M.Sc. CHEMISTRY

TWO-YEARS FULL-TIME PROGRAMME

(Four-Semester Course)

LINGAYA'S VIDYAPEETH

choose to know

CHOICE BASED
CREDIT SYSTEM
2018-20

Vision, Mission and Core Values of the Vidyapeeth

VISION OF VIDYAPEETH

Traditionally believing that God is the Source of all Truth, Goodness and Beauty, Lingaya's Vidyapeeth, wishes to develop in students a wisdom that translates academic achievementsinto responsible citizenship, sincere professional service and a deep respect for life and beauty in God's Creation and Recreation.

MISSION OF VIDYAPEETH

- To impart knowledge and skills in the field of Engineering/ Technology, Management, Education, Science & Arts and related areas;
- To dedicate itself for improvement of social and economic status and enhancement of the quality of life for all;
- To strive for maximizing human welfare through education;
- To produce effective knowledge workers, practitioners and educators who will be guided by vision, compassion, knowledge, discipline, discovery with deep respect for human values;
- To provide an individual engineering and other professional COURSE experience for each student;
- To develop critical thinking, analytical ability and creative skills;
- To supplement the curricula, team work, leadership, communication skills, project management, social concerns and ethics and
- To establish interaction with industries for Technology, Research & Development.

In line with above vision and mission statements, Lingaya's Vidyapeeth has the following special characteristics:

- Lingaya's Vidyapeeth is an Institution for providing a student with opportunity for allround development and education with the aim of effective living as a good citizen.
- It has special strength in the field of Engineering and Technology with emphasis onpractice and problem solving skills.
- Its activities and course curriculum concentrate on design, self-COURSE and research, which are the unique features of the Vidyapeeth.
- The primarily value of knowledge and skill imparted by Lingaya's Vidyapeeth residesin its utility in creating an infrastructure for the physical welfare of the general public,in sustaining good health of individual and the community.
- Lingaya's Vidyapeeth facilitates and promotes creativity and critical thinking capabilities in its students.
- The education in Lingaya's Vidyapeeth enhances the inherent capacity of a studentwith honesty, courage and fairness.

SCHOOL OF BASIC AND APPLIED SCIENCES LINGAYAS VIDYAPEETH

VISION OF SCHOOL

To be a School committed to promote Science and research exploration and education for attracting young talented students to contribute effectively in augmenting the national poolfor scientific development who are responsible citizens and sincere professionals with the deep knowledge.

MISSION OF SCHOOL

1. To strive to maximize human welfare through the understanding the different phenomena of science with advance scientific development.
2. To develop and maintain state –of –the –art infrastructure and research facilities to enable create, apply and disseminate knowledge.
3. To create inter-disciplinary research environment and
4. To prepare students who are capable to take up their future educational and career challenges.

Vision and Mission of Department of Chemistry

School of Basic and Applied Sciences LV

VISION OF DEPARTMENT

To be a department dedicated to promoting multidisciplinary chemical science and research activities, as well as education for interesting young brilliant students, in order to efficiently contribute to augmenting the local and national pool of responsible people and genuine professionals with deep expertise.

MISSION OF DEPARTMENT

1. To encourage young minds and help them to explore their strengths in both theory and experimental work of chemical sciences
2. To prepare our graduate to understand the chemical analysis to apply in other disciplinary approach.
3. To explore applications of chemical sciences in engineering, medical sciences and engage in collaborative research in a multidisciplinary environment.
4. The Chemistry Department is dedicated to producing competitive and professional graduates in multi-area

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1. After completion of Chemistry program students will able to get exposed to strong theoretical and practical background in fundamental concepts.
PEO2: Graduates will be practitioners in their chosen field and will function in their profession with social awareness and responsibility
PEO3. Graduates will be successful in pursuing higher studies in their chosen field
PEO4. Graduates will pursue career paths in teachingor research

Mapping of PEOs with Mission Statements

PEO Statements	Department Mission 1	Department Mission 2	Department Mission3	Department Mission4
PEO1	3	2	1	1
PEO2	1	2	3	2
PEO3	2	3	2	1
PEO4	2	1	2	3

PROGRAM OUTCOMES (PO'S)

PO-1: Identify and resolve complex scientific issues in national and local level.

