Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

CIRCULAR NO.SU/ Sci. & Tech./Sub-Campus, Osmanabad/NEP/14/2023

It is hereby inform to all concerned that, the syllabi prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted **the following curriculum of All Post Graduate Degree Courses as per Norms of National Education Policy – 2020 under the Faculty of Science & Technology run at University Department, Dr.Babasaheb Ambedkar Marathwada University, Sub-Campus, Osmanabad** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Syllabi of Deptt of BAMU, Sub Campus, Osmanabad.	Semester
1.	M.Sc. Chemistry specialization Analytical Chemistry, Organic Chemistry, Drug Chemistry.	Ist and IInd Semester
2.	M.Sc.Microbiology	Ist and IInd Semester
3.	M.Sc.Mathematics	Ist and IInd Semester
4.	M.Sc.Physics	Ist Semester
5.	M.Sc.Water & Land Management	Ist and IInd Semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/NEP/2023/8541-49
Date:- 08.08.2023.

★★★★★

Deputy Registrar,
Academic Section

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1] **Head of the Department, All Departments, Dr.Babasaheb Ambedkar Marathwada University, Sub-Campus, Osmanabad.**
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD, SUB-CAMPUS OSMANABAD

NAAC Reaccredited with 'A' Grade

Faculty of Science and Technology

Department of Chemistry
(Autonomous)

2 Years P.G. Programme in Science
(M.Sc.)

As per National Education Policy-2020
(To be implemented from Academic Year-2023-24)

Course Structure and Curriculum
(Outcome Based Credit System)

Subject :Chemistry

Specialization : 1. Analytical Chemistry
2. Drug Chemistry
3. Organic Chemistry

(Effective from 2023-24)

31.07.2023

Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad

PREAMBLE

Master of Science (M.Sc.) in Chemistry Program

Welcome to the Master of Science (M.Sc.) in Chemistry Program at Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabad. This preamble gives an introduction of our esteemed program, its objectives, curriculum, and other information to the students, who wish to pursue the advanced studies in the field of Chemistry.

Program Overview:

The M.Sc. in Chemistry program at Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabadis designed to provide a comprehensive and rigorous education in the fundamental principles, theories, and experimental techniques of modern chemistry. The program is designed to provide the necessary skills and knowledge, which help to become adept researchers, critical thinkers, and problem solvers in the field of chemical sciences.Department running the programme in three specializations viz. Analytical Chemistry, Drug Chemistry and Organic Chemistry.

Objectives:

M. Sc. in Chemistry program aims to provide the following objectives:

1. Provide the Advanced Knowledge: The program aims to provide the core/basic concepts in chemistry, including organic, inorganic, physical, and analytical chemistry, while also exploring interdisciplinary areas.

2. Provide the Research Skills: Students will get the research-oriented environment in the department and learns the laboratory techniques and methodologies required in the research.

3. Create Analytical Thinking: We will encourage the students to create analytical thinking and encouraging to approach complex challenges with creativity and scientific reasoning.

4. Ability of Communication and Collaboration:
In the program, students will work on their abilities to present and discuss scientific ideas clearly and work collaboratively with others.

Curriculum:

The M.Sc. in Chemistry program is structured to have a balance between core components, specialized electives, and research components. Some of the key subjects covered in the curriculum include:

1. Analytical Chemistry
2. Inorganic Chemistry
3. Organic Chemistry
4. Physical Chemistry
5. Advanced Analytical Techniques
6. Spectroscopic techniques and applications
7. Environmental Chemistry
8. Retrosynthetic approach
9. Drug synthesis
10. Drug discovery
11. Materials Science
12. Advanced Laboratory Techniques
13. Research project

Faculty:
Our faculty members are distinguished scholars and experts in various fields of chemistry. They are committed to providing mentorship and guidance to the students and creating passion for chemistry in the students.

Conclusion:
The M.Sc. in Chemistry program at Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabad gives various future possibilities. Student can do their carrier in academia, industry, or research.Our program will empower students to make significant contributions to the field of chemistry and beyond.

Department of Chemistry,
Dr. Babasaheb Ambedkar Marathwada University,
Sub-Campus Osmanabad.
Date:

Vision:

A Master of Science (M.Sc.) in Chemistry is a postgraduate degree that provide students with in-depth knowledge, research skills, and practical expertise in the field of chemistry. Some of key points of our M. Sc. Chemistry program are mentioned below:

1. Comprehensive Core Curriculum: Our course having a strong core curriculum covering fundamental principles in organic, inorganic, physical, analytical, and drug chemistry. This foundational knowledge is crucial to build a solid understanding of the discipline.
2. Specialization Options: To cater to the diverse interests of students, students have option to select different specialization. We are offering three specializations viz, Analytical Chemistry, Drug Chemistry and Organic Chemistry. By choosing a specialization, students can focus on topics that align with their career aspirations and research interests.
3. Research Emphasis: Research is a crucial aspect of an M.Sc. Chemistry program. Students have opportunities to work on research projects under the guidance of experienced faculty members. This hands-on experience will enhance critical thinking, problem-solving skills, and laboratory techniques.
4. Modern Analytical Techniques: The course will provide the training or interpretation in modern analytical techniques, such as spectroscopy, chromatography, mass spectrometry, and so on. Proficiency in these techniques is vital for conducting advanced research and for industry applications.
5. Green Chemistry and Sustainability: Incorporation of principles of green chemistry and sustainability into the curriculum will promote awareness of environmental impact and encourage students to develop eco-friendly solutions.

Overall, the vision for M.Sc. Chemistry course is to produce well-rounded, skilled, and ethical chemists who can contribute meaningfully to scientific advancements and societal needs.

Mission:

The mission of the M.Sc. Chemistry program is to provide advanced education and training in the field of chemistry. Student will get the understanding of chemical principles, analytical techniques, and specialized knowledge in various sub-disciplines. The program aims to foster critical thinking, research skills, and ethical practices among students, enabling them to contribute significantly to scientific advancement, innovation, and societal needs. Further, program focus is to encourage the students to stand in competitive examinations in the field of chemistry such as NET, SET and GATE and contribute to the academic field.

Eligibility: Candidate has passed Bachelor's Degree Examination with Chemistry as one of the major subject, eligible for M. Sc. (Chemistry) for all three specializations. Further, B.Sc. Forensic Science student is eligible only for Analytical Chemistry specialization.

Duration: Post- Graduate Degree in Chemistry- 2 Years

Medium of Instruction: English

Attendance: The students will not be allowed to appear for the examination if he/she do not attend minimum 75 % classes of theory, practical, project, etc.

