two (or more) stereogenic centres: diastereomers, Newman, Fischer and Sawhorse formulae.

Unit 3: Optical Isomerism

Erythro/threo, syn/anti configurations, meso configuration

Block II: Stereochemistry

Unit 4: Stereochemistry of Fused, Bridged, and Caged Ring Systems

Stereochemistry of fused, bridged, and caged ring systems

Unit 5: Resolution of Enantiomers
Resolution of enantiomers
Unit 6: Chirality Without Stereogenic Carbon
Chirality without stereogenic carbon: allenes, biphenyls, cyclophanes, helicenes, atropisomerism.

Block III: Steroisomerism in Cyclic Compounds
Unit 7: Steroisomerism in Cyclic Compounds
Steroisomerism in cyclic structures: cyclopropane, cyclobutene, cyclopentane.
Unit 8: Cyclohexane
Cyclohexane, decalins, anomeric effect, conformational analysis
Unit 9: Diasterotopic Groups and Faces
Prochirality, enantiotopic and diasterotopic groups and faces

Block IV: Reaction Intermediates
Unit 10: Carbocations, Carbanions and free radicals
carbocations, carbanions, Free radicals: Definition, Structure, Geometry, Stability, Reactivity and Applications.
Unit 11: Carbenes
Enolates, Carbenes, nitrenes, benzyne: Geometry, Stability, Reactivity and Applications.
Unit 12: Kinetic and Thermodynamic Control of Reactions
Kinetic and Thermodynamic control of reactions

Block V: Reaction Mechanism
Unit 13: Substitutions, Eliminations Reactions
Reaction mechanism: substitutions, eliminations reactions.
Unit 14: Additions, Rearrangements
Additions, rearrangements reactions
Unit 15: The Hammett Relationship
The Hammett relationship, stereochemistry and mechanism

Books Recommended/Suggested Reading:

1. *F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry, Part A", fifth edition, Springer.*
2. *E. L. Eliel, "Stereochemistry of Organic Compounds", John Wiley & Sons.*
3. *J. March, "Advanced Organic Chemistry", fifth edition, John Wiley & Sons.*
4. *J. Clayden, N. Greeves and S. Warren, "Organic Chemistry", Second Edition, Oxford University Press.*

Course Outcomes:
On successful completion of this course, students shall be able to:
1. Classify Stereoisomers.
2. Explain stereochemistry of fused, bridged, and caged ring systems.
3. Interpret Stereoisomerism in cyclic structures.
4. Define and discuss Reaction intermediates.
5. Identify and explain reaction mechanism.

Course Code: CHM-6113 **Credits: 4**

Course Name: Physical Chemistry- I

Course Objectives:

Physical Chemistry is an important branch of Chemistry which deals at the small systems. Various phenomenons such as black body radiations, photoelectric effect, Heisenberg's uncertainty principle etc. are some important concepts in quantum mechanism. The use of Schrodinger wave equation for one electron as well as multi electron system is the main objective of this study. Using the wave function, the molecular orbital diagram as well as Huckel's energy level diagram can also be explained for various acyclic and cyclic systems.

Block I: Introduction to Quantum Mechanism

Unit 1: Dawn of Quantum Mechanics

Introduction of Quantum Mechanics, Spectrum, black-body radiation, heat capacities, photoelectric and Compton effects

Unit 2: Atomic and Molecular Spectra

Atomic and molecular spectra, particle diffraction, wave-matter duality, Significance and Implications

Unit 3: Foundation of Quantum Theory

Foundation of Quantum Theory, Postulates of quantum mechanics, operators, role of operations in Quantum mechanism, specification and evolution of states

Block II: Schrodinger Wave Equation and its Applications

Unit 4: Schrodinger Wave Equation

Schrodinger wave equation, physical significance of wave functions and Properties of Eigen wave value

Unit 5: Translational Motion

Introduction of Translational Motion: Particle-in-a-box, penetration into and through barriers.

Unit 6: Harmonic Oscillator Rotational Motion

Introduction of Harmonic Oscillator Rotational Motion: Particle-on-a-ring, particle-on-a-sphere, motion in a coulombic field.

Block III: Hydrogen Atom

Unit 7: Hydrogenic Atoms and Angular Momentum

Hydrogenic Atoms and Angular Momentum

Unit 8: Many Electrons Atoms

Many Electron Atoms

Unit 9: Approximate Methods Perturbation theory

Approximate Methods and its challenges in quantum mechanics and purpose, Types of approximated methods, Perturbation theory and variational methods.

Block IV: Huckel Theory and its Molecular Orbital Wave Function

Unit 10: Huckel's Theory

Huckel's theory, resonance integral, energy level diagram, Resonance diagrams for ethene, cyclobutadiene, allyl system, butadiene, benzene.

Unit 11: Delocalization Energy of Organic Molecules

Delocalization energy of Organic Molecules: Ethene, cyclobutadiene, benzene, allyl cation, allyl radical, allyl anion, cyclopropyl anion, cyclopropyl radical and cyclopropyl cation

Unit 12: Huckel's Molecular Orbital Wave Function

Huckel's molecular orbital wave function electron density and bond order. Huckels molecular Orbitals for ethene, allyl cation, cyclobutadiene, benzene

Block V: Molecular Structure

Unit 13: Introduction to Molecular Structure

Introduction to Molecular Structure: Born-Oppenheimer approximation, molecular orbital theory.

Unit 14: Valence Bond Theory

Introduction and postulates of Valence bond theory, number of orbital and types hybridization, applications, limitations.

Unit 15: Computational Chemistry

Molecular modeling, drug designing, software used in molecular modeling, applications of Computer chemistry in drug.

Books Recommended/Suggested Reading:

1. *Quantum Chemistry, Donald A. McQuarrie, Viva Books.*
2. *Modern Quantum Chemistry, Attila Szabo & Neil S. Ostlund, Dover Publications.*
3. *Quantum Chemistry and Molecular Interactions, Andrew Cooksy, Pearson Press.*
4. *Quantum Chemistry & Spectroscopy, Thomas Engel, Pearson Education.*
5. *Molecular Quantum Mechanics, Peter Atkins & Ronald Friedman, Oxford Press.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain origin of quantum chemistry.
2. Define the concepts and postulates of quantum mechanics.
3. Illustrate Schrodinger wave equation and its application to particle in a box and harmonic oscillator.
4. Interpret molecular orbital theory and valence bond theory.
5. Solve Huckel theory.

Course Code: CHM-6114 **Credits: 4**

Course Name: Analytical Chemistry- I

Course Objectives:

The objective of this course is to explain the general concept of analytical techniques and related methods; the interpretation of data using various types of spectroscopy such as atomic absorption spectroscopy, emission spectroscopy, nuclear magnetic spectroscopy, mass spectroscopy and x-ray spectroscopy, and their applications in different fields.

Block I: General Introduction to Analytical Methods

Units 1: Measurement Basics and Data Analysis

Measurement basics and data analysis, Classification and selection of analytical methods, Types and Calibration of Instruments, Signals and Noise, Linear and Nonlinear regression analysis

Unit 2: Introduction to Spectrometric Methods

Introduction to Spectrometric Methods: General properties of electromagnetic radiation

Unit 3: Basic Elements of Spectroscopy

Basic elements of spectroscopy and its advantages, Einstein coefficients.

Block II: Spectroscopic Analysis

Unit 4: Atomic Absorption

Atomic Absorption Spectrometry: Sample atomization techniques, atomic Absorption instrumentation, Interferences in Atomic Absorption Spectroscopy, Atomic Absorption Analytical Techniques.

Unit 5: Emission Spectroscopy

Fluorescence Emission Spectroscopy: Atomic Fluorescence Spectroscopy, Emission Spectroscopy based on Plasma Sources, Emission Spectroscopy based on arc and Spark Sources.

Unit 6: Mass, And X-Ray Spectroscopy

Mass and X-Ray Spectroscopy: Introduction to Atomic Mass and X-Ray Spectrometry.

Block III: UV-VIS molecular absorption and Raman Spectroscopy

Unit 7: UV-VIS Molecular Absorption Spectrometry

UV-VIS Molecular Absorption Spectrometry: Measurement of Transmittance and Absorbance, Beer's Law, Effects of Instrumental Noise on Spectrophotometric Analyses, Instrumentation, Magnitude of Molar Absorptivity's, Absorbing Species.

Unit 8: Qualitative and Quantitative Analysis

Application of Absorption Measurement to Qualitative Analysis, Quantitative Analysis by Absorption Measurements, Photometric Titrations

Unit 9: Raman Spectroscopy

Raman Spectroscopy: Theory of Raman Spectroscopy, Instrumentation, Applications of Raman Spectroscopy, Types of Raman Spectroscopy.

Block IV: Infrared Spectrometry and Thermogravimetric Analysis

Unit 10: Infrared Absorption Spectrometry Structure

Theory of Infrared Absorption Spectrometry, Infrared Sources and Transducers, Infrared Instruments

Unit 11: Application of Infrared Spectroscopy

Application of Infrared spectroscopy, Photoacoustic Infrared Spectroscopy, Near-Infrared Spectroscopy

Unit 12: Thermogravimetric Analysis

Instrumentation, Thermogravimetric Curves, Sources of Errors in TGA, Factors Affecting TG Curve, Applications of Thermogravimetric Analysis

Block V: NMR and Mass Spectroscopy

Unit 13: Nuclear Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: Theory of Nuclear Magnetic Resonance (NMR), Environmental Effects on NMR Spectra, NMR Spectrometers, Applications of Proton NMR.

Unit 14: Carbon 13 NMR

Carbon13 NMR, Application of NMR to Other Nuclei, Two-Dimensional Fourier Transform NMR, Magnetic Resonance Imaging.

Unit 15: Mass Spectrometry

Mass Spectrometry: Molecular Mass Spectra, Ion Sources, Mass Spectrometers, Applications of Molecular Mass Spectrometry, Quantitative Applications of Mass Spectrometry.

Books Recommended/Suggested Reading:

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. *Rubinson, K. A.; Rubinson, J. F. Contemporary Instrumental Analysis , 1st Ed., Prentice Hall, 2000.*
5. *Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 4th Ed., John Wiley and Sons, 1998.*
6. *Settle, F. A. Handbook of Instrumental Techniques for Analytical Chemistry, 1st Ed., Prentice Hall, 1997.*
7. *Kaur, H. Instrumental Methods of Chemical Analysis, 1st Ed., Pragati Prakashan, 2001.*
8. *Ewing, G. W. Instrumental Methods of Chemical Analysis, 5th Ed., Mcgraw-Hill, 1985.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Understand the basic concept of analytical methods.
2. Define emission and absorption spectroscopy and their applications.
3. Explain the absorption peaks using UV-Visible spectroscopy.
4. Identify infrared Spectrometry and Thermogravimetric analysis.
5. Interpret NMR and Mass Group Spectrometry.