PO-2:Analyze and interpret data using analytical instruments to investigate chemical problems.

PO3: To solve chemical problems, choose, plan, and implement suitable experiment techniques, as well as instrumentation handling.

PO-4:Recognize and use contextual multidisciplinary information to evaluate societal, health, safety, and global problem that are important to research practices.

PO-5:Adopt scientific ideas about environmental use and long-term sustainability.

PO6: Enhance skills for future employability through activities such as seminar, communication skills, industrial visit, and internship.

PO-7: Recall the chemistry courses that are available for competitive test.

PO8: The students attain sound knowledge in the areas of organic, inorganic, physical, pharmaceutical chemistry and material for pursing higher education and research.

Mapping of Program Outcome with Program Educational Objectives

	PEO1	PEO2	PEO3	PEO4
PO1	1	2	1	2
PO2	2	1	3	2
PO3	2	1	3	1
PO4	2	1	3	1
PO5	1	1	1	3
PO6	3	3	1	1
PO7	2	3	1	1
PO8	1	2	2	3

PSO1: Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.

PSO2: Apply advanced concepts of Inorganic, Organic, physical and analytical chemistry for the benefit of human being.

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M.Sc. Chemistry Specialization in Organic Chemistry
(Two Year Programme)

M.Sc. 1st Semester

S.No.	Subject Code	Subject	L-T-P	Credits	Type of Course: CC,AECC,SEC,DSE,GE	Course focus on Employability/ entrepreneurship /Skill Development
1.	MCH-111	Organic Chemistry-I	4-1-0	5	CC	Course focus On Employability
2.	MCH-112	Physical Chemistry-I	4-1-0	5	CC	Course focus On Employability
3.	MCH-120	Inorganic Chemistry-I	4-1-0	5	CC	Course focus On Employability
4.	MCH-161	Organic Chemistry –I Lab	0-0-4	2	CC	Course focus On Employability
5.	MCH-162	Physical Chemistry-I Lab	0-0-4	2	CC	Course focus on Employability
6.	MCH-170	Inorganic Chemistry Lab-I	0-0-4	2	CC	Course focus On Employability
		Total		**21**	CC	Course focus On Employability

M.Sc. IInd Semester

S.No.	Subject Code	Subject	L-T-P	Credits	Type of Course: CC, AECC, SEC, DSE, GE	Course focus on Employability/ entrepreneurship /Skill Development
1.	MCH-114	Inorganic Chemistry-II	4-1-0	5	CC	Course focus on Employability
2.	MCH-115	Organic Chemistry-II	4-1-0	5	CC	Course focus On Employability
3.	MCH-116	Physical Chemistry-II	4-1-0	5	CC	Course focus on Employability
4.	MCH-117	Analytical Chemistry	4-1-0	5	CC	Course focus On Employability
5.	MCH-164	Inorganic Chemistry Lab-II	0-0-4	2	CC	Course focus on Employability
6.	MCH-165	Organic Chemistry Lab-II	0-0-4	2	CC	Course focus on Employability
7.	MCH-166	Physical Chemistry Lab-II	0-0-4	2	CC	Course focus on Employability
8.	MCH-167	Analytical Chemistry Lab-I	0-0-4	2	CC	Course focus on Employability
9.	MCH-168	Summer Project	0-0-4	2	CC	Course focus on Employability
		Total		**30**		

M.Sc. III[rd] Semester

S.No.	Subject Code	Subject	L-T-P	Credits	Type of Course: CC, AECC, SEC, DSE, GE	Course focus on Employability/ entrepreneurship /Skill Development
1.	MCH-212	Heterocyclic Compounds	3-1-0	4	CC	Course focus on Employability
2.	MCH-213	Physical Chemistry III	3-1-0	4	CC	Course focus on Employability
3.	MCH-219	Nuclear & Radioactive Chemistry	4-1-0	5	CC	Course focus on Employability
4.	MCH-220	Bio Inorganic & Environmental Chemistry	4-1-0	5	CC	Course focus on Employability
5.	MCH-260	Inorganic Chemistry-III Lab	0-0-4	2	CC	Course focus on Employability
6.	MCH-261	Organic Chemistry-III Lab	0-0-4	2	CC	Course focus on Employability
7.	MCH-263	Physical Chemistry-III Lab	0-0-4	2	CC	Course focus on Employability
		Total		**24**		