AS PER NEP 2020

Illustrative Credit distribution structure for Two Years/One Year Programme with Multiple Entry and Exit options

Class: M.Sc. First Year **Semester: I[st] Semester**

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned			Marks		
			Theory	Practical	Theory	Practical	Total Credits	Conti.Inter.Assmen.	End. Sem Exam	Total Marks
Major Mandatory DSC	CHE/MJ/500	Analytical Chemistry	2	-	2	-	8T	20	30	50
	CHE/MJ/501	Inorganic Chemistry	2	-	2	-		20	30	50
	CHE/MJ/502	Organic Chemistry	2	-	2	-		20	30	50
	CHE/MJ/503	Physical Chemistry	2	-	2			20	30	50
	CHE/MJ/504	Laboratory course (Inorganic Chemistry)	-	4	-	2	6L	20	30	50
	CHE/MJ/505	Laboratory course (Organic Chemistry)	-	4	-	2		20	30	50
	CHE/MJ/506	Laboratory course (Physical Chemistry)	-	4	-	2		20	30	50
DSE (Choose one from your specialization and any one from remaining two)	CHE/DSE/507	Analytical Chemistry	2	-	2	-	4T	20	30	50
	CHE/DSE/508	Stereochemistry	2	-	2	-		20	30	50
	CHE/DSE/509	Organic Chemistry	2	-	2	-		20	30	50
Research methodology	CHE/RM/510	Research methodology	4	-	4	-	4T	40	60	100
Total			16	12	16	06	22	220	230	550

Class: M. Sc. First Year: First Semester:

1. Major Mandatory (DSC)- Master Programme is based on DSC Specialization
   CHE/MJ/500: Analytical Chemistry
   CHE/MJ/501: Inorganic Chemistry
   CHE/MJ/502: Organic Chemistry
   CHE/MJ/503: Physical Chemistry
   CHE/MJ/504: Laboratory course (Inorganic Chemistry)
   CHE/MJ/505: Laboratory course (Organic Chemistry)
   CHE/MJ/506: Laboratory course (Physical Chemistry)
2. DSE: (Choose one from your specialization and any one from remaining two)
   CHE/DSE/507: Analytical Chemistry
   CHE/DSE/508: Stereochemistry
   CHE/DSE/509: Organic Chemistry
3. Research methodology (RM):
   CHE/RM/510: Research methodology

Class :M.Sc. First Year Semester: II

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned			Marks		
			Theory	Prac-tical	Theory	Prac-tical	Total Credits	Conti.Inter.Assmen.	End. Sem Exam	Total Marks
Major Mandatory DSC	CHE/MJ/550	Analytical Chemistry	2	-	2	-	8T	20	30	50
	CHE/MJ/551	Inorganic Chemistry	2	-	2	-		20	30	50
	CHE/MJ/552	Organic Chemistry	2	-	2	-		20	30	50
	CHE/MJ/553	Physical Chemistry	2	-	2	-		20	30	50
	CHE/MJ/554	Laboratory course (Inorganic Chemistry)	-	4	-	2	6L	20	30	50
	CHE/MJ/555	Laboratory course (Organic Chemistry)	-	4	-	2		20	30	50
	CHE/MJ/556	Laboratory course (Physical Chemistry)	-	4	-	2		20	30	50
DSE (Choose one from your specialization and any one from remaining two)	CHE/DSE/557	AnalyticalTechnology	2	-	2	-	4T	20	30	50
	CHE/DSE/558	Bio-organicChemistry	2	-	2	-		20	30	50
	CHE/DSE/559	Organic Chemistry	2	-	2	-		20	30	50
OJT/FP (Chose any one)	CHE/OJT/560	On Job Training	-	8 4	-	4	4L	-	-	100
	CHE/FP/561	Field Project	-		-			-	-	100
Total			16	12 6	16	06	22	220	330	550

Class: M. Sc. First Year: Second Semester:

1. Major Mandatory (DSC)- Master Programme is based on DSC Specialization
   CHE/MJ/550: Analytical Chemistry
   CHE/MJ/551: Inorganic Chemistry
   CHE/MJ/552: Organic Chemistry
   CHE/MJ/553: Physical Chemistry
   CHE/MJ/554: Laboratory course (Inorganic Chemistry)
   CHE/MJ/555: Laboratory course (Organic Chemistry)
   CHE/MJ/556: Laboratory course (Physical Chemistry)
2. DSE: (Choose one from your specialization and any one from remaining two)
   CHE/DSE/557: Analytical Chemistry
   CHE/DSE/558: Bio-organic Chemistry
   CHE/DSE/559: Organic Chemistry
3. On Job Training/Field Project-1(OJT/FP-1):
   CHE/OJT/560: On Job Training
   CHE/FP/561: Field Project

M. Sc. First Year (First Semester)

CHE/MJ/500: Analytical Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To provide general information about different spectral methods.
2. To provide information about instrumentation, principal and applications of microwave spectroscopy.
3. Outline the information about vibrational spectroscopy.
4. To provide information about electronic spectroscopy (i.e. atomic spectroscopy, molecular spectroscopy and photoelectron spectroscopy).

Course Outcomes:

Students will be able to -

1. Understand, analyze and interpret various chemical phenomena and processes such as absorption, emission, reflection, refraction, dispersion, polarization with the basic knowledge of spectroscopic techniques.
2. Provides outline of technique and instrumentation of microwave spectroscopy, vibrational spectroscopy, Raman spectroscopy and electronic spectroscopy with their applications.
3. Gives information on the geometrical structure of a molecule as well as dipole moment and a molecular system physically and chemically (microwave spectroscopy).
4. Able to solve various differential equations and solve the problems related on polyatomic molecules (vibrational spectroscopy).
5. Able to detect atom, molecule with their energy levels (Electronic spectroscopy).
6. Able to detect vibrational rotational and other states in a molecular system, capable of probing the chemical composition of material (Raman spectroscopy).

Course Contents:

Unit I: **10 Hrs.**

a) General Introduction of Spectral Methods: Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter–absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, Basic elements of practical spectroscopy, Resolving power, Signal to noise ratio, Uncertainty relation and natural line width, Natural line broadening, Intensity of spectral lines, Energy levels, Selection rules, Components of spectrometer and their functions.

b) Microwave spectroscopy: Rotation of molecules, Rotational spectra, Diatomic molecules–rigid diatomic

Unit II: Vibrational Spectroscopy **10 Hrs.**

a) Infrared spectroscopy – Review of linear harmonic oscillator, The vibrating diatomic molecule, The simple harmonic oscillator, The anharmonic oscillator, The diatomic vibrating rotator, Vibration–rotation spectrum of carbon monoxide, Breakdown of Born–Oppenheimur approximation, The

vibration of polyatomic molecules, Overtones and combination frequencies, The influence of rotation of the spectra of polyatomic molecules the influence of nuclear spin, Symmetric top molecules analysis by infra–red technique–Group frequencies, Outline of technique and Instrumentation.

b) Raman spectroscopy –Classical and Quantum of theory of Raman effect, Pure rotational, vibration and vibrational–rotational Raman spectra, Rule of mutual exclusion, Overtone and combination vibrations Rotational fine structure, Outline of technique and instrumentation, Applications.

Unit III: Electronic Spectroscopy **10 Hrs.**

a) Atomic spectroscopy: Energies of atomic orbitals, Vector representation of momenta and vector coupling, Spectra of hydrogen and alkali metal atoms.

b) Molecular spectroscopy: Energy levels, Molecular orbitals, Vibronic coupling, Vibrational progression, Franck–Condon principle, Electronic spectra of polyatomic molecules.

c) Photoelectron spectroscopy: Basic principle, photoelectric effect, ionization process, Koopman theorem, Instrumentation (Sources for ESCA & AES, Vaccum System, Specimen & its manipulation, Analyzers, Detectors), Satellite peaks, Spectral splitting ESCA, Chemical shifts, PES spectra of simple molecule, Applications, Auger effect (KLL effect).

Reference Books:

1. Physical Chemistry, G. M. Barrow
2. Instrumental Methods of Chemical Analysis, Chatwal Anand
3. A Text book of Physical Chemistry, A. S. Negi & S.C. Anand
4. Instrumental Methods of Chemical Analysis, Willard, Merritt, Dean &Seatle
5. Instrumental Methods of Chemical Analysis, B. K. Sharma
6. Instrumental Methods of Chemical analysis, R.D. Braun
7. Principles of Instrumental Analysis, Skoog and West
8. Fundamental of Molecular Spectroscopy, Banwell
9. Atomic and Molecular structure, Manas Chanda
10. Molecular Spectroscopy, B. D Acharya
11. Molecular Spectroscopy, Dyer
12. X–ray Diffraction, B.D. Cullity.