Course Code: CHM-6115 **Credits: 4**

Course Name: Photochemistry and Pericyclic Reactions

Course Objectives:

The effect of light on the reaction mechanism and possible rearrangements is important concept in photochemistry. The photochemical laws and reactions using different conditions can be explained in various electron systems. Therefore, the objective of this study is to explain the photochemistry and pericyclic reactions in 4n and 4n+2 electron systems.

Block I: Photochemistry

Unit 1: Photochemical Processes and Excited States Properties

Absorption of light (radiation), Laws of photochemistry, Quantum yield or Quantum efficiency (Φ), Determination of Quantum yield (Efficiency of Quantum yield), Factors affecting quantum yield, Photosensitized Reaction, Photosynthesis, Photophysical Processes, Photochemical Processes, Jablonski Diagram, Potential Energy Surface, Potential Energy Curves (1-DPotentialEnergySurfaces), Mathematical definition and computation, Application of Potential Energy Surfaces, Properties of excited state, Dipole moment

Unit 2: Deactivation and Energy Transfer Mechanisms

Theories, factor effecting and application of Uni and Bimolecular deactivation, Quenching – types and factors affecting, applications, Electronic Energy Transfer Mechanisms and their factors

Unit 3: Photochemical Transformations

Intramolecular and Intermolecular photochemical processes- Isomerizations, rearrangements & dissociation, Factors impacting intermolecular additions in photochemical processes

Block II: Inorganic photochemistry

Unit 4: Fundamentals of Inorganic Photochemistry

Introduction to inorganic photochemistry, photochemical laws and photochemical kinetics, Laws of Absorption, Units of Molar Absorption Coefficient

Unit 5: Electronic Absorption in Inorganic Compounds

Photochemical processes. The electronic absorption spectra of inorganic compounds, Characteristics of the electronically excited states of inorganic compounds

Unit 6: Excited State Redox and Photosensitization

Photo electro chemistry of excited state redox reactions, Photosensitization

Block III: Photochemical reactions

Unit 7: Overview of Photochemical Reactions

Absorption of light (radiation), Laws of photochemistry: Quantum yield or Quantum efficiency (Φ), Determination of Quantum yield (Efficiency of Quantum yield), Factors affecting quantum yield, Photosensitized Reaction, Photosynthesis, Photophysical Processes, Photochemical Processes, Jablonski Diagram, Potential Energy Surface, Potential Energy Curves (1-DPotentialEnergySurfaces), Mathematical definition and computation, Application of Potential Energy Surfaces, Properties of excited state, Dipole moment

Unit 8: Miscellaneous Photochemical Reactions

Photo-Fries reactions of anilides, Photo Fries rearrangement, Barton reaction, Singlet molecular oxygen reactions, Photochemical formation of smog, Photo degradation of polymers, Photochemistry of vision.

Unit 9: Photochemistry in Biological Process

Photosynthesis, Photosystem I and Photosystem II, Excited States of Porphyrins and Metalloporphyrins, Porphyrins, Other Bioinorganic Systems

Block IV: Molecular orbital approach and pericyclic reactions

Unit 10: Symmetry and Molecular Orbitals

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.

Unit 11: Molecular Orbital Theory

Woodward–Hoffmann: Conservation of Orbital Symmetry, Fukui: Frontier Molecular Orbital Theory Dewar–Zimmerman: Aromatic Transition State, Types of Diels–Alder Reactions, Net Bonding Interaction, Diastereoselectivity: Endo vs. Exo, Regioselectivity & Rates: Substituent Effects, Lewis Acid Effects

Unit 12: Electrocyclic Reactions and Molecular Motions

Electrocyclic Reactions- 4n, 4n+2 and Allyl Systems, Synthetic Applications of Electrocyclic Reactions

Block V: Cycloaddition reactions

Unit 13: Introduction of Cycloaddition Reactions

Cycloadditions - antarafacial and suprafacial additions, 4n and 4n+2 systems, 2 + 2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic reactions, Endo and Exo Stereochemistry.

Unit 14: Sigmatropic Rearrangements: H and C Shifts

Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5 - sigmatropic rearrangements.

Unit 15: Rearrangements and Reactive Dynamics

Claisen, Cope and aza-Cope rearrangements, Fluxional tautomerism, Ene reaction

Books Recommended/Suggested Reading:

1. Fundamental of Photochemistry, K.K. Rohtagi- Mukherji, Wily- Eastern.

2. Essentials of Molecular Photochemistry, A.Gilbert and J.Baggott, Blackwell Scientific Publication.

3. Molecular Photochemistry, N.J. Turro, W.A. Benjamin. R. B. Woodward and R. Hoffmann, "The Conservation of Orbital Symmetry", Academic Press, New York.

4. Introductory Photochemistry, A. Cox and T. CAMP, Mc Graw-Hill,

5. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.

6. Organic Photochemistry, J. Coxon and b. Halton, Cambridge University Press.

7. Pericyclic Reactions, S.M. Mukherji, Macmillan, India

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain photochemical mechanisms and rearrangements.
2. Define Inorganic photochemistry.
3. Illustrate photochemical reactions.
4. Interpret molecular orbital approach and pericyclic reactions.
5. Describe cycloaddition reactions

Course Code: CHM-6151 **Credits: 4**

Course Name: Chemistry Lab-I

Course Objectives:

The objective of the course is to study the analysis of mixture of rare earth metals, and preparation of some inorganic as well as organic compounds.

1. Qualitative Analysis of Inorganic Mixture

Identification of unknown radicals including insoluble residue by semi-micro analysis

2. Preparations of some Inorganic Complex Compounds

- ***(i)*** Tetrammine Cupric Sulphate
- ***(ii)*** Prussian Blue (Potassium Ferric Ferro cyanide)
- ***(iii)*** Reineckes salt [Ammonium diammine tetra thio cyanato chromate (III)]

3. Preparations

- **(i)** To perform Bromination: 2, 4, 6-tribromoaniline from aniline
- **(ii)** To perform Oxidation: Benzil from benzoin by means of cupric salts

4. Separation of dyes using TLC method.

5. Perform pH-metric and potentiometric titration of phosphoric acid solution against standard NaOH solution. Compare the two results.

SUGGESTED READINGS:

1. Ozin G.A., Arsenault A.C. and Cademartiri L.: NANOCHEMISTRY: A CHEMICAL APPROACH TO NANOMATERIALS (2009).
2. Sergeev G.B.: NANOCHEMISTRY, Elsevier, B.V. (2006).
3. Day R.A. and Underwood A.L.: QUANTITATIVE ANALYSIS, Prentice Hall India Pvt. Ltd., New Delhi, 3rd Ed., (1997).
4. Yadav J.B.: ADVANCED PRACTICAL PHYSICAL CHEMISTRY, Krishna Prakashan Media (P) Ltd., Meerut (2016).
5. Jeffery G.H., Bassett J., Mendham J. and Denney R.C.: VOGEL'S TEXTBOOK OF QUANTITATIVE CHEMICAL ANALYSIS, 5th Ed.,
6. John Wiley & Sons, Inc., New York (1989).
7. Sime R.J.: PHYSICAL CHEMISTRY: METHODS, TECHIQUES, AND EXPERIMENTS, Sounders College Publishing (1990).

Course Outcomes:

At the end of this course, students will be able to

1. Identify the rare earth metals from the mixtures.
2. Explain the preparation method of inorganic compounds.
3. Understand the reaction mechanism in the conversion of organic compounds.
4. Demonstrate the potentiometric titration as well as pH analysis.

Semester: II

Course Code: CHM-6211 **Credit: 4**

Course Name: Inorganic Chemistry – II

Course Objectives:

Transition elements which are also known as d-block elements are important constituents in co-ordination chemistry. Their binding with strong and weak filed ligands, tendency to form complexes and related theory etc. are some important concepts which are explained in this course. The objective of this unit is to explain the properties of transition metals in terms of formation of octahedral, square planar complex and various theories related to the coordination chemistry.

Block I: Coordination Chemistry: General Introduction

Unit 1: Introduction to Coordination Chemistry

Introduction of Coordination compounds, Structure, bonding and Isomers, Coordination Numbers and Structures.

Unit 2: Ligand Field Theory, Molecular Orbital Theory

Introduction to theories of Coordination compounds, Werner coordination theory, Crystal Field Theory, Ligand Field Theory, Angular Overlapping

Unit 3: Magnetic and Spectral Characteristics of Inner Transition Metal Complexes

Magnetic Susceptibility, Electronic Spectra, Coordination Number and Molecular Shapes/Geometry

Block II: Electron Transfer Reaction

Unit 4: Electron Transfer and Photochemical Reactions

Electron transfer and photochemical reactions of transition metal complexes, The Jahn-Teller Effect, Absorption of Light, Beer-Lambert Absorption Law.

Unit 5: Spectroscopic Properties of Transition Metal Complexes

Spectroscopic properties of transition metal, Magnetic Moments of Molecules and Ions, Colours of Transition Metal Complexes

Unit 6: Kinetics and Reaction Mechanism

Kinetics of the Reaction Mechanism, Rate Law for Dissociative Mechanisms, Rate Laws for Interchange Mechanisms, Rate Law for Associative Mechanisms

Block III: Metal-Metal Bonded Compounds and Bioinorganic Chemistry

Unit 7: Metal-Metal Bonded Compounds and Transition Metal Cluster Compounds.

Molecular orbital considerations in Dinuclear Metal Complexes with Multiple M-M Bonds, Cluster Compounds

Unit 8: Uses of Lanthanide Complexes

Lanthanide Complexes, Shift Reagents, Magnetic Compounds, Fluorescence

Unit 9: Bioinorganic Chemistry

Bioinorganic chemistry of iron, Haemoglobin, Myoglobin, Cytochromes, Bioinorganic chemistry of zinc, cobalt and copper

Block IV: Transition Elements

Unit 10: Introduction of Transition Elements

Electronic configuration, oxidation states, complex compounds, Configuration and Oxidation states, Coordination Chemistry of Lanthanides

Symmetry Operations and Elements, Point Groups, Groups of Low and High Symmetry, Properties and Representations of Groups

Unit 12: Stereochemistry of Octahedral Reactions

Substitution in (trans-sys) octahedral complexes, Substitution in cis-en octahedral complexes Isomerization of Chelate Rings

Block V: Block II Struture/Isomers

Unit 13: Introduction to Structures and Isomers of Coordination Compounds

Nomenclature and Ligands, Isomerism, Stereoisomerism

Unit 14: Coordination Compounds of Transition Metals

Nomenclature of Complexes, Structure of Complexes, Isomerism in Complexes

Unit 15: Coordination Complexes in Nature and Technology

Transition Metal catalysis, Uptake and Storage of Transition Metals, Metalloproteins and Metalloenzymes

Books Recommended/Suggested Reading:

1. Basic Inorganic Chemistry, F. A. Cotton and G. Wilkinson, Wiley Easter.

2. Inorganic Chemistry, R.A. Plane.

3. Chemical Principles and Properties, McGraw Hill, J. D. Lee, Concise, Van Nostrand Reinhold.

4. Organometallics and catalysis An introduction. Bochmann, M, 1st edn, Oxford, 2014.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain general introduction of coordination chemistry.
2. Define electron transfer reactions.
3. Interpret metal-metal bonding and bioinorganic compounds.
4. Illustrate transition elements.
5. Evaluate the chemistry of some elements

Course Code: CHM-6212 **Credits: 4**

Course Name: Organic Chemistry - II

Course Objectives:

The scope of organic chemistry in different fields is highly important. The objective of this study is to explain the synthesis of organic compounds, their derivative for various reaction mechanisms.