M.Sc. 1V[th] Semester

S.No.	Subject Code	Subject	L-T-P	Credits	Type of Course: CC, AECC, SEC, DSE, GE	Course focus on Employability/ entrepreneurship /Skill Development
1.	MCH-221	Organo Transition metal Chemistry	4-1-0	5	CC	Course focus on Employability
2.	MCH-222	Electro Analytical Chemistry	4-1-0	5	CC	Course focus on Employability
3.	MCH-223	Medical aspects of Inorganic Chemistry	4-1-0	5	CC	Course focus on Employability
4.	MCH-224	Industrial Chemistry	4-1-0	5	CC	Course focus on Employability
5.	MCH-271	Inorganic Chemistry-IV Lab	0-0-4	2	CC	Course focus on Employability
6.	MCH-272	Inorganic Chemistry-V Lab	0-0-4	2	CC	Course focus on Employability
7.	MCH-267	Dissertation/ Major Project	0-0-6	3	CC	Course focus on Employability
		Total		24		

Semester: I

(2020-2021)

INORGANIC CHEMISTRY-I: (MCH-120)

Course Objective:

1. The learners should be able to analyse the mechanism of selected catalytic organic reactions from
2. Organometallic reaction mechanisms are thoroughly discussed with emphasis on ligand substitution, oxidative addition, reductive elimination, insertion and elimination reactions.
3. The application of organometallics in catalysis is highlighted with selected important industrial processes.

Course Outcomes:

1. Identify the structure and bonding aspects of simple organometallic compounds
2. Apply different electron counting rules to predict the shape/geometry of low and high nuclearity metal carbonyl clusters Identify the different types of organometallic reactions
3. Apply the above concepts to explain different catalytic reactions.
4. To know about the bioinorganic compounds, trace elements, and essential humanrequired compounds

Unit-I Organometallic Chemistry:

Basic concept of organometallic chemistry, Metal carbonyl, Phosphine's, alkenes, alkynes & allyl complexes. Hydride, carbenes ,carbynes, metallocene, metal arenes compresses.
Fluxonality in Organometallic compound.

Unit-II Organometallic Chemistry:

Homogeneous & Heterogeneous catalysis: Oxidative all & reductive elimination, Insertion reaction, Agostic Interaction, Hydroformylation, Zeigler Natta catalyst, Wilkinson catalyst, Syntheses gas. Monasto process &waker process, catalytic.

Unit- III Inorganic Reaction mechanism:

Mechanism of substitution reaction of tetrahedral, trigonal bipyramidal, square planar & octahedral complexes. Potential energy diagram. Factors affecting reactivity of square planercomplex. Trans effect & its application to synthesis of complexes.

Unit-IV Molecular rearrangement Process:

Electron transfer reaction: outer & inner sphere complexes formation & rearrangement, Nature of bridging ligands, fission of successor complex, two electron transfers, syntheses of coordination compounds using electron transfer reaction.

Unit-V Bioinorganic Chemistry:

Basic Introduction (Porphyrin Ring, metallo porphyrin ring) , oxygen transport & oxygen storage system (Hemoglobin, myoglobin, hamocyanin, Hemerythrin), Metalloeneyme- CAE , CP, LADH , Xanthine Oxidase, Tyrosine, Cytochrome –C, Cyt-P-450, Vitamin B-12), Coenzyme-12.Electron transfer protean, Fe-Sulphur protein, cytochrome.Metal storage & metal transfer system ferritin , transferrin.