M. Sc. First Year (First Semester)

CHE/MJ/501: Inorganic Chemistry

2 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To provide a comprehensive understanding of the reaction mechanisms of transition metal complexes.
2. To provide applications of trans effect.
3. To provide in detail concepts of symmetry in chemistry, and representation of groups using matrix methods.
4. Learn to determine point group of molecules like H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_5, PCl_3, C_6H_6, $[PtCl_4]^{2-}$, HCl, CO, $[FeF_6]^{3-}$, Ortho–, meta– & para–disubstituted benzene molecules.
5. Learn the Group multiplication table, Matrix representation, Reducible and Irreducible representations.
6. Learn the Great orthogonally theorem and Mulliken symbolism rules

Course Outcomes:

Students will be able to -

1. understandand perform mechanism of reaction especially mechanism of substitution of reaction.
2. understand acid hydrolysis & their mechanisms.
3. understand base hydrolysis & their mechanism.
4. understandand apply Trans effect and electron transfer reaction.
5. understand and apply symmetry elements & operation
6. understand point group and identify point groups
7. understand and perform matrix, group representation, character table, Muliken symbols.

Course Contents:

Unit I: Reaction Mechanism of Transition Metal Complexes **10 Hrs.**

Classification of Inorganic reactions, Energy profile diagram with terminology, Types of ligand or nucleophilic substitution reactions in octahedral complexes with their mechanism, Reactivity of metal complexes with Valence Bond & Crystal Field theories approach, Acid hydrolysis and its factors affecting (atleast four factors), Base hydrolysis and its conjugate base mechanism, Anation reaction with mechanism, Reactions without metal–ligand bond cleavage, Nucleophilic substitution reactions in square planner complexes, Trans effect, Trans–directing series, Polarization and Π–bonding theories of trans effect, Applications of trans effect, Electron transfer redox reactions of complexes, Inner and Outer sphere redox reactions with features & mechanisms.

Unit II: Concepts of Symmetry **10 Hrs.**

Introduction to Symmetry, Symmetry operation, Symmetry elements, Point group and its classification (Cn, Dn, Special type), Schoenflies symbol for point groups, Determination of point group of H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_5, PCl_3, C_6H_6, $[PtCl_4]^{2-}$, HCl, CO, $[FeF_6]^{3-}$, Ortho–, meta– & para–disubstituted benzene molecules.

Unit III: Representation of groups **10 Hrs**

Symmetry and stereoisomerisms, Definition of group, Properties of group, Group multiplication table, Subgroups, Classes, Matrix representation of symmetry elements and point groups, Reducible and Irreducible representations, Character of a representation (character of matrix and conjugate matrix), Properties of Irreducible representation, Great orthogonally theorem (without proof) and its importance, Construction of character table of C_{2v}& C_{3v} point groups, Mulliken symbolism rules for irreducible representations & its illustrations.

Reference Books:

1. Inorganic Chemistry, *IVth Eds.,Shriver and Atkins*, Atkins, Overton, Rourke, Weller, Armstrong.
2. Mechanism of Inorganic Reaction, *IIndEds.,* F. Basolo and R. G. Pearsons.
3. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson.
4. Advanced Inorganic Chemistry, Vol.I & II, Gurdeep Raj.
5. Concise Inorganic Chemistry, J.D. Lee.
6. Symmetry and Spectroscopy of Molecules, *IInd Rev. Eds.,New Age Inter. Publishers 2009* K. Veera Reddy.
7. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan.
8. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu, R.D. Madan.
9. Group Theory and Symmetry in Chemistry, Gurdeep Raj, Ajay Bhagi, Vinod Jain
10. Inorganic Chemistry, J.E. House.

M. Sc. First Year (First Semester)

CHE/MJ/502: Organic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To learn in detail about aliphatic and aromatic nucleophilic substitution reactions.
2. To learn the in detail mechanism of aliphatic and aromatic nucleophilic substitution reactions.
3. To provide detail information about aliphatic and aromatic electrophilic substitution reactions.
4. To learn the in detail mechanism of aliphatic and aromatic nucleophilic substitution reactions.
5. To provide in-depth knowledge so that student will able to predict the product or assign the suitable reaction for these substitutions.

Course Outcomes:

Students will be able to –

1. understand different types of aliphatic and aromatic nucleophilic substitution reactions and their mechanisms.
2. understand aliphatic and aromatic electrophilic substitution reactions and effect of various parameters.
3. learn different reactions such as Finkelstein reaction, Appeal Delepine reaction, nitration, sulphonation and Friedel craft's reactions, Diazonium coupling.
4. identify, give the mechanism and predict the products for nucleophilic and electrophilc substitution reactions.

Course Contents:

Unit I: Aliphatic Nucleophilic Substitutions **10 Hrs**

The SN^2, SN^1, mixed SN^1& SN^2, and SET mechanisms, Neighbouring group mechanism, Neighbouring group participation by π and 6–bonds, Anchimeric assistance. Nucleophilic substitution at an allylic aliphatic trigonal and a vinylic carbon.Reactivity: Effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, Ambident nucleophiles, regioselectivity. Finkelstein reaction, Appeal Delepine reactions.

Unit II: **10 Hrs**

a) Aliphatic Electrophilic Substitution: Bimolecular mechanisms: SE^2 and SE^i, The SE^1 mechanisms. Electrophilic substitution accompanied by double bond shifts.

b) Aromatic Nucleophilic Substitution: The SN^{Ar},SN^1, SN^2 and benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophilic on reactivity.

Unit III:Aromatic Electrophilic Substitution **10 Hrs**

The arenium ion mechanism, Orientation and reactivity, Energy profile diagram, The orto/para ratio, IPSO substitution, Orientation in other ring system, Recapitulation of halogenations, nitration, sulphonation and Friedel craft's reactions, Diazonium coupling.

Reference books:

1. Advanced Organic Chemistry, IV Edn : J. March
2. Advanced organic chemistry: Part A and B; F. A. Carey and R. J. Sundberg
3. A guide book to mechanism in organic chemistry: Peter Sykes.
4. Mechanism and Structure in organic Chemisry: E.S.Gould
5. Principle of Organic Synthesis: R.O.C. Norman.
6. Modern Methods of Organic Synthesis: W. Carruthers
7. Organic Chemistry: Clayden, Greeves, Warren and Wothers

M. Sc. First Year (First Semester)

CHE/MJ/503: Physical Chemistry

02 Hrs/Week Credits: 02 Marks 50

Course Objectives:

1. To provide detail information about chemical equilibrium and dynamics.
2. To provide information of different theories and factor affecting degree of ionization.
3. To learn the modified collision theory, kinetics of fast reactions and related numericals.
4. To provide detail information about electrochemistry and associated theories such as Debye–Huckel theory, Debye–Huckel–Onsager equation, Testing of the equation, Dehye–Falkenhagen, Wein effect
5. Determination of activity coefficient, ionic strength, mean ionic activity coefficient and related numericals.
6. To study the surface chemistry (micelles and adsorption), related theory and numericals.