Block I: Organic Synthesis

Unit 1: Formation of Carbon-Carbon Bonds and Applications

Organometallic reactions, Synthetic applications of organoboranes and organ silanes

Unit 2: Carbon-Hydrogen Bond Activation

C-H bond activation, Oxidations, Reductions, Newer Reagents, Design of organic synthesis

Unit 3: Retrosynthetic Analysis

Selectivity in organic synthesis, Protection and deprotection of functional groups, Multistep synthesis of some representative molecules

Block II: Synthetic equivalents

Unit 4: Strategy and Design of Organic Synthesis

Introduction, scope and brief history of organic synthesis, synthetic strategy, retro-synthesis, analysis and practice of total synthesis, linear and convergent synthesis

Unit 5: Concepts of Synthetic Equivalents and Umpolung

Synthetic equivalents and Umpolung benzoyl and acyl anion equivalents, dithianes, enol ethers and nitro compounds

Unit 6: Alkylation Reactions

Alkylation of enolates, enamines and hydra zones, alkylation of heteroatom stabilized anions.

Block III: Carbon-Carbon double bond formation

Unit 7: Carbon-Carbon Double Bond Formation

Carbon-Carbon double bond formation, Aldol condensation, Wittig and related reactions

Unit 8: Some Name Reactions

Peterson olefination, Julia-Lythgoe olefination, carbonyl coupling reaction (McMurry reaction)

Unit 9: Tebbe Reagent, Shapiro and Related Reactions

Tebbe reagent, Shapiro and related reactions

Block IV: Carbon-Carbon Triple Bond Formations and Cross Coupling Reaction

Unit 10: Elimination and Dehydration Reactions

Elimination reaction, Dehydration reaction, olefin metathesis and transition metal catalysed cross coupling reactions.

Unit 11: Carbon-Carbon Triple Bond Formations

Carbon-Carbon triple bond formations from acetylenes and from carbonyls

Unit 12: Triple Bond Formations from Olefins and Other Compounds

Olefins triple bonds, Cycloalkanes- strained rings, Eschenmoser fragmentation, allenes etc.

Block V: Ring Compounds

Unit 13: Three Membered Rings

Epoxides- using peracids, hydroperoxides and dioxiranes; transition metal catalysed epoxidation, halohydrins, Darzen's condensation, sulphur ylides, Cyclopropanes- Simmons Smith reaction, diazo compounds, sulphur ylides

Unit 14: Four Membered Rings

Various methods of forming cyclobutanes, cyclobutene's and oxetanes

Unit 15: Five Membered Rings

Intramolecular SN2 reactions, intramolecular Michael and aldol condensation reactions, intramolecular Wittig olefination, ring expansion and contraction reactions, 1,3-dipolar cycloaddition reactions.

Books Recommended/Suggested Reading:

1. *David J. Hart "Organic Synthesis via Examination of Selected Natural Products" World Scientific.*
2. *S. Warren, "Designing Organic Syntheses", John Wiley & Sons.*
3. *"Modern Organic Synthesis-An Introduction", G. S. Zweifel and M. H. NantzW. H. Freeman and Company, 2006.*
4. *"Principles of Organic Synthesis", R. O. C. Norman and J. M. Coxon.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Examine the organic synthetic analysis.
2. Outline synthetic equivalents.
3. Interpret Carbon-Carbon double bond formation.
4. Illustrate Cross coupling reaction and Carbon-Carbon triple bond formations.

Course Code: CHM-6213 **Credits: 4**

Course Name: Physical Chemistry – II

Course Objectives:

Thermodynamics which is an important branch of science and deals with the study of heat, work, temperature etc. and their relation to various types of energy and the physical properties of the matter. Their behaviour can be explained by laws of thermodynamics. Therefore, the objective of the study is to explain the concept of thermodynamics, their laws, states as well as path function and ideal and non-ideal solutions.

Block I: Introduction to Thermodynamics

Unit 1: Basics Concepts Thermodynamics

Basics concepts, Introduction of Laws of thermodynamics, Gibb's free energy, Chemical potential, Ideal and non-ideal solution

Unit 2: Phase Rule

Phase rule, Phase diagram, Solutions, Chemical equilibrium.

Unit 3: Postulates of Statistical Thermodynamics & Ensembles

Postulates of statistical thermodynamics, Ensembles, Monoatomic and polyatomic ideal gases, Molar heat capacities

Block II: Laws of Thermodynamics

Unit 4: Basic Concepts of State Function

Basic concepts (State function, mixed derivative, Equations of gases)

Unit 5: First Law of Thermodynamics

First law of thermodynamics (internal energy, enthalpy, heat capacity, Joule Thomson experiment)

Unit 6: Second and Third Law of Thermodynamics

Second and Third law of thermodynamics (entropy change, Clausius inequality, probability, absolute entropy)

Block III: Chemical Potential and Statistical Thermodynamics

Unit 7: Chemical Potential

History, Related terms, Thermodynamic chemical potential, Electronic chemical potential

The values of the chemical potential, Fundamental particle chemical potential, Clausius-Clapeyron Equation

Unit 8: Change of Chemical Potential

Definition, Effect of Change of chemical potential with reference to Temperature, pressure and addition of solute

Unit 9: Statistical Thermodynamics

Introduction of Statistical thermodynamics hemodynamic ensembles, mono and polyatomic ideal gases, molar heat capacities, Classical statistical mechanics

Block IV: Chemical and Phase Equilibrium

Unit 10: Ideal and Real Gases

Ideal and real gases, properties of fugacity, mixing and excess functions

Unit 11: Chemical Equilibrium

Chemical equilibrium, Conditions for Chemical Equilibrium, Equilibrium Constant, Reaching Chemical Equilibrium, Dynamic Equilibrium, Factors Affecting Chemical Equilibrium Le Chatelier's principle, partial molar quantities, standard states.

Unit 12: Phase Equilibrium

Phase equilibrium involving one, two and three components.

Block V: Equilibrium in Condensed Phases

Unit 13: Solutions

Types of solutions, concentration of solutions, solubility, colligative properties, binary solutions and azeotropes

Unit 14: Non-Ideal Systems

Non-ideal systems, activity and activity coefficients, Relationship between activity and activity Coefficients, Thermodynamic formulation of surface phenomena

Unit 15: Surface Chemistry

Adsorption, Distinction Between Adsorption And Absorption, Adsorption Mechanism, Types of Adsorption, Adsorption From Solution Phase, Catalysis, Homogeneous Catalysis, Heterogeneous Catalysis , Colloids, Emulsions.

Books Recommended/Suggested Reading:

1. Physical Chemistry: Statistical Mechanics Kindle Editio by Horia Metiu Kindle Edition.

2. Physical Chemistry by Peter Atkins , Julio De Paula.

3. Physical Chemistry by Arun Bahal, B.S. Bahal.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain the general concepts of thermodynamics.
2. Define the laws of thermodynamics.
3. Examine classical statistical mechanism.
4. Summarize Chemical equilibrium and phase Equilibrium.
5. Illustrate equilibrium in condensed phase.

Course Code: CHM-6214 **Credits: 4**

Course Name: Analytical Chemistry - II

Course Objectives:

Spectroscopy is that branch of chemistry that deals with the interaction of electromagnetic radiations with matter. Different spectroscopy is used for different purposes. Therefore, the objective of the

course is to explain the basic concept of electron spectroscopy, microscopy and particle size determination method.

Block–1: Electron Microscopy and X-ray Crystallography

Unit 1: Scanning electron microscopy (SEM):

Introduction of Scanning electron microscopy (SEM), Basic principles, instrumentation and Sample Preparation, applications of SEM

Unit 2: Transmission electron microscopy (TEM)

Transmission electron microscopy (TEM): Introduction of Transmission electron microscopy (TEM), Basic Principles, Electron gun, Electromagnetic lenses, Imaging, Operating parameters-magnification, resolution, depth of field, Applications of TEM

Unit 3: Energy Dispersive X-ray Spectroscopy (EDS)

Energy Dispersive X-ray Spectroscopy (EDS): Introduction of EDS, Basic principles, instrumentation and Sample Preparation, interpretation and applications of EDS.

Block 2: Electroanalytical Techniques

Unit 4: Polarography

Polarography- Principles, Ilkovic Equation, factors affecting on polarographic wave, application.

Unit 5: Voltammetry

Voltammetry - Principle, cyclic Voltammetry, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes, application

Unit 6: Coulometry

Coulometry: Principles, types of Coulometric Methods; Controlled Potential Coulometry, Constant Current Coulometry; Applications of Coulometric Methods

Block 3: Thermal Analysis Techniques

Unit 7: Thermogravimetric Analysis

Thermogravimetric Analysis: Principle; Instrumentation: Working Function of Each Component; Sources of Error in TGA; Factors Affecting TG Curve; Interpretation of TG Curve Thermogravimetric analysis (TGA); Application of Thermogravimetric Analysis; Analysis of Inorganic Mixtures, Determination of nature of Gravimetric Precipitation, Reaction Kinetics

Unit 8: Differential Thermal Analysis

Differential Thermal Method of Analysis; Principle, Instrumentation, DTA Curves, Factors Affecting DTA Curves, Sources of Errors; Applications of DTA

Unit 9: Differential Scanning Calorimetry

Differential Scanning Calorimetry: Experimental Setup, Interpretation of DSC Curve, Applications of DSC, Advantages of DSC

Block 4: Chromatography Techniques

Unit 10: Thin layer chromatography (TLC)

Thin layer chromatography (TLC) - Fundamentals and Principles of Thin Layer Chromatography (TLC), Mobile- Stationary phases, Normal- Reverse phases, visualizing reagent ($KMnO_4$, Ninhydrin, DD and others), Applicability and Importance with examples

Unit 11: Gas Chromatography (GC)

Gas Chromatography (GC) -Fundamentals and Principles of Gas Chromatography (GC), Instrumentation, Sample preparation, Carrier gases , Injectors (split/splitless, PTV, Head Space, Pyrolyzer and others), Pack and Capillary Columns, Detectors (TCD, FID, ECD, NPD, TEA, Ion Mobility Scan), Applications and importance with examples, Limitations.