Reference Books:

1. Principle of Bioinorganic chemistry – Lippard and Berg, Univ. Science Books,1994.
2. Bio-coordination chemistry – Fenton, Oxford chemistry primer,1995.
3. Bioinorganic chemistry: Inorganic perspective in the chemistry of Life, Kaimand Schwederski,1994.
4. Inorganic chemistry – Shriver, Atkins, and Langford, 1994.
5. Bioinorganic Chemistry – Bertini, Gray, Lippard and Valentine Viva books Pvt. Ltd.1998.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	1	-	-	3	1	-	2	3	1	2

PRACTICAL INORGANIC CHEMISTRY-I: (MCH-170)

Course Objectives:

1. Students will get acquainted with the unifying techniques of synthesis and characterization of inorganiccompounds.

Course Outcomes:

1. The students have the detailed knowledge of synthesis of different inorganic compound
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of characterizing Organic compounds.

Practical Description

1. Preparation of Hexaamminecobalt(lII)chloride

2. Synthesis of CHLOROPENTAAMMINECOBALT(III) CHLORIDE

3. Preparation of ChloropentaamminecobaIt (III) chloride

4. To determine the molar conductance of [Co(NH3)5]Cl3, and [Co(NH3)5Cl]Cl2 by measuring conductivity of thesecompounds.

5. To determine the number of chloride ions in the [Co(NH3)5]Cl3 and[Co(NH3)5Cl]Cl2.

6. Synthesis of trans-dichlorobis (ethylenediamine) cobalt (III)Chloride

7. Synthesis of cis-Dichlorobis(ethylenediamine)cobalt (III)Chloride

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2

ORGANIC CHEMISTRY-I: (MCH-111)

Course Objectives:

1. Differentiate chiral and achiral molecules.
2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso-compounds.
3. Identify the stereocenters in a molecule and assign the configuration as R or S.
4. Know the relationship between enantiomers and their specific rotations.

Course Outcomes:

1. Draw all the stereoisomers of organic compounds, and recognize diastereomers, enantiomers, meso compounds and centres of symmetry
2. Calculate optical purity and enantiomeric excess, Discuss the relative stability of conformational isomers of cyclohexanes and related compounds.
3. Recognise and discuss the stereoisomers of chiral compounds that do not contain a stereogenic carbon centre and assign the configuration of the stereoisomers.
4. To learn the involvement of reactive intermediates and understand their structure and reactivity through various organic reactions.

Unit-1: Stereochemistry-I:

Molecular Symmetry and Chirality: Symmetry operations and elements, point groups and symmetry number, Stereoisomerism: classification, racemisation, molecules with one, two ormore chiral centres, DL, RS and EZ nomenclature. Planar and axial chirality. Stereochemistryof allenes, spiranes, alkylidine cycloalkanes, adamantanes, catenanes, biphenyls(atropisomerism), bridged biphenyls andcyclophanes.

Unit-2 Stereochemistry-II:

Topicity and prostereoisomerism: topicity of ligands and faces and their nomenclature, stereogenicity, pseudoasymmetry, stereogenic and prochiralcentres.Simple chemicalcorrelation of configurations with examples, quasiracematesCyclostereoisomerism: configuration, conformation, stability of cyloheanes(mono, di and tri- substituted), cyclohexenes, cyclohexanones, halocyclohexanones. Asymmetry induction: Cram's, prelog's and Horeau's rules; Dynamic stereochemistry (acyclic and cyclic) Curtin-HammettPrinciple, circular dichromism and cotton effect.

Unit-3 Study of reactive intermediates-I:

Linear free energy relationships and their applications (Hammett equation and modifications) Carbocations: Classical and non-classical, NGP (Neighbouring group participation), ion- pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridged-head carbocations.

Unit-4 Carbanions:

Generation, structure and stability, ambident ions and their general reactions; HSAB principle and its application Radicals: Generation, structure and stability and reactions, radical cations and anions.

Unit-5 Carbenes:

Formation and structure, reactions invovingcarbenes and carbenoids. Nitrenes: Formation, structure, reactions of nitrenes Nucleophilic aromatic substitution: Benzynes. SNAr and SRN1 mechanisms; Ipso effect.