Course Outcomes:

Students will be able to –

1. understand the concept of acid and base using Arrhenius, Laury-Bronsted, and Lewis acid-base theory
2. understand redox reactions as well as identify the pH of the maximum dilution solution.
3. understand collision theory.
4. understand surface tension, the Laplace equation, the Kelvin equation, and Gibbs' adsorption isotherm.
5. understand Debye Huckel Theory in strong electrolytes
6. understand Debye Huckel Theory for an electrolytic solution's activity coefficient.

Course Contents:

Unit I: Chemical Equilibrium andDynamics **10 Hrs.**

Introduction, Concept of Acid and Base including Arrhenius , Bronsted –lowery, Lewis of Acid and Base theory , Arrhenius theory for Ionization (Ionic Dissociation) and factor affecting degree of ionization ,Ionic Product of Water, Dissociation constant of complex ions, logarithmic expression for pH and pOH..Modified collision theory, Weakness of the collision theory, Theory of absolute reaction rates, Derivation of rate equation, Isotope effect on reaction rate.Primary salt effect.Dynamics of uni–molecular reaction, Lindmann, Hinshelwood, KRR and Slater's treatment for unimolecular reaction. Kinetics of fast reactions, Study of fast reaction by flow method, relaxation method, flash photolysis and NMR method. Numericals.

UnitII:Electro–Chemistry **10 Hrs.**

Debye–Huckel theory of Strong electrolytes, Debye–Huckel–Onsager equation, Testing of the equation, Dehye–Falkenhagen, Wein effect, Debye Huckel theory for activity coefficient of electrolytic solutions; determination of activity coefficient, ionic strength, mean ionic activity

coefficient , Debye–Huckel limiting law ionic strength, Numericals. Electro capillary phenomena, and its measurements Effect of anions, cations and molecules on electro–capillary curves Electro capillary properties of mercury– solution interface. Lippmann equation.Structure of electrified interfaces –Helmholtz, Gouy–Chapman, Stern, Grahm, Devnathhan models.

Unit III: Surface Chemistry **10 Hrs.**

A. Micelles:Micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants. Thermodynamics of micellizatioti, solubilization .Micro emulsion.

B. Adsorption:Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm. estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, Numericals.

Reference Books:

1. Chemical Kinetics, Laidler (McGraw–Hill).
2. Physical Chemistry, G. M Barrow.
3. Advanced Physical Chemistry, Gurdeep Raj.
4. Micelles: Theoretical and Applied Aspects, V. Moroi (Plenum).
5. Text Book of Physical Chemistry – S. Glasstone (McMillan).
6. Electrochemistry: Principles, Methods and Application, C.M. A. Brett & A.M.O. Brett (Oxford).

M. Sc. First Year (First Semester)

CHE/DSE/507: Analytical Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To learn the concept of chromatography, its classification and associated different terms.
2. To learn the selection of chromatograph system, qualitative and quantitative analysis by chromatography.
3. To provide the detailed information of Thin layer Chromatography, Liquid-liquid Partition Chromatography, Column Chromatography, and Ion exchange chromatography and their applications.
4. To provide details of gas chromatography, High Performance Liquid chromatography and their applications and related numericals.

Course Outcomes:

Students will be able to –

1. Describe the principle and types of planar chromatography. List the various methodological aspects of paper and thin layer chromatography.
2. Able to explain principle, instrumentation and application of paper chromatography thin layer chromatography, column chromatography, gas chromatography and high pressure liquid chromatography.
3. Able to explain stationary phase, mobile phase in chromatography and understand details of solvent system in chromatography.
4. Explain the fundamental concepts & theories of separation techniques in GC and HPLC (schematic diagrams, the function of each component in GC and HPLC).
5. Identify the strength and limitations of GC and HPLC technique.
6. Able to explain the principles and theoretical concepts of liquid-liquid extraction and ion exchange.
7. Able to explain principle and various aspects of gel permeation chromatography (theory, column efficiency, factors affecting efficiency and applications).

Course Contents:

Unit-I: Chromatography **10 Hrs.**

Definition of Chromatography, Classification of Chromatographic methods, Theory of chromatographic techniques (plate theory, rate theory), Zone broadening, Development of the chromatograms (Frontal analysis, elution analysis, displacement analysis), Selection of chromatograph system, Qualitative and Quantitative analysis by chromatography.

Unit-II: Chromatographic System **10 Hrs.**

(a) Thin layer Chromatography: Basic Principles, Experimental Techniques–Solvent systems, Plate development, Detection of components, Evaluation of chromatogram by different methods, Applications of TLC.

(b) Liquid-liquid Partition Chromatography: Introduction, theory, solid support, selection of stationary and mobile phases, reverse phase chromatography, choice of adsorption or partition, applications of partition chromatography

(c) Column Chromatography: Principle, Experimental Details, Theory of development, Column efficiency, Factors affecting column efficiency, Applications.

(d) Gel permeation chromatography: Principle, materials, gel preparation, column packing, detectors and applications.

(e) Ion exchange chromatography: Ion exchange resins, ion exchange equilibria, ion exchange capacity of resins and its determination, applications of ion exchange resins to chromatography, ion chromatography based on suppresser.

Unit III: **10 Hrs.**

(a) Gas Chromatography: Introduction, Principles, Types of GC (Gas–Liquid and Gas–Solid), Instrumentation and Working of GLC (Carrier gas, Sample introduction system, Columns and Stationary Phases, Detectors), Theory of GLC (Theoretical plate concept, Calculation of number of theoretical plates, The van Deemter Equation, Resolution, Factors in Retention, Applications, Numericals.

(b) High Performance Liquid chromatography: Principle, Instrumentation (Solvent systems, Pumping systems, Sample Injection system, Columns, Detectors systems), Applications, HPLC adsorption and partition chromatography.

References:

1. Quantitative Analysis, 6th Eds., R.A. Day Jr., A.L. Underwood
2. Fundamental of Analytical Chemistry, 8th Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
3. Analytical Chemistry, 6th Eds. G D. Christian.
4. Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.O. Barnes, M. Thomas, B. Sivasankar.
5. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.
6. Basic Concepts in Analytical Chemistry, S.M. Khopkar,
7. Quantitative Analytical Chemistry, 2ndEds. James S Fritz and George H. Schenk Jr.
8. Handbook of Instrumental Methods for Analytical Chemistry, F. Settle.
9. Modern Instrumental Analysis, Volume 47. Edited by S. Ahuja, N. Jespersen, Elsevier

M. Sc. First Year (First Semester)

CHE/DSE/508: Stereochemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To provide in information of symmetry elements, Chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature, etc.
2. To provide optical activity of different compounds ((Biphenyls, allenes and Spirans, Chirality due to helical shape),
3. To know the methods of resolution, optical purity and related numericals.
4. To study of stereochemistry of Nitrogen, Sulphur and Phosphorous containing compounds.
5. To know the conformations of cycloalkanes, mono and disubstitutedcyclohexanes, and decalins.

Course Outcomes:

Students will be able to –

1. understand and define symmetry and related terms.
2. assignR and S, E and Z nomenclature to given molecules.
3. understandprochiral relationships, groups and faces, Stereospecific and stereoselective reactions.
4. assign the optical activity to Biphenyls, allenes and Spirans.
5. know about methods of resolution, Optical purity, Stereochemistry of the compounds containing Nitrogen, Sulphur and Phosphorous.
6. learn conformational analysis of cyclohexanes, decalins.
7. understand the effect of confirmation on reactivity.

Course Contents:

Unit-I: **10 Hrs**

Elements of symmetry, Chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature, Molecules with more than one chiral center, Threo and Erythro isomers.