Unit 12: High Performance Liquid Chromatography (HPLC)

High Performance Liquid Chromatography (HPLC): Fundamentals and Principles of High Performance Liquid Chromatography (HPLC), Instrumentation, Types of HPLC–Normal phase HPLC, Reverse Phase HPLC, Mobile phases, Sample preparation, Limitations of HPLC, HPLC injectors, HPLC pumps, HPLC columns, HPLC detectors (UV-Visible, fluorescence, PDA, RI and others).

Block 5: Analytical Biochemistry

Unit 13: Body Fluids Analysis

Body fluids analysis: Composition of body fluids and detection of abnormal level of certain constituents leading to diagnosis of diseases, Physiological and nutritional significances of water and fat soluble vitamins and minerals.

Unit 14: Immunological Methods

Immunological methods: General Processes of immune response, Antigen-antibody reactions, Precipitation reactions, radio, enzyme, and fluoro-immuno assays, affinity chromatography.

Unit 15: Analysis of Human Nutrition

Analysis of Human nutrition: Biological values and estimation of enzymes, carbohydrates, essential amino acids, proteins, and lipids.

Books Recommended/Suggested Reading:

1. *Instrumental Analysis, 2nd Ed., Bauer, Christian, O'Reilly, Allyn and Bacon.*
2. *Instrumental Methods of Analysis, 7th Ed., Willard, Merritt, Dean and Settle, CBS Publishers.*
3. *Principles of Instrumental Analysis, 5th Ed- Indian Reprint, Skoog, Holler, Nieman, Harcourt Asia.*
4. *Instrumental Analysis, 1/e, Skoog, Holler, Crouch, Brooks Cole- Cenage Learning*
5. *Analytical Chemistry, 6th Ed., G.D. Christian, John Wiley & Sons (Asia) Pte. Ltd, New Delhi*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain electron spectroscopy.
2. Define electron microscopy.
3. Evaluate particle size.
4. Illustrate automations
5. Choose unit operation

Course Name: Polymers Chemistry

Course Code: CHM-6215 **Credits: 4**

Course Objectives:

Polymers are the substances made up of large number of molecules called the macromolecules and are the important constituents of many materials. On the other hand inorganic polymers also made up of large number of molecules but do not include carbon atoms in the backbone. The detailed study of inorganic polymers, their classification, structure, and advanced applications are the objectives of this course.

Block I: Introduction to Polymers

Unit 1: Introduction and Classification of Polymers

Introduction and history of polymeric materials, Classification of Polymers-Thermoplastics and Thermosets, Classification based upon polymerization mechanism, classification based upon polymer structure.

Unit 2: Polymer Structure and Molecular Weight

Polymer structure (Copolymers, Tacticity, geometrical isomerism, nomenclature), Molecular weight (molecular-weight averages and molecular-weight distribution), chemical structure and thermal transitions.

Unit 3: Stereochemistry and Polymerization Methods

Stereoisomerism in polymers, Monosubstituted ethylenes (Site of steric isomerism, Tacticity), Stereoregular polymers: Significance of stereoregularity (isotactic, syndiotactic, and atactic polypropenes), Coordination polymerization: Ziegler Natta catalyst.

Block II: Polymer Synthesis

Unit 4: Step-Growth Polymerization: Synthesis and Kinetics

Synthesis and kinetics of step-growth polymerization, molecular weight in step-growth polymerization

Unit-5: Chain-Growth Polymerization: Mechanisms and Types

Chain-growth polymerization- free-radical polymerization and copolymerization, Ionic polymerization and copolymerization, coordination polymerization

Unit 6: Polymerization Techniques: Methods and Applications

Important techniques of polymerization such as bulk, solution, suspension, emulsion, melt polycondensation, solution polycondensation, interfacial-condensation, solid and gas phase polymerization.

Block III: Polymer-Structure Characterization

Unit 7: Determination of Polymer Molecular Weight

Determination of molecular weight of polymers (Mn, Mw, etc), by end group analysis, viscometry, light scattering, gel permeation chromatography and osmotic pressure methods

Unit 8: Molecular Weight Distribution in Polymers

Molecular weight distribution and its significance, Polydispersity index

Unit 9: Polymer Characterization Techniques

Polymer characterization by IR, NMR, X-ray etc

Block IV: Polymer Degradation And Stabilization

Unit 10: Types and Mechanisms of Polymer Degradation

Degradation in polymers, Types of degradation (chain-end and random), thermal degradation, mechanical degradation, degradation by ultrasonic waves, photodegradation, degradation by high-energy radiation, oxidative degradation,

Unit 11: Oxidation Processes in Polymers

Mechanism of rubber oxidation, ozone oxidation, oxidative degradation of saturated Polymers.

Unit 12: Polymer Stabilization Techniques

Polymer stabilization: antioxidants, photstabilisers.

Block V: Polymer Rheology

Unit 13: Fundamentals of Polymer Rheology

Introduction to polymer rheology: Newtonian and non-Newtonian flow, pseudo plastic, bingham,

dilatants and thixotropic behaviour, Origin of non-Newtonian flow, Factors influencing flow behaviour: molecular weight dependence, chain branching, temperature dependence and time dependence.

Unit 14: Rheometry and Flow Property Testing

Boundary conditions of rheometry, Standard test methods for melt flow rate, Measurement of flow properties, characteristics.

Uni -15: Thixotropy and Yield Stress Measurement

Measuring thixotropy: measuring the breakdown of thixotropic structures and measuring the rate of recovery of gel structure, measurement of yield stresses using CS and CR rheometers.

Books Recommended/Suggested Reading:

1. Fundamentals of Inorganic Chemistry by Puri-Sharma and Kalia

2. Inorganic Chemistry by Cotton & Wilkinsen

3. Teraoka, Polymer Solutions: An Introduction to Physical Properties, John Wiley & Sons, 2002.

4. J.E. Mark, H.R. Allcock, R. West, Inorganic Polymers, 2nd Edn., Oxford University Press, 2005.

5. V. Chandrasekhar, Inorganic and Organometallic Polymers, Springer, 2005.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Define Inorganic Polymers.
2. Explain coordination polymer.
3. Summarize polymer reaction and mechanism.
4. Interpret Inorganic polymers in nanotechnology.
5. Understand Advanced Inorganic Materials

Course Code: CHM-6251 **Credits: 4**

Course Name: Chemistry Lab-II

Course Objectives:

The objective of the course is to understand standard method used for the analysis of elements. To understand the preparation of inorganic compounds, physical analysis and estimation of various ions present in the water sample is also discussed in this course.

1. Inorganic analysis

(i) Estimation of chromium using certified standard materials colorimetrically.

(ii) Morphological analysis of metal oxides nano particles by Scanning Electron Microscopy.

2. Preparation of some inorganic Compounds

(i) Potassium tri oxalato ferrate (III) trihrdrate.

(ii) Sodium hexa nitrito cobaltate (III)

3. Organic Analysis

(i) Separation of organic compounds (phenol, catechol, resorcinol and pyrogallol) using TLC method

(ii) Paper chromatographic separation of Cu^{2+} and Cd^{2+}

4. Physical Analysis

(i) Determine the activity coefficient of Ag^+ ions in $AgNO_3$ solution, potentiometrically, using a concentration cell with a salt bridge.

(ii) Study spectrophotometrically the kinetics of the reaction between potassium per sulphate and potassium iodide and determine the order and rate constant of the reaction.

(iii) A kinetic study of a solvolysis reaction-solvolysis of t-butyl CHMoride in acetone-water mixture.

5. Environmental Analysis

(i) Analysis of major anions (F, Cl, NO_3, SO_4) and major cations (Na, Ca, K, Mg, NH_4) in water by ion- exchange chromatography.

(ii) Determination of Cu/ Cd/Fe in water samples by Atomic Absorption Spectrophotometer.

SUGGESTED READINGS:

1. Khosla B.D., Gulati A. and Garg V.C.: SENIOR PRACTICAL CHEMISTRY, R. Chand & Co., (2008).
2. Shoemaker D.P., Garland C.W. and Nibler J.W.: EXPERIMENTS IN PHYSICAL CHEMISTRY, McGraw Hill, New York (1996).
3. Yadav J.B.: ADVANCED PRACTICAL PHYSICAL CHEMISTRY, Goel Publishing House (2000).
4. Lewitt B.P.: FINDLEY'S PRACTICAL PHYSICAL CHEMISTRY, Longman (1990).

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Evaluate the morphology and amount of metal ions in the given msample.
2. Explain general preparation method of inorganic compounds.
3. Interpret organic analysis
4. Illustrate physical analysis.
5. Define environmental analysis.

Semester: III

Course Code: CHM-7111 **Credits: 4**
Course Name: Bioinorganic and Biophysical Chemistry

Course Objectives:
The objective of this course is to explain the role of essential metal ions, metalloenzymes, biopolymer and biomolecular simulation in biological systems.

Block I: Essential Metal Ions and their Deficiency
Unit 1: Essential and Trace Metal Ions
Introduction to essential and trace metal ions, Importance in biological system.
Unit 2: Deficiency of Essential Metal Ions
Deficiency causes by lack /excess of Mn, Co, and Zn metal ions.
Unit 3: Types of Photosystems and their Structures
Structure of Chlorophyll, Photosynthesis, Photo system I and Photo system II

Block II: Metalloenzymes
Unit 4: Metalloenzymes: Zinc Enzymes and their Catalytic Roles
Zinc enzymes, carboxypeptidase and carbonic anhydrase.
Unit 5: Biochemical Pathways
Cytochromes, iron-sulphur proteins, and nitrogen fixation
Unit 6: Metalloenzymes In Action: Iron, Copper and Cobalt Enzymes
Iron enzymes-catalase and peroxidase, Copper enzyme –superoxide dismutase, Cobalt enzyme; cyanocobalamin.

Block III: Biopolymers Interactions and Thermodynamics of Macromolecular Solvation
Unit 7: Fundamentals of Non-Covalent Interactions
Non-covalent interaction, Electrostatic- dipole-dipole interaction, Dispersion force interaction, Hydrophobic interaction.
Unit 8: Equilibria and Binding Processes in Biological Systems
Multiple Equilibria and various types of binding processes in biological systems, Thermodynamics of biopolymer solutions
Unit 9: Polymer Solvation and Membrane Equilibria
Flory-Huggins model of macromolecular solvation, Osmotic pressure and Donnean membrane equilibriums.

Block IV: Statistical Mechanics and Biomolecular Simulations
Unit 10: Macromolecular Structure
Chain configuration of macromolecule, Random walk model
Unit 11: Statistical Analysis of Macromolecular Conformation
Statistical distribution of end to end dimension
Unit 12: Average Dimension Analysis of Chain Structures
Calculation of average dimension of various chain structures

Block V: Conformational transitions

Unit 13: Understanding Protein Structure

Helix-coil transition, Protein folding problem, primary, secondary, tertiary and quaternary structure of protein

Unit 14: Molecular mechanics and dynamics

Basic principles, molecular representations, force fields, atom-atom pair potentials, bond length and bond angle and torsion angle potential

Unit 15: Fundamentals of Molecular Dynamics

Van-der Waal's and electrostatic potential, concepts of molecular dynamics, introduction to time-step integration algorithms and force fields

Books Recommended/Suggested Reading:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.