Reference Books:

1. F. A. Carey and R. A. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th edition, Springer, New York,2007.

2. W. Carruthers and I. Coldham, Modern methods of Organic Synthesis, First South Asian Edition 2005, Cambridge UniversityPress.

3. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley,2007.

4. I. Fleming, Frontier Orbitals and Organic Chemical Reactions, Wiley, London,1976.

5. S. Sankararaman, Pericyclic Reactions- A text Book, Wiley VCH,2005.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	1	1
CO2	1	2	1	-	-	2	3	2	1	2
CO3	1	2	-	-	-	2	3	3	2	2
CO4	2	2	2	-	-	2	3	3	2	2

PRACTICAL ORGANIC CHEMISTRY-I: (MCH-161)

Course Objectives:

1. Students will get acquainted with the unifying principles of spectroscopy.
2. Students will learn atomic absorption spectroscopy, its basic principle, instrumentation and applications.

Course Outcomes:

1. Study detailed knowledge of analytical ore analysis of different element, quantitative organic compound analysis and also have the spectroscopic determination method.
2. Learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Capable of synthesizing Organic compounds.

PRACTICAL DESCRIPTION

I) Qualitative analysis of mono and bifunctional compounds.

II) Small Scale organic synthesis using one of the followingreactions:

i) Acylationreaction

ii) Bromination and bromineaddition

iii) Diazotizationreactions

iv) Couplingreactions.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	1	1
CO2	1	2	1	-	-	2	3	2	1	2
CO3	1	2	-	-	-	2	3	3	2	2

PHYSICAL CHEMISTRY-I: (MCH-112)

Course Objectives:

1. Recognize the most significant and elementary solutions of Schrodinger equation in molecular quantum mechanics.

2. Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformations of coordinate matrix, representation of operators, eigenvalue problem.

Course Outcomes:

1. Know about the elementary principles of quantum mechanics with particle in 1D box.
2. You understand the electronic structure of atoms and their periodicity.
3. Know about the electronic structure of molecules and chemical bonding.
4. You have a basic understanding of chemical structure determination.

Unit-I Quantum chemistry:

Postulates of quantum mechanics, Linear and Hermition operator, Commutation of operators and uncertainty principles.Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformations of coordinate matrix, representation of operators, eigenvalue problem, orthonormal sets Fourier and Laplace transforms.

Unit-II-Some exactly soluble problems:

Particle in a box and ring. Concept of degeneracy and Jahn-Teller distortion. Simple harmonic oscillator problem and its solution using series solutions or factorization method. Calculation of various average values using ladder operators and recursion relations of Hermitepolynomials. Angular momentum operators. Eigenvalues and eigenfunctions. Ladder operators. Rigid rotator and hydrogen atom: Complete solution. Radial distributions. Virial theorem.

Unit-III-HMO method and its applications:

π-Electron approximation, Huckel molecular orbital theory of conjugated systems, calculation of properties- delocalization energy, electron density, bond order, alternant and nonalternant hydrocarbons, pairingtheorem.

Unit-IV-Approximate methods-I:

First order time-independent perturbation theory for non degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator, approximate functions for particle in a box and hydrogen atom).

Unit-V-Approximate methods-II:

Ground and excited state of helium atom.Pauli's exclusion principle. Many-electron atoms. Concept of spin and determinantal wave functions.

Reference Books:

1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, Oxford University Press, Oxford, 2004. (Must for Quantum Chemistrybasics)
2. Quantum Chemistry by RKPrasad
3. Quantum Chemistry by Era Levine (For Advance Quantum Chemistry)
4. Introduction to Quantum Chemistry by Clifford Dykstra
5. Elementary Quantum Chemistry by Frank Pilar, Mineola, N.Y. Dover,2001
6. Quantum chemistry and spectroscopy by Thomas Engel, Pearson/Benjamin Cummings, 2006
7. Quantum chemistry: fundamentals to applications by Tamás Veszprémi, Kluwer Academic/Plenum,1999.
8. J. P. Lowe and K. Petersen, Quantum Chemistry, Elsevier Academic Press, MA,USA, 2006

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	3	-	1	-	2	1	1	1
CO2	3	2	2	-	1	-	3	-	1	2
CO3	1	2	2	-	-	-	3	2	-	2
CO4	-	2	2		-	-	2	2	2	2

PRACTICAL PHYSICAL CHEMISTRY-I: (MCH-162)

Course Objectives

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

Course Outcomes:

1. The students have the detailed knowledge of analytical ore analysis of different element,
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

PRACTICAL DESCRIPTION

Chemical kinetics:

1. Determine the specific rate constant for the acid catalysed hydrolysis of methyl acetate bythe initial rate method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
2. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.