Unit-II: **10 Hrs**

Prochiral relationships, Groups and faces, Stereospecific and stereoselective reactions.Optical activity in the absence of Chiral carbon (Biphenyls, allenes and Spirans), Chirality due to helical shape, Methods of resolution, Optical purity, Stereochemistry of the compounds containing Nitrogen, Sulphur and Phosphorous.

Unit-III: **10 Hrs**

Conformations analysis of cycloalkanes, Mono and disubstitutedcyclohexanes, decalins, Effect of conformation on reactivity.

Reference books:

1. Stereochemistry of carbon compounds: E. L. Eliel
2. Organic Chemistry: Clayden, Greeves, Warren and Wothers
3. Stereochemistry of Organic Compounds: D. Nasipuri
4. Stereochemistry: P. S. Kalsi
5. Basic Stereochemistry of Organic Molecules: Subrata Sen Gupta

M. Sc. First Year (First Semester)

CHE/DSE/509: Organic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To provide the information about nature of bonding in organic molecules and different terms such Cross conjugation, Resonance, Hyperconjugation, Tautomerism, aromaticity in benzenoid and non–benzenoid compounds, Huckel rule, PMO approach etc.
2. To know about alternant and non–alternant compounds, crown ethers complexes and cryptands, Inclusion compounds, cyclodextrins, catenanes and rotaxanes.
3. To know the types of reaction mechanisms, types of reaction, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammonds postulates, Curtin–Hammett principle, Potential energy diagrams, Transition states and intermediates.
4. To known the methods of determining the reaction mechanisms.
5. To known the detailed information about reaction intermediates Carbocations, Carbanions, Free radicals, Carbenes and Nitrenes.
6. To known the Hammett equation and Taft equation.

Course Outcomes:

Students will be able to –

1. describe the chemical and molecular processes involved in organic chemical reactions.
2. explain the nature of chemical bonding in organic molecules.
3. describe the different methods to determine the reaction mechanisms.
4. learn the different factors affecting on reactivity.
5. explain the concept and types of aromaticity.

Course Contents:

Unit I: Nature of Bonding in Organic Molecules **10 Hours**

Delocalized chemical bonding conjugation, Cross conjugation, Resonance, Hyperconjugation, Bonding in fullerenes, Tautomerism, Aromaticity in benzenoid and non–benzenoid compounds, Huckel rule, Energy level of μ-molecular orbitals, Annulenes, Aromaticity, homo–aromaticity, ψ–aromaticity, PMO approach, Alternant and non–alternant compounds, Crown ethers complexes and cryptands, Inclusion compounds, Cyclodextrins, Catenanes and Rotaxanes.

Unit II: Reaction Mechanism: Structure and Reactivity (Part-I) **10 Hours**

Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammonds postulates, Curtin–Hammett principle, Potential energy diagrams, Transition states and intermediates.

Unit-III: Reaction Mechanism: Structure and Reactivity (Part-II) **10 Hours**

Methods of determining mechanisms, Isotope effects, Hard and soft acids and bases, Generation, structure, stability and reactivity of Carbocations, Carbanions, Free radicals, Carbenes and Nitrenes. Effect of structure on reactivity, Resonance and field effect, Steric effect quantitative treatment, The Hammett equation, Linear free energy relationship, Substituents and reaction constants, Taft equation.

Reference books:

1. Advanced Organic Chemistry, IV Edn : J. March
2. A guide book to mechanism in organic chemistry: Peter Sykes.
3. Organic Chemistry: Clayden, Greeves, Warren and Wothers
4. Reaction Mechanism: P. S. Kalsi
5. Organic Chemistry: Sing and Mukharji

M. Sc. First Year (First Semester)

CHE/RM/510: Research Methodology

04 Hrs/Week | Credits: 04 | Marks 100

Course Objectives:

1. To define research and describe the research process and research methods
2. To understand qualitative research and methods used to execute and validate qualitative research
3. To know how to apply the basic aspects of the research process in order to plan and execute a research project.
4. To provide insight into the processes that lead to the publishing of research.
5. To be able to present, review and publish scientific articles.
6. To provide the details about the analysis of statistical data, provide the details of related terms (error, mean, median to Q test), and solve the related numericals.
7. To know about the separation techniques distillation and solvnt extraction (theory, principle, numericals etc.)

Course Outcomes:

Students will be able to -

1. understand and explain research process
2. do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
3. to design a research approach for a specific research issue of their choice.
4. select a suitable analytical method for a specific research approach.
5. demonstrate a good understanding of how to write a research report.
6. critically assess published quantitative research with regard to the statistical methods and approaches adopted.
7. create a research document for implementation research project.
8. learn various terms such as accuracy, precision, standard deviation, average deviation etc. and perform the related calculations.
9. understand quantitative and qualitative analysis of known standards as well as unknown samples.
10. perform practical uses of accuracy, precision, standard deviation, average deviation etc. and solve the related numerical.
11. able to learn the theoretical concepts of distillation and solvent extraction and learn the theories related to it.
12. able to perform numerical problems related to solvent extraction.

Course Contents:

Unit - I: Research Fundamentals and Identification of Research Problem: 10 Hrs.

Research Fundamentals

Introduction: Definition, objectives of the research, characteristics of the research, what makes people to do research, importance of research, Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, and replication. Merging the two approaches.

Identification of Research Problem

Defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of research problem definition, some facts involved in defining research problem, Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables, Case Studies,

Unit- II: Formulation of Research Problem **10 Hrs.**

Formulation of the problems: steps involved in defining a problem, formulation of the problems, Formulation of hypothesis: Concept of hypothesis, hypothesis testing, developing the research plan: implementation, interpreting and reporting the findings, Importance of hypothesis in decision making, Case Studies. Interpretation of Data.Measurement: Concept of measurement- what is measured?Problems in measurement in research- Validity and Reliability. Levels of measurement Nominal, Ordinal, Interval, Ratio.

Unit – III : Research Report and Proposal Writing **10 Hrs.**

Introduction, research proposal writing: costing, the research proposal, rationale for the study, research objectives, research methodology, target respondents, research Centres, sample size and sample composition, sampling procedures, research project execution, research units; An insight into research report and proposal, research project synopsis, research report writing : types of research reports, guidelines for writing reports; Steps in writing report, report presentation, typing the report, documentation and bibliography, formatting guidelines for writing a good research report / research paper, Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Case Studies.

Unit-IV: Statistical Treatmentof Analytical Data: **15 Hrs.**

Introduction, Error & its types, Significant figures, Accuracy and Precision, Methods of expressing accuracy, Methods of expressing precision, Statistical treatment of finite samples (Mean, Median, Range, Average deviation, Relative average deviation, Standard Deviation, Coefficient of Variation, Variance), Confidence limit, Tests of significance–the 'F' test, the student's 't' test, Rejection of results–'Q' test, Numericals.

Unit-V: Basic Separation Techniques: Distillation and Solvent Extraction **15 Hrs.**

Distillation, Fractional distillation, Distillation under vacuum, Theory of operation of distillation methods, Some practical considerations.Solvent Extraction: Principle, Partition/Distribution coefficient and Distribution ratio, Classification of extractions, Mechanism of Extraction, Extraction by Chelation with equilibrium, Extraction by Solvation with equilibrium, Practical Illustrations – Extraction of metals, Extraction by Ion pair, Accelerated and Microwave assisted extraction, Solid phase extraction, Numericals.

References:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd **(2013),** ISBN-10: 8191064278, ISBN-13: 978-8191064278
2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi **(2010),** ISBN-10: 8132104579, ISBN-13: 978-8132104575
3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers **(2011)** ISBN 978-81-224-1522-3
4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York **(2012),** ISBN-ebook: 1461433592, ISBN (Hardcover): 978-1461433590
5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK **(2011),** ISBN-9780857023452
6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd**(2010)**, ISBN- 1849203016.
7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US **(2010),** ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562
8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, **(2011)**, ISBN: 9780199760237
9. Handbook of Scientific Proposal Writing- A.YavuzOruc; CRC Press, Taylor & Francis group **(2011)**, ISBN: 9781439869185.
10. Treatise on Analytical Chemistry: Vol.I to Vol. II–I .M. Kolthoff.
11. Basic Concepts in Analytical Chemistry, S.M. Khopkar,
12. Quantitative Analysis, 6^{th} Eds., R.A. Day Jr., A.L. Underwood
13. Fundamental of Analytical Chemistry, 8^{th} Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
14. Analytical Chemistry, 6^{th} Eds. G D. Christian.
15. Quantitative Analysis, 6^{th} Eds., R.A. Day Jr., A.L. Underwood.

M. Sc. First Year (First Semester)

CHE/MJ/504: Laboratory course (Inorganic Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcome:

1. Able to conduct the experiments for the preparation, characterization of metal complexes.
2. Able to perform chemical analyses by qualitative and quantitative analysis of metal complexes.

Course Contents:

This practical course involves synthesis of the metal complexes.

M. Sc. First Year (First Semester)

CHE/MJ/505: Laboratory course (Organic Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcome:

1. Able to perform the separation of organic binary mixture.
2. Able to perform of separation, crystallization derivatization and function group detection.
3. Able to check the melting point of separated compounds.

Course Contents:

This practical course involves qualitative analysis of ternary mixture of organic compounds.

M. Sc. First Year (First Semester)

CHE/MJ/506: Laboratory course (Physical Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcomes:

1. Able to perform the experimental using conductometer, spectrophotomer, pH meter, polarometry etc.
2. To conduct the experiment using various non-instrumental techniques.
3. Able to describe the principles behind the experiment performed in the laboratory.

Course Contents:

This practical course involves instrumental as well as non-instrumental practicals.

M. Sc. First Year (Second Semester)

CHE/MJ/550: Analytical Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To know the principle, theory and instrumentation of Ultraviolet-Visible Spectroscopy, Infrared Spectroscopy, and Nuclear Magnetic Resonance Spectroscopy.
2. To solve the problems related to these spectroscopic techniques.
3. To know the frequencies related to different functional groups and factors affecting to it.
4. To know the calculations of λ_{max} of different compounds.
5. To know the prediction of δ values for different types of protons.
6. To know the structure determination (simple molecules) from given spectral data.

Course Outcomes:

Students will be able to -

1. describe the spectroscopic techniques (NMR, IR, and UV-Visible) including the basic principles for recording of NMR, IR, and UV-Visible spectroscopy.
2. calculate the λmax for polyenes, enones and other compounds.
3. solve the simple problems on IR, UV-Visible and NMR spectroscopy.
4. determine of molecular structures of simple organic molecules by combining information from the NMR, IR, and UV-Visible spectroscopictechniques.

Course Contents:

Unit-I: **10Hrs.**

a)Ultraviolet-Visible Spectroscopy : Various Electronic transition, Chromophores, Auxochromers, Bathochromic and Hypsochromic Shifts, Effect of solvent on electronic transitions, Woodward–Fieser rules dienes, enones and aromatic compounds, Applications.

b) **Infrared Spectroscopy:** Instrumentation and sample handling, Various vibrational transitions, Characteristic vibrationl frequencies of alkenes, alkynes, aromatic compounds, Carbonyl compounds, hydroxyl compound and amines. Factors affecting IR group frequencies, overtone, combination bands and Fermi resonance. Applications.

Unit-II: Nuclear Magnetic Resonance Spectroscopy **10 Hrs.**

Elementary Ideas, Chemical Shifts, Factors affecting chemical shifts, Spin–Spin coupling constants (J) Instrumentations, Applications.

Unit-III: Problems based on combined application of UV, IR and NMR **10 Hrs.**

Reference Books:

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein- 6th Edition
2. Spectroscopy of Organic Compounds, V.M. Parikh.
3. Organic Spectroscopy, P.S. Kalsi
4. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.L. Nelson.
5. Mass Spectroscopy, K.G. Das& James.
6. Spectroscopy Methods in Organic Chemistry D. H. Williams and I. Fleming

M. Sc. First Year (Second Semester)

CHE/MJ/551: Inorganic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To know about spectroscopic term symbols, related different terms and solve the related numericals.
2. To draw the Orgel diagram for d^1 to d^9 configuration in Octahedral and Tetrahedral environments.
3. To provide information about electronic spectra of transition metal complexes such as experimental recording, selection rule, band intensities and so on.
4. To calculate D_q, B' and β parameters.
5. To know the detail chemistry of metal carbonyls and nitrosyls (Classification, Preparation, properties, structures and bonding), calculation of EAN, numericals and so on.

Course Outcomes:

Students will be able to -

1. understand how to determine terms, states & microstates for d^1 to d^5 configurations.
2. understand how to draw the microstate table.
3. understand the different types of energy levels diagrams.
4. understand and apply the EAN /18 electron Rule.
5. understand the preparation, properties, structure & bonding in metallic carbonyl &nitrosyl compounds.
6. understand biological significance of NO for living animals.

Course Contents:

Unit I: Spectroscopic Term Symbols **10 Hrs.**

Terms, States, Microstates, Inter–electronic repulsion, Spin–orbit vector coupling, Ground term and excited terms, Determination of terms symbol for d^1 to d^5 Configurations, Microstate table, Hunds rule, Fine, Hyperfine and Superhyperfine Splitting of Free ions, Racah Parameters, Numericals.

Weak and stronger field approach of terms, Orgel diagrams of d^1 to d^9 configuration in Octahedral and Tetrahedral environments, Correlation diagrams of d^1, d^2, d^8 and d^9 configuration in Octahedral and Tetrahedral environments, Non–crossing Rule, Tanabe–Sugano diagrams of d^2 and d^3 configurations of an octahedral environment.

Unit II: Electronic Spectra of Transition Metal Complexes **10 Hrs.**

Types of experimental recording of the spectra, Selection rule for electronic spectra, Relaxation in Selection rules, Band intensities, Intensity of d–d bands, Intensity of change transfer bands, Classification of Electronic spectra, Interpretation of electronic spectra of transition metal ions with

suitable examples, Charge transfer spectra & its types with mechanism, Evaluation of D_q, B' and β parameters (Graphical and Konig method), Numericals.

Unit III: Chemistry of Metal Carbonyls and Nitrosyls **10 Hrs.**

Classification, Preparation, properties, structures and bonding in –iron carbonyls ,$Ni(CO)_4$ $Co_2(Co)_8$ $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Mo(CO)_6$,$W(CO)_6$, $C_{O4}(CO)_{12}$ and V $(CO)_6$, Effective Atomic Number (EAN or 18 electron) rule applied to these carbonyls. Structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations of carbonylate ions, and carbonyl hydrides.Classification ,Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl, Compounds containing neutral NO, NO^- group, NO^+ group, Preparation, structure and application of Sodium Nitropruside, EAN rule applied to Nitrosyl compounds of Cobalt, Iron and Manganese.