2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.

3. Inorganic Biochemistry, vols I and II. ed., G.L. Eichhorn, Elsevier.

4. Progress in Inorganic Chemistry, Vols. 18 and 38 ed. J.J. Lippard, Wiley

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Define essential and trace metal ions.
2. Outline Metalloenzymes.
3. Interpret Biopolymer interactions and Thermodynamics of Macromolecular solutions.
4. Explain Statistical Mechanics and Biomolecular simulations.
5. Interpret conformational transitions

Course Code: CHM-7112 **Credits: 4**

Course Name: Organometallic Chemistry

Course Objectives:

The objective of this course is to understand the organometallic compounds and reactions involving formation of metal-carbon bonds. To explain the structure of organometallic compounds, role of electron donor as well acceptor, applications of organometallic compounds and the concept of hapticity is also the major objective of this course.

Block I: Metal-Carbon Bond

Unit 1: General Introduction of Organometallics

Introduction, factors guiding metal-carbon bond formation, general synthetic methods for Main Group organometallics

Unit 2: Alkali and Alkaline-Earth Organometallics

Structure and bonding of alkali, alkaline-earth organometallics, EAN rule

Unit 3: Classification of Carbon-Based Ligands

Classification of carbon-based ligands by donor atoms and number of electrons donated by the ligand, sigma-donor and pi-acceptor, transition metal organometallics; reactivity studies

Block II: Organometallics as Homogeneous Catalysis

Unit 4: Applications of Organometallic Compounds

Applications of organometallic compounds in homogenous catalysis; hydrogenation, carbonylation, metal-mediated C-X (X = C, heteroatom) bond formations.

Unit 5: Olefin Metathesis

Olefin metathesis and Ziegler-Natta polymerization

Unit 6: Stereochemistry

Stereochemistry, applications in asymmetric synthesis

Block III: Organometallic Chemistry and their Synthesis

Unit 7: Organometallic Chemistry

Organometallic chemistry of main group, transition and inner transition metals

Unit 8: Synthesis and Applications of Buli, Grignard, Organo aluminum and Organozinc Reagents

Synthesis and applications of Buli, Grignard, organo aluminum and organozinc reagents

Unit 9: d- and f-Block Organometallic Compounds

Simple Alkyl Ligands, Alkylidene Ligands, Alkylidyne Ligands, Alkene And Alkyne Ligands, Polyene Ligands, Cyclic Polyene Ligands

Block IV: Metal Carbonyls

Unit 10: Metal Carbonyls

The Structure of Metal Carbonyls, Metal Carbonyl Anions, Compounds with Metal-Carbon Bonds: Metal carbonyls- bonding and infrared spectra, phosphines and NHC's

Unit 11: Different Alkenes, Alkynes, Carbenes and Carbines Ligands

Alkenes and alkynes, carbenes and carbines, Hapto ligands with hapticity from 2- 8

Unit 12: Oxidative Addition and Reductive Elimination Reactions

Oxidative addition and reductive elimination, 1,1 and 1,2-migratory insertions and β hydrogen elimination, mechanism of substitution reactions.

Block V: Organometallic Cluster and Cross Coupling Reactions

Unit 13: Organometallic Clusters

Fluxionality and hapticity change, organometallic clusters, C-H activationagostic and anagostic interactions.

Unit 14: Homogeneous Catalysis

Homogeneous catalysis: hydrogenation, hydroformylation, methanol to acetic acid processes, Wacker oxidation.

Unit 15: Introduction to Cross Coupling and Olefin Metathetical Reactions

Introduction to cross coupling and olefin metathetical reactions, Olefin oligomerization and polymerization

Books Recommended/Suggested Reading:

1. G. O. Spessard, G. L. Miessler, Organometallic Chemistry, Prentice Hall

2. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry

3. The organometallic chemistry of the transition metals, Crabtree R H

4. Gupta, B.D, Elias, A J; Basic Organometallic Chemistry, Concepts, syntheses and applications, 2nd edn, Universities Press, 2013.

5. Organometallics, Elschenbroich, Ch, 3rd edn, Wiley VCH, 1989.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Define metal-carbon bond.
2. Explain organometallic compounds as homogeneous catalysis.
3. Interpret Organometallic chemistry of main group elements.
4. Understand metal carbonyls.
5. Illustrate Organometallic cluster and cross coupling reactions

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Course Name: Organic Photochemistry
Course Code: CHM-7113 **Credits: 4**

Course Objectives:
Organic photochemistry is special branch of chemistry that involves organic reaction induced by the action of light. The action of light causes several reactions such as absorption, emission, fluorescence, phosphorescence etc. Therefore, the objective of this course is to explain the photochemistry of organic molecules and corresponding reactions as well as rearrangements.

Block I: Introduction to Photo-Physical Chemistry
Unit 1: Interaction of electromagnetic radiations
Interaction of electromagnetic radiations with matter, types of excitations, Distinctionof photoreactions from thermally initiated reactions,
Unit 2: Basic laws of photochemistry
Basic laws of photochemistry; Grothus & Draper law, law of photo chemical equivalence and law of absorption (Lambert Beer's law) and its limitations, Quantum yield.
Unit 3: Fates of Excited States
Fates of excited states; Jablonski Diagram, Fluorescence and phosphorescence, Vibrational relaxation, Intersystem crossing and internal conversion, Intramolecular VibrationalRedistribution, Dissociation/Predissociation, Quantum yield, Lifetimes of excitedstates. Emission spectra, Excitation spectra, Stokes shift, Effects of molecularstructure on fluorescence

Block II- Photoadditon, Substitution and Fragmentation
Unit 4: Photoreduction of Carbonyl Compounds
Photoreduction of carbonyl compounds-Linear addition initiated by hydrogen abstraction reaction, Synthetic applications of photochemical hydrogen abstraction reactions
Unit 5: Intramolecular Hydrogen Abstraction
Intramolecular hydrogen abstraction: The type-II family of reaction, Addition reactions of cyclic conjugated enones, Homolytic α– cleavage of ketones.
Unit 6: Photochemical Reactions of Cyclobutanones
Photochemical reactions of cyclobutanones, Sigmatropic rearrangements of β, γ– unsaturated ketones initiated by α - cleavage.

Block III: Cycloadditions
Unit 7: Theory of Cycloaddition Reactions
Theory of cycloaddition reactions: FMO method, [2+2] cycloadditon and [4+2] cycloaddition reactions, mechanism and stereochemistry of cycloadditionsreactions,
Unit 8: Correlation Diagrams of Cycloaddition Reactions

Correlation diagrams of cycloaddition reactions, Woodward-Hoffmann rulein [4+2] and [2+2] cycloaddition reactions, Huckel-Mobius method,

Unit 9: Retrocycloaddition reactions

Retrocycloaddition reactions, [4+2] cycloadditions of cations and anions, [2+2] chelotropic cycloadditions, 1,3-dipolar cycloadditions, cycloadditions involving more than [4+2] electrons

Block IV- Isomerisations and Rearrangements

Unit 10: Photochemical cis-trans Isomerisation of Alkenes

Photochemical cis-trans isomerisation of alkenes, photochemical cis-transisomerisation of conjugated dienes, cis-trans isomerisation of cycloalkenes

Unit 11: Photovalence isomerisation reactions of benzene

Photovalence isomerisation reactions of benzene: Photochemistry of benzene valenceisomers. Photorearrangements of 2, 4-cyclohexadienones

Unit 12: Sigmatropic Isomerisation

Sigmatropic isomerisations of β, γ - unsaturated enones, Norrish-I and Norrish-II leavages, Paterno-Buchoreaction, Fries rearrangement, Barton reaction

Block V: Advanced Topics in Photochemistry

Unit 13: Supramolecular Photochemistry

Supramolecular photochemistry – Photochemistry in organized and constrained media – Organic photoresponsive materials

Unit 14: Applications of Photochemistry

Applications of photochemistry in biochemistry, biology, medicine and technology

Unit 15: Some Current Topics in Photochemistry

Chemistry of stratospheric ozone, Plant photosynthesis, Photodynamic therapy of tumour.

Books Recommended/Suggested Reading:

1. *Fundamental of Photochemistry, K.K.Rohtagi- Mukherji, Wily- Eastern.*
2. *Essentials of Molecular Photochemistry, A.Gilbert and J.Baggott, Blackwell Scientific Publication.*
3. *Molecular Photochemistry, N.J. Turro, W.A. Benjamin.*
4. *Introductory Photochemistry, A. Cox and T. CAMP, Mc Graw-Hill.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Analyze Fundamental Principles of Photochemistry.
2. Examine Photochemistry of excited state and Carbonyl Compounds.
3. Explain Photochemistry of Aromatic Compounds.
4. Evaluate Miscellaneous Photochemical Reactions.
5. Interpret rearrangement reactions.

Course Code: CHM-7114 **Credits: 4**

Course Name: Research Methodology

Course Objectives:

To familiarize students with basic of research, research process and enable the participants in conducting research work and formulating research synopsis and report.

Block I: Research Formulation

Unit 1: Introduction, meaning of research,

Unit 2: Types, Role of research in important area and Process of Research,

Unit 3: Defining research Problems, Hypothesis Formulation.

Block II: Research Elaborated

Unit 4: Research Design, Research plan, Concept of sample, Sample size, various types of sampling techniques.

Unit 5: Types of Data and Methods of its Collection; Questionnaire Design,

Unit 6: Precautions in preparation of questionnaire, Measurement scales.

Block III: Data Analysis and Interpretation-1

Unit 7: Processing and Analysis of Data by application of statistical tools

Unit 8: various kinds of charts and diagrams used in data analyses

Unit 9: Application of Data Analysis

Block IV: Data Analysis and Interpretation-2

Unit 10: Hypothesis Testing (F-test, ANOVA, Chi–square test, t-test)

Unit 11: Multivariate Statistical techniques-Multiple regression, discriminate analysis, Factor analysis, Multivariate analysis of variance

Unit 12: Conjoint analysis, Cluster analysis, Multidimensional Scaling, Role of computer in research, Excel-A tool for statistical analysis, SPSS, Interpretation and conclusion

Block V: Report Writing

Unit 13: Report Writing, Significance of report writing, Steps in report writing

Unit 14: Layout of research report, Types of reports; Appendices

Unit 15: Bibliography, Characteristics of a good report; Precautions for report writing; Ethics in business research.