Conductometry:

1. Determine the cell constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (aceticacid).
2. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration ofions
3. Determine the equivalent conductance, degree of dissociation and dissociation constant (Ka) of aceticacid.
4. Study the conductometric titration of acetic acid vs. sodiumhydroxide

Potentiometry:

1. Prepare and test Calomel electrode.
2. Titrate hydrochloric acid and sodium hydroxide potentiometrically.
3. Determine the dissociation constant of acetic acid potentiometrically.
4. Titrate oxalic acid and sodium hydroxide potentiometrically.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	1	1
CO2	1	2	1	-	-	2	3	2	1	2
CO3	1	2	2	-	-	2	3	3	2	3

SEMESTER II

INORGANIC CHEMISTRY-II: (MCH-114)

Course Objectives:

1. Apply the concept of linear combination of atomic orbitals to hybridization and directedbonding in polyatomic molecules.
2. Solve the real-world problem using advanced numerical programs through Gaussianorbitals.
3. Show that molecular symmetry operations form a group and can be characterized by fundamental representations of groups known as irreducible

Course Outcomes:

1. Analyze point group theory to the study of electrical, optical and magnetic properties andselection rules for absorption.
2. Apply time independent perturbation theory to complex problems ofmolecular energy levels in the presence of external electric and magnetic fields.
3. Determine the symmetry operations of any small and medium-sized molecule.
4. Explain various symmetry elements and operations of different molecules

Course A: Group Theory and its Applications:

Symmetry elements and symmetry operations, Groups, subgroups, classes and its characteristics, products, classes and application of symmetry operations.

Equivalent atoms, equivalent symmetry elements, relation between symmetry elements andoperations.

Point group classification along with the Optical activity and Dipole moment based applications.

Reducible and irreducible representations, position vector, base vector for representation, character table, Wave functions for irreducible representations (p- and d- block only), Correlation diagram, Russell-Saunders coupling, vibronic coupling, non-cetrosymmetric complexes.

Infrared and Raman spectroscopy, SALCs, Hybridization and its applications, LCAO.

Course B: d- and f- block elements:

Russel Saunders state, Term and symbols, CFT and splitting in T_d, D_{4h}, C_{4v} systems, Determination of D_q and Racah parameters, Orgel and Tanabe sugano diagrams, electronic absorption spectra (complex ions), Magnetic properties (Transition metal complexes) Structure and bonding in complexes containing π-acceptor ligands. Spectrochemical and nephelauxetic series.

Reference Books:

1. D. M. P. Mingos and D. J. Wales; Introduction to Cluster Chemistry, Prentice Hall,1990.
2. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, Second Edition, Butterworth- Heinemann,1997.
3. T. P. Fehlner, J. F. Halet and J-Y. Saillard; Molecular Clusters: A Bridge to solid-state Chemistry, Cambridge University press,2007.
4. B. D. Gupta and A. J. Elias; Basic Organometallic Chemistry: Concepts, Synthesis, and Applications, Universities Press (India),2010.

5. D. M. P. Mingos, Essential Trends in Inorganic Chemistry, Oxford, University Press,1998.
6. C. E. Housecroft, Metal-Metal Bonded Carbonyl Dimers and Clusters, Oxford Chemistry Primers (44), Oxford, University Press,1996.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	-	3	-	-	-	-	2	3	1	1
CO2	-	2	1	-	1	-	3	2	1	2
CO3	-	3	-	-	1	-	3	3	3	2
CO4	-	3	-	-	1	-	3	3	3	2

PRACTICAL INORGANIC CHEMISTRY-II: (MCH-164)

Course Objectives

1. The objective of this course is to get the knowledge of analysis of various mixture of inorganic salts.

Course Outcomes:

1. The students have the detailed knowledge of qualitative analysis of mixture of inorganicsalts,
2. Students will learn about the titration, volumetric analysis and chromatography.
3. Anayse the various inorganic mixtures.