Reference Books:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson.
2. Advanced Inorganic Chemistry, Vol.I & II, Gurdeep Raj.
3. Concise Inorganic Chemistry, J.D. Lee.
4. Chemical applications of Group Theory, F.A. Cotton.
5. Symmetry and Spectroscopy of Molecules, *IInd Rev. Eds.,New Age Inter. Publishers 2009* K. Veera Reddy.
6. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan
7. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu and R.D. Madan.
8. Inorganic Chemistry, Holleman–Wiberg.
9. Inorganic Chemistry, Willam W. Porefield
10. Element of Magnetochemistry– By A. Samal& R.L. Datta.

M. Sc. First Year (Second Semester)

CHE/MJ/552: Organic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To know about addition reactions (mechanism, stereochemical aspects, involving electrophile, nucleophile and free radical, regioselectivity and chemoselectivity and so on).
2. To learn the Michael addition and Sharpless asymmetric epoxidation reactions.
3. To know about addition to Carbon–Hetero atom multiple bond, related metal hydride reduction, different reagents (Grignard reagent, Organozinc and Organolithium reagent).
4. To know the mechanism of different condensation reactions (Aldol, Knovenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Prins reaction, Hydrolysis of ester and amides).
5. To know about different elimination reactions, their mechanisms and reactivity.

Course Outcomes:

Students will be able to -

1. describe various reactions involved in addition to C-C and C-O double bond.
2. explain the stereochemical aspects in addition reaction.
3. demonstrate/apply the concepts involved in elimination reaction.
4. learn to prepare organic compounds using advanced synthetic methodology.
5. learn the mechanism of various organic reactions like Aldol, Knovenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Prins reaction, Hydrolysis of ester and amides.
6. predict the products for these reactions from the reactants.

Course Contents:

Unit I:Addition reactions **12 Hrs**

Mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radical, Regioselectivity and chemo selectivity, Orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.

Unit II: Addition to Carbon–Hetero atom multiple bond **12 Hrs**

Mechanism of Metal hydride reduction of saturated and unsaturated carbonyl compound, acid, ester and nitriles, Addition of Grignard reagent, Organozinc and Organolithium reagent to carbonyl and unsaturated carbonyl compounds, Witting reaction, Mechanism of condensation reaction involving enolates : Aldol, Knovenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Prins reaction, Hydrolysis of ester and amides.

Unit III: Elimination reactions **06 Hrs**

The E1, E2 and E1cb mechanism. Orientation of double bond, reactivity: Effect of substrate substance, attacking base, the leaving group and the medium, pyrolytic elimination.

Reference books:

1. Advanced Organic Chemistry, IV Edn : J. March
2. Advanced organic chemistry: Part A and B; F. A. Carey and R. J. Sundberg
3. A guide book to mechanism in organic chemistry: Peter Sykes.
4. Mechanism and Structure in organic Chemisry: E.S.Gould
5. Principle of Organic Synthesis: R.O.C. Norman.
6. Modern Methods of Organic Synthesis: W. Carruthers
7. Organic Chemistry: Clayden, Greeves, Warren and Wothers

M. Sc. First Year (Second Semester)

CHE/MJ/553: Physical Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To know the details about quantum mechanics (Schrodinger equation, Schrodinger equation to some model system viz particle in a one dimensional box and three dimensional box, Harmonic oscillator, Rigid rotor, the hydrogen atom, and related numericals).
2. To know the details about angular momentum, addition of angular momenta and related numericals.
3. To know about variation theorem, perturbation theory, their applications, Huckel Theory of conjugated systems and its applications.
4. To know the about classification of solids (on the basis of shapes) Crystal lattice and unit cell, Law of crystallography and related terms.
5. To know in detail about crystal structure (Principle, close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures, etc.).

Course Outcomes:

Students will be able to -

1. understand the Schrodinger equation in one-dimensional and three-dimensional boxes.
2. capable of comprehending perturbation theory.
3. understand and apply the angular momentum vector, the angular momentum operator, and the commutation rules.
4. learn the delocalization energy of conjugated and non-conjugated molecules using Huckel theory
5. understands the crystal lattice and crystallographic laws.
6. understand HCP, CCP, and BCC structures

Course Contents:

Unit I: Introduction to Quantum Mechanics **10 Hrs**

The Schrodinger equation, Discussion of solution of the Schrodinger equation to some model system viz particle in a one dimensional box and three dimensional box , Harmonic oscillator, Rigid rotor, the hydrogen atom, Numericals.Theory of Angular Momentum: Angular momentum vector, Angular momentum operator, Commutation rules and their physical signification, Ladder operator, Orbital and Spin angular momentum, Addition of angular momenta: Russell–Saunder coupling scheme and term symbols, Numericals.

Unit II: Approximate Methodsand Molecular Orbital theory **10Hrs**

The variation Theorem, Linear variation principle, Perturbation theory (First order and non–degenerate), Applications of variation method to hydrogen atom and perturbation theory to Helium

atom.(Assignment: application to Variation method to Helium atom).Huckel Theory of conjugated systems, Application to ethylene, butadiene, cyclopropenyl radical and cyclobutadiene, Numericals

Unit II: Crystallography **10 Hrs**

Classification of solids on the basis of shapes, Crystal lattice and unit cell, Law of crystallography, Crystal symmetry, Lattice planes and their designation.Principle of crystal structures: Close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures, packing in ionic solids, ionic radius, radius ratio rule (3,4,6,8 co–ordinate structures), octahedral and tetrahedral voids, isomorphism and polymorphism, Numericals.

Reference Books

1. Quantum Chemistry, Ira N. Levine.
2. Quantum Chemistry, R.K.Prasad.
3. Quantum Chemistry, B.K.Sen.
4. Principle of Physical Chemistry, Puri, Sharma, Pathania.
5. Advanced Physical Chemistry, Gurdeep Raj.
6. Solid State Chemistry, D.K.Chakraborti.
7. Solid State Chemistry and its applications, A. R. West.
8. Principle of Solid State, H.V.Keer.

M. Sc. First Year (Second Semester)

CHE/DSE/557: AnalyticalTechnology

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To know about in detail about biomass (sources, classification, characteristics, composition, properties and so on).
2. To know about agriculture waste, its sources, preparation of activated carbon, application of activated carbon.
3. To know about the classification of textile colorants.
4. To know about the biodiesel (production, transesterification reaction, types of esterification, etc.).

Course Outcome:

Students will be able to -

1. demonstrate/describe methods to convert agriculture waste into useful materials.
2. describe the fundamentals of biomass, types, sources and their value added products.
3. explain the process of conversion of agriculture waste biomass.
4. explain the process of conversion of agriculture waste biomass into activated carbon and their various application.
5. describe the production chemicals form agriculture waste.
6. describe the production process of biodiesel.

Course Contents:

Unit-I: Sources of Biomass **10 Hrs.**

Biomass, classification of biomass, characteristics of biomass, composition of biomass, Properties of Biomass, Classification of Conversion Technologies. Waste agricultural biomass, Types and composition, moisture content, energy content.

Unit-II: Activated carbon from agriculture waste **10Hrs**

Sources of agriculture waste, Preparation of activated carbon, process, types of charcoal Kiln, factors influencing charcoal yield, surface area, BET Analysis, pore size, characterization and application of activated carbons, Gas-Phase applications, liquid-Phase applications, Treatment of textile effluents, textile dyes, classification of textile colorants.

Unit-III: Biodiesel from agriculture waste **10 Hrs.**

Production process, transesterification reaction, types of esterification, catalysts for biodiesel Production, catalytic transesterification, acid catalyzed transesterification.