Books Recommended/Suggested Reading:

1. *Kothari C.R.: Research Methodology, New Age International Publishers.*
2. *Sinha S.C. and Dhiman A. K.; Research Methodology, EssEss Publications.*
3. *Anderson T.W.; An Introduction to Multivariate Statistical Analysis ,Wiley.*
4. *Garg B.L., Karadia R., Agarwal F. and Agarwal U.K. ;An Introduction to Research Methodology, RBSA Publishers.*

Course Outcomes: After the completion of the course, student shall be able to:

1. Elaborate various concepts related to research.
2. Enumerate various kinds of research design & process.

3. Develop adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
4. Demonstrate various techniques of data analysis-and hypothesis testing procedures.
5. Articulate appropriate research ethics for doing meaningful research

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Course Code: CHM-7151 **Credits: 4**
Course Name: Chemistry Lab – III

Course Objectives:
The objective of this course is to identify the various radicals and insoluble residues from the mixture and understand the various reaction mechanism. Analysis of the quality of water is also the goal of this course.

Course Outcomes:
At the end of this course, students will be able to:
1. Identify various rare earth metals as well as insoluble residues.
2. Explain the preparation of inorganic compounds.
3. Define the reaction mechanism in various reactions.
4. Evaluate the water quality parameters such as pH, BOD, COD etc.
5. Perform the transport number based experiments.

1. **Qualitative Analysis of Inorganic Mixture**
   Identification of insoluble residue by semi-micro analysis
   Insoluble Residue: $PbSO_4$, $SrSO_4$, Al_2O_3, Cr_2O_3, Fe_2O_3, SnO_2, AgX, TiO_2, ThO_2, $WO_2.xH_2O$
2. **Preaprationi of Inorganic Compounds:**
   (ii) trans-potassium di aqua bis(oxalato) chromate (III)
   (iii)cis-potassium di aqua bis(oxalato) chromate (III)
3. **Reaction Mechanism**
   (ii) To perform Cannizaro reaction: Benzyl alcohol and benzoic acid from benzaldehyde
   (iii)To perform Perkin reaction: Cinnamic acid from benzaldehyde
4. Analysis of water quality parameters: pH, conductance, dissolved oxygen, hardness, CHMoride and fluoride.
5. Determine the transport number of Ag^+ and NO_3^- ions in solution using 0.1 M and 0.01 M $AgNO_3$ solutions (Given: Mean ionic activity coefficients of $AgNO_3$ in 0.01 M and 0.1 M solutions are 0.89 and 0.73, respectively).

SUGGESTED READINGS:

1. Yadav J.B.: ADVANCED PRACTICAL PHYSICAL CHEMISTRY, Krishna Prakashan Media (P) Ltd., Meerut (2016).
2. Jeffery G.H., Bassett J., Mendham J. and Denney R.C.: VOGEL'S TEXT BOOK OF QUANTITATIVE CHEMICAL ANALYSIS, 5th Ed.,

3. John Wiley & Sons, Inc., New York (1989).

Semester: IV

Program Elective - I

Course Code: CHM-7211 **Credits: 4**
Course Name: Supramolecular Chemistry

Course Objectives:
The objective of this study is to explain the host-guest interaction, reactivity and physical method used for the determination of supramolecular chemistry.

Block I: Host-Guest Chemistry
Unit I: Exploring Host-Guest Chemistry
Host-Guest Chemistry, Definition, classifications of host guest compounds
Unit 2: Interactions in Supramolecular Systems
Hydrodynamics and kinetic stability, role of weak interactions in supramolecules, Complementarity and cooperativity
Unit 3: Macromolecular Hosts and Hydride Clathrates
Hydride sponge and related clathrates, Different macromolecular hosts, host design, preorganised hosts, cyclodextrins, calixarenes, cucurbiturils etc.

Block II: Recognition and Reactivity
Unit 4: Molecular Recognition and Reactivity
Recognition and reactivity, molecular and Ion recognition, enatioselectivity, proton pumps and basis of supramolecular catalysis
Unit 5: Metal-Directed Inorganic Hosts
Inorganic host design, Metal directed assemblies, confinement, container molecules.
Unit 6: Structural Diversity in Molecular Assemblies
Molecular flasks, layered solids, channel structures, Intra-cavity complexes of neutral molecules.

Block III: Physical Methods of Characterization
Unit 7: Quantifying Molecular Affinities
Physical methods in understanding supramolecular chemistry, Determination of binding constant
Unit 8: Calorimetric Analysis
Isothermal titration calorimetry
Unit 9: Advanced Materials Characterization
Rheology, SEM, TEM etc

Block IV: Supramolecular Polymers and Gel
Unit 10: Advanced Polymer Architectures and Applications
Co-ordination polymers, hydrogen bond-based polymers, guest included polymers examples and applications.
Unit 11: Supramolecular Gels: Structure and Applications
Supramolecular gels, hydrogel and organogel and their structure and applications.
Unit 12: Transient Gels: Properties and Uses
Transient gels, and their applications.

Block V: Molecular Machines

Unit 13: Dynamic Molecular Systems

Molecular machines: interlocked dynamic systems, molecular motors, switch, and shuttles.

Unit 14: Amphiphiles and Self-Assembly

Amphiphiles and their self-aggregation: micelle, vesicles, liposomes, microemulsions.

Unit 15: Self-Aggregation of Amphiphiles

H and J aggregates, aggregation induced emission and quenching. Natural processes, Peptide self-assembly, Protein and DNA aggregation, amyloid and cell membrane.

Books Recommended/Suggested Reading:

1. Core Concepts in Supramolecular Chemistry and Nanochemistry, J. W. Steed, D. R. Turner, K. Wallace, 1st Edition, Wiley, 2007.
2. Supramolecular Chemistry: Concepts and Perspectives, J. M. Lehn, 1st Edition, VCH, 1995.
3. H. Dodziuk, Introduction to Supramolecular Chemistry, 1st Edition, Springer, 2001.
4. Supramolecular Chemistry: Fundamentals and Applications, Katsuhiko, 1st Edition Springer, 2006.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Define host-guest chemistry.
2. Explain Recognition and reactivity.
3. Interpret physical methods.
4. Illustrate supramolecular polymers and gel.
5. Understand molecular machines.

Program Elective - II

Course Code: CHM-7212 **Credits: 4**

Course Name: Green and Environmental Chemistry

Course Objectives:

The objective is to familiarize students with the fundamental concepts and methodologies of green chemistry and sustainability, with a specific focus on the significance of reducing the environmental footprint in chemical processes. The aim is to provide a thorough comprehension of the fundamental principles and important ideas of green chemistry, together with practical examples.

Block I: Introduction of Green Chemistry

Unit 1: Introduction to Green Chemistry and Sustainability

Green chemistry: History, need, and goals, Green chemistry and Sustainability, Dimensions of sustainability, Limitations/Obstacles in pursuit of the goals of Green Chemistry, Opportunities for the next generation of materials designers to create a safer future

Unit-2: Foundations of Green Chemistry

Basic principles of Green Chemistry and their illustrations with examples

Unit-3: Green Synthesis

Green starting materials, Green reagents, Green solvents and reaction conditions, Evolution of the type of the reaction ***i)*** Rearrangements (100% atom economic), ***ii)*** Addition reaction (100% atom economic), Microwave assisted reaction, Ultrasound assisted reactions, Photochemical reactions using sunlight.

Block II: Green Solvents & Ionic Liquids

Unit 4: Green Solvents, Aqueous Medium

Green solvents, aqueous medium: Enhancement of selectivity, efficiency, and industrial applicability, Ionic liquids, Supercritical fluids.

Unit 5: Solvent Free Neat Reactions in Liquid Phase

Solvent free neat reactions in liquid phase, Solvent free solid phase reactions, Nonconventional energy sources, Microwave assisted reaction, Ultrasound assisted reactions, photochemical reactions using sunlight.

Unit 6: Characteristics of Catalysts

Characteristics of catalysts, catalyst affecting energy usage, stoichiometric of reagents, zeolite for solid acid catalysis, Bio catalysis for the synthesis of catechol, Baeyer- Villiger reaction, comparison of molecular and enzymatic catalysis.

Block III: Future Trends in Green Chemistry

Unit 7: Future Trends in Green Chemistry

Future trends in Green Chemistry: oxidation-reduction reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry;

Unit 8: Proliferation of Solvent less Reaction

Proliferation of solvent less reactions; Noncovalent derivatization, Biomass conversion, emissioncontrol

Unit 9: Chemical Industry Hazards: Assessment & Mitigation

Biocatalysis, Hazard assessment and mitigation in chemical industry

Block IV: Introduction to Environmental Chemistry

Unit 10: Fundamentals of Environmental Chemistry

Concept and scope of Environmental Chemistry, Environmental terminology and nomenclatures, Environmental segments, Vertical temperature and vertical structure of the atmosphere, Biogeochemical cycles in the environment (Oxygen, Carbon, Nitrogen, Phosphorous and Sulphur cycles).

Unit 11: Atmospheric Chemistry and Air Pollution

Photochemical smog and formation of Peroxyacylnitrate (PAN), Formation and depletion of ozone in the atmosphere, Green House effect, Particulate pollutant: Classification, Physical, chemical and biological characteristics of particulate, Significance of PM-2.5 and PM-10, Effects of particulates on human health.

Unit 12: Environmental Management and Resource Conservation

Environmental Management: Methods of environmental management, Radioactive waste management, Environmental impact assessment, Natural resources of energy-consumptions and conservation.

Block V: Pollution

Unit 13: Air Pollution

Air pollutants (sources, classification, sampling and monitoring): Particulates, Aerosols, SOx, NOx, COx and hydrocarbon emission, Photochemical smog, Acid rains, Air-quality standards, Air pollution controls and their chemistry.

Unit 14: Water Pollution

Water pollutants (sources, classification, sampling and monitoring), *Water-quality parameters and standards*: physical and chemical parameters (colour, odour, taste and turbidity), Dissolved oxygen, BOD and COD.

Unit 15: Radiation pollution

Classification & effects of radiation; Effects of ionizing radiation on man; Effects of non ionizing radiation on life; Radioactivity and Nuclear fallout; Protection and control from radiation.

Books Recommended/Suggested Reading:

1. *"Green Chemistry: Theory and Practice" by Paul T. Anastas and John C. Warner*
2. *"Green Synthetic Approaches for Biologically Relevant Heterocycles" edited by Wei Zhang*
3. *"Handbook of Green Chemistry and Technology" edited by James H. Clark and Duncan J. Macquarrie*
4. *"Introduction to Environmental Chemistry" by Julian E. Andrews and Peter Brimblecombe*
5. *"Air Pollution and Control" by C. David Cooper and F. C. Alley*

Course Outcomes:

1. Students will be proficient in utilizing green synthesis techniques to design environmentally friendly chemical processes.
2. Students will be familiar with advanced topics in green chemistry, such as the use of green solvents, catalysts, and solvent-free reactions.
3. Students will be able to identify and discuss future trends in green chemistry and their implications for sustainable development.
4. Students will gain a comprehensive understanding of environmental chemistry principles, including the identification and management of various types of pollution.
5. Students will develop skills in assessing environmental impact and implementing strategies for pollution control and resource conservation.