PRACTICAL DESCRIPTION

1. Qualitative analysis of mixtures of inorganic salts including rare earthsalts.
2. Quantitative analysis of mixtures of metal ions by complexometric titrations using masking and de masking agents.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	1	1
CO2	1	2	1	1	1	2	3	2	1	1
CO3	1	2	1	1	1	1	2	2	1	1

ORGANIC CHEMISTRY-II: (MCH-115)

Course Objectives:

1. The course aims to improve a student's understanding of fundamental organic reactions and to add further transformations and principles to their knowledge base.
2. They will encounter anion, radical, pericyclic and organometallic mediated processes, gaining new insights into the factors governing the mechanistic, stereo-chemical and region-chemical course of such reactions.
3. Throughout the course the usefulness of the chemistry discussed with be highlighted through applications.

Course Outcomes:

1. Delineate the mechanistic and stereochemical course of some sophisticated cascade.
2. Can learn different reducing and other reagents with stereoselectivity
3. Can describe different approaches to the formation of carbanions, discuss their structures, stabilities/reactivities and applications in synthesis
4. Radical reactions and appreciate their value in target oriented synthesis.

Course A: Organic Synthetic methodology:

Reduction Chemistry: Stereochemistry and selectivity of catalytic hydrogenation along with the mechanism, Applications of Lithium aluminium hydride, Sodium borohydride, sodium cyanohydride, alkoxy substituted LAH, DIBAL, diborane, diisoamylborane, thexyborane, 9-BBN as reducing agents, Homogeneous hydrogenation mechanism using Ru and Rh metal complexes along with its applications.

Oxidation Chemistry: Sharpless epoxidation, Applications of DDQ, SeO_2, $Tl(NO_3)_3$. Coupling Reactions with Pd(0) and Pd(II): Stille, Suzuki and Sonogashira coupling, Heckreaction and Negishicoupling.

Reductions: stereochemistry, stereoselection and mechanism of catalytic hydrogenation andmetal-liquid ammonia reactions.

Course B: Spectroscopy:

PMR: Effect of external magnetic field on the spinning nucleus, precessional motion and frequency. Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effects. Integrals of protons, spin-spin coupling, magnitude of coupling constant. Chemical and magnetic equivalence, proton exchange, factors affecting the coupling-first and non-first order spectra. Simplification of complex spectra and NOE experiments. Applications of PMR in structural elucidation of simple and complex compounds.

CMR: Resolution and multiplicity of ^{13}C NMR. ^{1}H-decoupling, noise decoupling, broad band decoupling, deuterium, fluorine and phosphorus coupling. NOE signal enhancement, off-resonance, proton decoupling, structure applications of CMR, DEPT and INEPT experiments. Introduction to 2D-NMR, COSY, HMQC and HETCORspectra.

ESR: Hyperfine splitting, g-values, ESR spectra of molecules.

MASS: Unit mass and molecular ions, Singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, Recognition of M^+ ion peak, Ionization methods (CI, EI and FAB), general fragmentation rules, fragmentation of various classes of organic

molecules, McLafferty rearrangement, ESI, APCI and MALDIetc.

Reference Books:

1. P. W. Atkins, Molecular Quantum Mechanics, 2nd edition, Oxford University Press,1983.

2. P. F. Bernath, Spectra of Atoms and Molecules, 2nd Edition, Oxford University Press, 2005.

3. E. B. Wilson, Jr., J. C. Decius and P. C. Cross, Molecular Vibrations: The Theoryof Infrared and Raman Spectra, Dover Publications, 1980.