Reference Books:

1. Technologies for converting waste agricultural biomass to energy- UNEP, Division of Technology, Industry and Economics International Environmental Technology Centre, Osaka

2. Biodiesel Production Technology – J. Van Gerpen, B.Shanks, and R. Pruszko,D. Clements ,G. Knothe, K. Shaine Tyson

3. Biomass Basics: Principles, Energy, and Sustainability– Jay Cheng, Jaya Shankar Tumuluru, and Shahab Sokhansanj.

4. Biomass Conversion: The Interface of Biotechnology, Chemistry, and Materials Science– ChinnappanBaskar, Shang-Tian Yang, and Hesham El-Ensashy.

5. Handbook of Solid Waste Management and Waste Minimization Technologies– Nicholas P. Cheremisinoff.

6. Activated Carbon for Water and Wastewater Treatment: Integration of Adsorption and Biological Treatment– FerhanCecen and OzgurAktas.

7. Biodiesel: Production, Properties, and Feedstocks– Colin Ratledge and Thomas A. Cohen.

8. Biodiesel: A Realistic Fuel Alternative for Diesel Engines– AyhanDemirbas.

M. Sc. First Year (Second Semester)

CHE/DSE/558: Bio-organic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To provide details about carbohydrates (classification, confirmation of monosaccharides, derivatives of monosaccharides, diasaccharides, polysaccharides, etc.)
2. To know about structure of polysaccharides (Cellulose, Chitin, Starch, Glycogen), Carbohydrate metabolism, etc.
3. To know about lipids, it's introduction, structure function, properties of lipid aggregates etc.
4. To know in details about amino acids, peptides and proteins: hydrolysis of proteins, amino acid sequencing, secondary structure of protein, triple helix structure of collagen, etc.
5. To provide the information about nucleic acids (Purine and pyrimidine bases, base pairing, structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix DNA and forces responsible
6. To know about chemical and enzymatic hydrolysis of nucleic acids.
7. To know details of replication of DNA,
8. To know about the chemical synthesis of mono and dinucleosides.

Course Outcome:

Students will be able to –

1. know about carbohydrates, monosaccharides, different derivatives of monosaccharides.
2. understand detail structural information of cellulose, chitin, starch, glycogen, glucosaminogycans etc.
3. learn the role of sugars in biological recognition.
4. learn carbohydrate metabolism.
5. learn about lipids and their functions.
6. detailed information about amino acids, peptides, proteins.
7. get information about nucleic acid, their components, hydrolysis of nucleic acid and synthesis of mono and dinucleosides.

Course Contents:

Unit I: Carbohydrates **10 Hrs**

Conformation of monosaccharides; structures and function of important derivatives of monosaccharides like Glycosides, Deoxy sugars, Myoinositol, amino sugars, N-aceylmuranic acid and

sialic acid, disaccharides and polysaccharides. Structural polysaccharides: Cellulose and Chitin.Storage polysaccharides: Starch and Glycogen.Structure and biological function of Glucosaminogycans or mucopolusaccharides.Carbohydrates of glycoproteins and glycolinides.Role of sugars in biological recognition. Blood group substances, Ascorbic acid. Carbohydrate metabolism: Kreb's cycle, Glycolysis, Glyvogenolusis, Gluconeogenesis and Pentose phosphate pathways.

Unit II: **10 Hrs**

a) Lipids: Fatty acids, essential fatty acids, structures and function of triglycerides, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins and function, role in antherosclerosis.Properties of lipid aggregates-Micelles, Bilayers, liposomes and their possible biological functions. Biological membranes, Fluid mosaic model membrane structure. Lipid metabolism: Beta oxidation of fatty acids.

b) Amino acids, Peptides and Proteins: Chemical and enzymatic hydrolysis of prteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structure a helix, beta-sheets, super secondary structure, triple helix structure of collagen.

Unit-III: Nucleic Acids **10 Hrs**

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible or Holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an Overview of replication of DNA, Transcription, translation and genetic code. Chemical synthesis of mono and dinucleosides.

Reference Books:

1. Bioorganic chemistry By Hermann Dugas.
2. Biotransformation in organic chemistry By K. Faber.
3. Bioorganic, Bioinorganic and Supramolecular chemistry By P. S. Kalsi and J. P. Kalsi.
4. Organic Chemistry IV EdnG.Marc Loudon.

M. Sc. First Year (Second Semester)

CHE/DSE/559: Organic Chemistry

02 Hrs/Week | Credits: 02 | Marks 50

Course Objectives:

1. To learn in detail about oxidation and reduction reactions for organic compounds using different reagents.
2. To learn in detail about to predict products by using different reagents.
3. To learn to suggest the suitable reagent for oxidative or reductive organic transformation.

Course Outcome:

Students will be able to –

1. understand about oxidation reactions in organic chemistry using different reagents.
2. know about oxidative cleavage of carbon-carbon double bonds using different reagents.
3. know about catalytic reduction, reduction using hydride ion transfer reagents and so on.
4. predict the product by the action of different oxidizing and reducing agents.
5. suggest a reagent for particular oxidation or reduction of organic compounds.

Course Contents:

Unit I:Oxidation reactions-I **10 Hours**

Oxidation of alcohol to aldehyde, ketone or acid: Jones reagent, Swern oxidation, Collins reagents, Fetizones reagents, PCC, PDC, PFC, IBX, Activation MnO_2, Chromyl chloride (Etard reaction), TEMPO, CAN, NMO, Moffatt oxidation.

Unit II:Oxidation reactions-II **05 Hours**

Oxidative cleavage of carbon-carbon double bonds: $KMnO_4$, Ozonolysis; (c) Oxidations using SeO_2, PhSeBr.

Unit III:Reduction reactions **15 Hours**

(a) Catalytic Hydrogenation; (b) Reduction of nitriles, oximes and nitro compounds; (c) Reduction of acids and esters; (d) Reduction with metal hydride- Sodium cyanoborohydride, Diborane, L- and K-Selectrides, $LiBH_4$, DIBAL-H; Birch reduction and related reactions, (h) Lucje reagent, Wolf-Kishner reduction, Clemmenson reduction, Wilkinson catalyst, TBTH

Reference books:

1. Advanced organic chemistry: F. A. Carey and R. J. Sundberg (Part A and B)
2. Principle of Organic Synthesis: R.O.C. Norman.
3. Modern Methods of Organic Synthesis: W. Carruthers
4. Organic Chemistry: Clayden, Greeves, Warren and Wothers

M. Sc. First Year (Second Semester)

CHE/MJ/554: Laboratory course (Inorganic Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcome:

Students will be able to-

1. conduct experiments for separation and estimation of amount of metal ions in binary metal ion mixture.
2. to carry out semi-microanalysis.

Course Contents:

This practical course involves:

Part A: Separation and estimation of metal ions

Part B: Semi micro analysis

M. Sc. First Year (Second Semester)

CHE/MJ/555: Laboratory course (Organic Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcome:

1. Able to perform preparation of organic compound by two step synthesis.
2. Able to check the purity of synthesized compounds (using TLC).
3. Able to check the melting point of synthesized compounds.

Course Contents:

Two step preparation of organic compounds.

M. Sc. First Year (Second Semester)

CHE/MJ/556: Laboratory course (Physical Chemistry)

04 Hrs/Week | Credits: 02 | Marks 50

Course Outcomes:

1. Able to perform the experimental using conductometer, spectrophotomer, pH meter, polarometry etc.
2. To conduct the experiment using various non-instrumental techniques.
3. Able to describe the principles behind the experiment performed in the laboratory.

Course Contents:

This practical course involves instrumental as well as non-instrumental practicals.

31.07.2023