Program Elective - III

Course Code: CHM-7213 **Credits: 4**

Course Name: Chemistry of Natural Products

Course Objectives:

Natural products are mostly present in the nature and produced by a living organism. The chemistry of natural products is mainly focused on the study of small organic molecules, especially secondary metabolites, produced by natural organism such as bacteria, fungi and plants. The detailed study of isoprene, steroids, alkoxides and their derivatives are the objective of this course.

Block I: History of Natural Products

Unit 1: Introduction and Function of Natural Products

Introduction, Functions, Primary and Secondary Metabolites

Unit 2: Classification of natural Products

Animal Based, Plant based, naturally occurring their sources and functions.

Unit 3: Isoprenoid Compounds

Terpene Hydrocarbon, Oxygenated Isoprenoid compounds, Animal based isoprenoid compounds.

Block II: Alkaloids

Unit 4: Nitrogen based natural products

Structure, stereochemistry, synthesis of morphine, Quinine, Nicotine, Caffeine

Unit 5: Unraveling Nature's Chemistry: Biosynthesis Pathways

Biosynthesis of the following Structure of morphine, reserpine

Unit 6: Exploring Pharmacologically Active Alkaloids

Structure, occurrence and functions of Ephedrine, (+) Conin.

Block III:

Unit 7: Steroids

Occurrence, nomenclature, basic skeleton

Unit 8: Exploring Steroid Hormones

Diels hydrocarbon and study of the following hormones, Androsterone, Testosterone, Estrone, Progesterone

Unit 9: Unraveling Steroid Biosynthesis

Aldosterone and cartisone. Biosynthesis of steroids.

Block IV: Prostaglandins

Unit 10: Occurrence and nomenclature Prostaglandins

Introduction, ocurrance and classification.

Unit 11: Effects of Prostaglandins

Biogenesis and physiological effects

Unit 12: Synthesis of Prostaglandins

Synthesis via PGE2 and PGF2 pathways

Block V: Biogenesis

Unit 13: Synthesis of Alkaloids

Pyridine, morphine and indole type, terpenoids of classes with examples, cholesterol, flavones, coumarins, carbohydrates and proteins.

Unit 14: Vitamins

Synthesis and structure of biotin and vitamin B2, synthesis of vitamin B1.

Unit 15: Biological Aspects

Biological functions of B6, B12, folic acid and thiamin.

Books Recommended/Suggested Reading:

1. *Apsimon: The total synthesis of natural products.*
2. *A.A. Newmen: Chemistry of Terpenes.*
3. *P. D B.Mayo: The chemistry of natural products.*
4. *T.W. Goddwin: Aspects of terpenoid chemistry and biochemistry.*
5. *Woguer: Vitamins and Co enzymes.*
6. *I. Finar: Organic chemistry Vol. II and I.*
7. *J.B. Hendrickson, The molecules of nature.*

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Define terpenoids.
2. Explain alkaloids.
3. Understand steroids.
4. Analyse prostaglandins.
5. Interpret biogenesis

Program Elective - IV

Course Code: CHM-7214 **Credits: 4**
Course Name: Solid State Chemistry

Course Objectives:

Solid is one of the most fundamental units of matter. The constituents particles in solids are closed packed together and form a complete unit cell. The arrangement of atoms in unit cell, and their diffraction through various crystal lattice planes are also discussed in this course. Therefore, the objective of this course is to study the arrangement of atoms in unit cell, presence of impurities which creates several defect and the synthesis of novel materials as well as identification and chemical composition of the molecule.

Block I: Bonding, Structure and Preparative Methods

Unit 1: Bonding

Bonding: Classification of solids based on nature of forces (Ionic, Covalent, Metallic, van der Waals, Hydrogen-bonded),

Unit 2: Crystal Structures

Crystal Structures: Symmetry and Choice of Unit- cell, Bravais lattice, Miller indices, Point groups and space groups, Close packing, Lattices and Unit- cells, Crystalline solids, ionic radii, radius ratio rule, lattice energy, crystal structure determination by powder diffraction and single crystal X-ray diffraction.

Unit 3: Preparative Methods

Preparative Methods: Solid state reactions (General Principles, precursor methods), Crystallization of solutions, melts, glasses and gels, vapour phase transport methods, Preparation of thin films, growth of single crystals, high pressure and hydrothermal methods.

Block II: X-ray Diffraction and Crystal Structure

Unit 4: Diffraction of X-rays by Crystals

Diffraction of X-rays by crystals: Bragg's law, Definitions related to crystal structure, crystallographic direction and crystallographic phases.

Unit 5: X-Ray Diffraction Experiments

X-ray diffraction experiments: The powder method and the single crystal method, Reciprocal lattice, Structure factor and its relation to intensity and Electron density, The phase problem, Description of procedure for an X-ray structure analysis,

Unit 6: Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects, point defects, Schottky and Frenkeldefects, Thermodynamics of Schottky and Frenkel defect, colour centres, non-stoichiometry and defects.

Block III: Phase Transitions and Diffusion in Solids:

Unit 7: Phase Transitions

Phase Transitions: Thermodynamic and Burger's classification of phase transition, Kinetics of phase transition- nucleation and growth, T-T-T diagrams,

Unit 8: Factors Influencing Kinetics of Phase Transition

Factors influencing kinetics of phase transition: Factors influencing kinetics of phase transition, Martensitic and order-disorder transitions.

Unit 9: Diffusion in Solids

Diffusion in solids: Mechanisms, Steady state and non-steady state diffusion, factors affecting diffusion, Kirkendall effect.

Block IV: Electrical and Magnetic properties

Unit 10: Electrical Properties

Electrical Properties: Electrical conductivity of metals, free electron theory, semiconductors, Intrinsic and extrinsic semi-conductivity, Band theory,

Unit 11: Superconductivity

Superconductivity: Conventional Superconductors, Bardeen-Cooper Schrieffer (BCS) theory, High temperature Superconductors, Ferromagnetic Superconductors, Uses of High temperature Superconductors.

Unit 12: Magnetic Properties

Magnetic Properties: Diamagnetism, paramagnetism, ferromagnetism, anti-ferromagnetism, ferrimagnetism, Calculation of magnetic moments, influence of temperature on magnetic behaviour, domains and hysteresis, Soft and hard magnetic materials.

Block V: Optical Properties and Dielectric Properties

Unit 13: Optical Properties

Optical Properties: Electron emission in Metals, Photovoltaic effect, Luminescence, Laser and Maser actions, The Ruby laser, Light emitting diodes, Optical fibers.

Unit 14: Dielectric Properties

Dielectric Properties: Dielectric constant, Clausius-Mosotti equation, Piezoelectricity, Ferroelectricity, Antiferroelectricity, Ferrielectricity.

Unit 15: Organic Solids

Organic Solids: Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors.

Books Recommended/Suggested Reading:

1. Principals of solid state, H. V. Keer, Wiley Eastern.
2. Solid state chemistry, N. B. Hannay.
3. Solid state chemistry, D. K. Chakrabarty, New Age International.
4. An Introduction to Crystallography: F. G. Philips.
5. Crystal Structure Analysis: M. J. Buerger.
6. Electronic processes in materials: L. U. Azroff and J. J. Brophy.
7. Chemistry of imperfect crystal: F. A. Krogen.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Explain solid state.
2. Interpret structure factor.
3. Define solid state reactions.
4. Evaluate electronic properties and band theory.
5. Analyse preparation methods.

Course Name: Chemistry Lab – IV

Course Code: CHM-7251 **Credits: 4**

Course Objectives:

The objective of the course is to explain the qualitative mixture analysis and topological analysis using AFM. The determination of rate constant, water quality parameters and pesticides determination in water sample is also the objective of this study.

1. Inorganic Analysis

(i) Semi-micro qualitative mixture analysis including less common metal ions, such as, TI, Mo, W, Ti, Zr, Th, V and U (two metal ions in cationic/anionic forms).
(ii) Topological analysis of nanostructured metal oxides using Atomic Force Microscope

2. Organic Analysis

(i) To perform Aldol condensation: Dibenzal acetone from Benzaldehyde
(ii) To perform Reduction: 1-amino-2-hydroxynaphthalene hydro Chloride from phenylazo-2-naphthol
(iii) Isolation and chromatographic separation of lycopene from tomatoes.
(iv) Green synthesis of p- bromo acetanilide.

3. Physical Analysis

(i) Determination of pKa of an indicator (methyl red) in aqueous media
(ii) Determination of rate constant for hydrolysis/inversion of sugar using polarimeter
(iii) Determine the equilibrium constant of the reaction Ag $(NH)_2$ + $\leftrightarrow Ag^+$ + 2NH potentiometrically.

4. Environmental Analysis

(ii) Analysis of water quality parameters: pH, conductance, dissolved oxygen, hardness, Chloride and fluoride.

(iii) Determination of Pesticides by Gas chromatography in drinking water samples.

(iv) Analysis of SO_2, NH_3, NO_2 and O_3 with real time value from online analyzers.

SUGGESTED BOOKS

(i) Burns D.T. and Rattenbury E.M.: INTRODUCTORY PRACTICAL PHYSICAL CHEMISTRY, Pergamon Press (1966).

(ii) Daniels F., Williams J.W., Bender P., Alberty R.A., Cornwell C.D. and Harriman J.E.: EXPERIMENTAL PHYSICAL CHEMISTRY, McGraw Hill (1962).

(iii) Day R.A. and Underwood A.L.: QUANTITATIVE ANALYSIS, Prentice Hall India Pvt. Ltd., New Delhi, 3rd Ed.,

(iv) Ewing G.W.: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS, McGraw Hills (1989).

(v) Yadav J.B.: ADVANCED PRACTICAL PHYSICAL CHEMISTRY, Goel Publishing House (2000).

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Evaluate the topology and qualitative analysis of some elements.
2. Explain organic analysis.
3. Interpret physical analysis
4. Define environmental analysis.

Course Code: CHM-7291 **Credits: 4**

Course Name: Project

Course Objectives:

The objective of the course is to work with students to identify mathematical problem. The course also focuses to find out probable solution of that mathematical problem.

Syllabus

Every student shall, in the Fourth (final) Semester, submit a Dissertation reporting the results of original research on a topic assigned at the beginning of the semester by the concerned research guide (faculty member) in consultation with the student, in his/her area(s) of special interest. The research guide shall be chosen by the student according to his/her interest and the faculty member's area of expertise. No faculty member shall guide more than five students.

The topic of the Dissertation shall be approved by the Head of the Department. For this purpose the candidate shall submit to the Head an application stating the topic for the dissertation along with a synopsis within three weeks of the commencement of classes of the Fourth Semester. Once approved, the topic of dissertation shall not be altered without a fresh proposal from the student accompanied by

a written request stating the reason for change. No such request shall be entertained after five weeks of the commencement of classes of the Semester in question.

Course Outcomes:

On successful completion of this course, students shall be able to:

1. Identify and Define appropriate research problems.
2. Explain appropriate research approaches for solving problems.
3. Apply various tools and techniques to complete research.
4. Analyse research report and make robust conclusion.

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Faculty and Support Staff

The University has identified the requisite faculty and support staff as mandated by UGC and formally they shall be allocated the required positions from amongst the existing faculty exclusively for ODL mode or fresh appointments as required so, shall be initiated for which Letter of Intent have been issued to the prospective faculty and staff. The course material prepared by this university will be on par with any open university/Distance education centre in the country.

List of Faculty associated with MSc- Chemistry program is as follows:-

S. No.	Name of Faculty	Designation	Nature of Appointment	Qualification	Subject
1	Prof. Ravi Kant	Professor	Full Time	Ph.D	Chemistry
2	Dr. Monika Singh	Associate Professor	Full Time	Ph.D	Chemistry

Delivery Mechanism

The ODL of MU follows a modern ICT (Information & Communication Technology) enabled approach for instruction. The methodology of instruction in ODL of MU is different from that of the conventional/regular programs. Our ODL system is more learner-oriented and the learner is an active participant in the teaching-learning process. ODL of MU academic delivery system comprises:

A. Print Material

The printed material of the programme supplied to the students will be unit wise for every course.

B. Counselling Sessions

Normally, counselling sessions are held as per a schedule drawn beforehand by the Subject Coordinator. There will be 6 counselling/ contact classes for 4 credit course will be held on the campus on Saturday and on Sunday of 2 hour duration for each course in face to face mode (In case of 2 credit course contact hours are required 6 hours and in case of 6 credit course contact hours required 18 hours). Contact classes will be held in the campus on Saturdays and on Sundays.

C. Medium of Instruction

Medium of Course Instruction: English

Medium of Examination: English

Student Support Systems

Universities Study Centres or Learner Support Centre shall be headed by a coordinator, not below the rank of Assistant professor and shall be augmented with academic and non-academic staff depending on the learner.

The university has made appropriate arrangements for various support services including counseling schedule and resource-oriented services evaluation methods and dates both online and offline modes for easy and smooth services to the students of distance mode.

At present the university have only one study centre on the campus. The institution is not promoting any study centers outside the campus. All student support services will be provided to the student through a single window method/mode onsite and online.

F. Procedure for Admissions, Curriculum, Transaction and Evaluation Admission Process

Admission to the M.Sc. (Chemistry) Programme will be done on the basis of screening of candidate's eligibility on first come first serve basis. The University will follow the reservation policy as per norms of the Government. Admission shall not be a right to the students and MU, CDOE shall retain the right to cancel any admission at any point of time if any irregularity is found in the admission process, eligibility etc..

Maximum Duration

A. The maximum duration of the M.Sc. (Chemistry) Programme is four years. Thereafter, students seeking completion of the left-over course(s) will be required to seek fresh admission.

B. The student can complete his programme within a period of 4 years failing which he/she shall seek fresh admission to complete the programme.

Eligibility

Science (PCM/PCMB) Graduate from a recognised University is eligible for admission into M.Sc. (Chemistry) programme.

Fee Structure

Name of the Program	Degree	Duration	Year	Tuition Fee/Year	Exam Fee/Year	Total (in Rs.)
Master of Science (Chemistry)	PG	2 to 4 Years	1	15000	2000	17000
			2	13500	2000	15500
Total						32500

Activity Schedule

S. No.	Name of the Activity	Tentative months schedule (specify months) during year			
		From	To	From	To
1	Admission	Jul	Sep	Jan	Mar
2	Assignment submission (if any)	Sep	Oct	Mar	Apr
3	Evaluation of Assignment	Oct	Nov	Apr	May
4	Examination	Dec		Jun	
5	Declaration of Result	Jan		Jul	
6	Re-registration	Jul		Jan	
7	Distribution of SLM	Jul	Sep	Jan	Mar
8	Contact Programmes (counseling, Practicals.etc.)	Sep	Nov	Mar	May

Credit System

MU, CDOE proposes to follow the 'Credit System' for most of its programs. Each credit amounts to 30 hours of study comprising all learning activities. Thus, a 8 credit course requires 240 hours, 6 credit course requires 180 hours , 4 credit course requires 120 hours and 2 credit course requires 60 hours of study. This helps the student to understand the academic effort to complete a course. Completion of an academic programme requires successful clearing of both, the assignments and the term-end examination of each course in a programme.

Duration of programme	Credits	Name of programme	Level of programme
2 to 4 Yrs.	80	M.Sc. (Chemistry)	Master's Degree

Assignments

Distance Education learners have to depend much on self study. In order to ascertain the writing skill and level of comprehension of the learner, assignment work is compulsory for all learners. Each assignment shall consist of a number of questions, case studies and practical related tasks. The Assignment Question Papers will be uploaded to the website within a scheduled time and the learners shall be required to respond them within a specified period of time. The response of the learner is examined by a faculty member.

Evaluation: The evaluation system of the programme is based on two components:

A. Continuous Evaluation in the form of assignments (weightage 30%): This Component carries a weightage of 30%. There will be at least one graded assignment and test per course. These assignments are to be submitted to the Co-ordinator of the CDOE/Study Centre to which the student is assigned or attached with.

B. Term-end examination (weightage 70%): This will be held twice every year in the months of June and December. The students are at liberty to appear in any of the examinations conducted by the University during the year. A student will be allowed to appear in the Term-End Examination only after she/he has registered for that course and submitted the assignment. For appearing in the Examination, every student has to submit an Examination form through online (www.mangalayatan.in)/ or offline before the due dates as given in the schedule of operations. If a student misses any term-end examination of a course for any reason, s/he may appear for any of them or all the courses subject to the maximum of 8 courses in the subsequent term-end examinations. This facility will be available until a student secures the minimum pass grade in the courses but up to a maximum period of four semesters, since the date of registration of the course is valid for four semesters. Beyond this period s/he may continue for another four semesters by getting Re-registration by paying fee again. In that case, the score of qualified assignments and/or term-end examination will be retained and the student will be required to complete the left out requirements of such re-registered courses. Minimum requirement for passing a course will be 40% marks.

G. Laboratory Support and Library Resources

The library of Mangalayatan University aims to empower the teaching mission and intellectual culture of the community through availability through an organized collection of information as well as instruction in its access, relevance and evaluation. The University Library enriches advance learning and discovery by providing access to a broad array of resources for education, research and creative work to ensure the rich interchange of ideas in the pursuit of knowledge.

The Centre of Distance Education of Mangalayatan University has initiated the process of setting up a dedicated Library for ODL program and acquiring printed books and e-books for this purpose. The required International and National subject journals are also provided. We have a full functioning community radio service onboard (90.4 FM). We already have annual journal subscriptions and the capacity can be enlarged at later stages as the University lines up with more online journals.

The collection of the Library is rich and diverse especially in terms of the breadth and depth of coverage. Collection encompasses subjects in Management, Commerce, Information Technology, Computer Applications, and other allied areas. This collection further includes Books, Research Journals, Project Reports/Dissertations and online Journals.

The Chemistry laboratory is well equipped with chemicals, reagents as well as instruments which are necessary for practical analysis.

The University has well equipped Computer Laboratories, Lecture Capturing Systems, Audio Video facilities, ICT enabled class rooms, Wi-Fi facilities etc.

H. Cost estimate of the programme and the provisions

Initial expenses have been done by the University in terms of provision of infrastructure, manpower, printing of Self Study Material etc. The University intends to allocate expenses out of the total fee collection as per following details:

a) SLM Development and Distribution: 20%

b) Postal and ICT Expenses: 10%

c) Salary and other Administrative expenses: 60%

d) Future Research development reserve: 10%

Once programmes are operational, the programme budget from fee receipts will be planned as per the guidelines of University Grants Commission.

I. Quality Assurance

The University has established the Centre for Internal Quality Assurance (CIQA) in the University campus. The CIQA will monitor and maintain the quality of the ODL programmes. It has the following objectives in making the compliances of quality implementations.

Objectives

The objective of Centre for Internal Quality Assurance is to develop and put in place a comprehensive and dynamic internal quality assurance system to ensure that programmes of higher education in the Open and Distance Learning mode and Online mode being implemented by the Higher Educational Institution are of acceptable quality and further improved on continuous basis.

Functions of CIQA

The functions of Centre for Internal Quality Assurance would be following:

1) To maintain quality in the services provided to the learners.

2) To undertake self-evaluative and reflective exercises for continual quality improvement in all the systems and processes of the Higher Educational Institution.

3) To contribute in the identification of the key areas in which Higher Educational Institution should maintain quality.

4) To devise mechanism to ensure that the quality of Open and Distance Learning programmes and Online programmes matches with the quality of relevant programmes in conventional mode.

5) To devise mechanisms for interaction with and obtaining feedback from all stakeholders namely, learners, teachers, staff, parents, society, employers, and Government for quality improvement.

6) To suggest measures to the authorities of Higher Educational Institution for qualitative improvement.

7) To facilitate the implementation of its recommendations through periodic reviews.

8) To organize workshops/seminars/symposium on quality related themes, ensure participation of all stakeholders, and disseminate the reports of such activities among all the stakeholders in Higher Educational Institution.

9) To develop and collate best practices in all areas leading to quality enhancement in services to the learners and disseminate the same all concerned in Higher Educational Institution.

10) To collect, collate and disseminate accurate, complete and reliable statistics about the quality of the programme(s).

11) To ensure that Programme Project Report for each programme is according to the norms and guidelines prescribed by the Commission and wherever necessary by the appropriate regulatory authority having control over the programme;

12) To put in place a mechanism to ensure the proper implementation of Programme Project Reports.

13) To maintain a record of Annual Plans and Annual Reports of Higher Educational Institution, review them periodically and generate actionable reports.

14) To provide inputs to the Higher Educational Institution for restructuring of programmes in order to make them relevant to the job market.

15) To facilitate system based research on ways of creating learner centric environment and to bring about qualitative change in the entire system.

16) To act as a nodal coordinating unit for seeking assessment and accreditation from a designated body for accreditation such as NAAC etc.

17) To adopt measures to ensure internalization and institutionalization of quality enhancement practices through periodic accreditation and audit.

18) To coordinate between Higher Educational Institution and the Commission for various qualities related initiatives or guidelines.

19) To obtain information from other Higher Educational Institutions on various quality benchmarks or parameters and best practices.

20) To record activities undertaken on quality assurance in the form of an annual report of Centre for Internal Quality Assurance.

21) It will be mandatory for Centre for Internal Quality Assurance to submit Annual Reports to the Statutory Authorities or Bodies of the Higher Educational Institution about its activities at the end of each academic session. A copy of report in the format as specified by the Commission, duly approved by the statutory authorities of the Higher Educational Institution shall be submitted annually to the Commission.

After enrolling in M.Sc. (Chemistry) programme of Mangalayatan University in ODL mode, student will exhibit knowledge, skill and general competence with scientific aptitude and innovation. After completion of M.Sc. (Chemistry) programme, student will pursue further studies in Chemistry for roles in academia, research, industry, laboratory, technology and government.