4. W. Demtroder, Molecular Physics, Wiley-VCH,2005.

5. J. A. Weil and J. R. Bolton, (Eds), Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, Second Edition, Wiley Interscience, John Wiley & Sons, Inc., 2007.

6. A. E. Derome, Modern NMR Techniques for Chemistry Research, Pregamon,1987.

7. C. P. Slichter, Principles of Magnetic Resonance, Third Edition, Springer-Verlag,1990.

8. T. C. Farrar and E. D. Becker, Pulse and Fourier Transform NMR, Academic Press,New York,1971.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	1	1	1	-	1	1	-	1	2	3

PRACTICAL ORGANIC CHEMISTRY-II: (MCH-165)

Course Objectives

1. The objective of this course is to understand the basic principle of organic synthesis.

Course Outcomes:

1. Study about the different functional groups.
2. Learn the basic principle of qualitative analysis.
3. Synthesize the various organic compounds.

PRACTICAL DESCRIPTION

I) Qualitative analysis of mono and bifunctional compounds.

II) Small Scale organic synthesis using one of the followingreactions:

i) Oxidation andreduction

ii) Condensations

iii) Diazotizationreactions

iv) Acylationreaction

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	2	2	1	-	1	-	3	-	1	1
CO3	2	1	1	-	1	-	2	1	1	1

PHYSICAL CHEMISTRY-II: (MCH-116)

Course Objectives:

1. The learners should be able to apply principles and laws of equilibrium thermodynamics to multicomponent systems.
2. Can use spectroscopic data to calculate thermodynamic properties of ideal gases, real gases, solids and metals using the principles and techniques of statistical thermodynamics.
3. The learners can to apply elementary laws of chemical kinetics and analyze reaction mechanisms and changes in transport properties of chemical reactions and collision processes.

Course Outcomes:

1. Understand and calculate change in thermodynamic properties, equilibrium constants,partial molar quantities, chemical potential.
2. Apply phase rule and, draw phase diagrams for one, and two component systems, identifythe dependency of temperature and pressure on phase transitions.
3. Calculate the absolute value of thermodynamic quantities (U, H, S, A, G) and equilibriumconstant (K) from spectroscopic data.
4. Predict heat capacity (Cv, Cp) of an ideal gas of linear and non-linear molecules from thenumber of degrees of freedom, rotational and vibrational wave numbers.

Course A:

Statistical mechanics, thermodynamics, kinetics and macromolecules statistical mechanicsand thermodynamics.

Fundamentals:

Concept of distribution. Thermodynamic probability and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in Chemistry. Types of statistics: Maxwell-Boltzmann. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers. Stirling's approximation, molecular partition function and its importance. Assembly partitionfunction.

Application to ideal gases:

The molecular partition function and its factorization. Evaluation of translational, rotational and vibrational partition function of monatomic, diatomic and polyatomic gases. The electronic and nuclear partition functions. Calculation of thermodynamic properties of ideal gases in terms of partition function. Statistical definition of entropy. Third law of Thermodynamics, Residual entropy.

Macromolecules:

Concepts of number average and mass molecular weights. Methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods). Distribution of chain lengths. Average end-to-end distance.

Course B: Kinetics:

Theories of reaction rates: Collision theory. Potential energy surfaces (basic idea). Transition

state theory (both thermodynamic and statistical mechanics formulations). Theory of unimolecular reactions, Lindemann mechanism, Hinshelwood treatment, RRKM model(qualitative treatment).

Solution kinetics:

Factors affecting reaction rates in solution. Effect of solvent and ionic strength (primary salt effect) on the rate constant. Secondary salt effects.

Electrochemistry:

Solutions: Activity coefficients and ion-ion interactions. Physical significance of activity coefficients, mean activity coefficient of an electrolyte and its determination. Derivation ofDebye-Huckel theory of activity coefficients (both point ion size and finite ion size models).Excess functions.

Reference Books:

1. P. Atkins and J. Paula, Physical Chemistry, 10th Edition, Oxford University Press,Oxford 2014.
2. D. A. McQuarrie and J. D. Simon, Molecular Thermodynamics, University ScienceBooks, California2004

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	2	2	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	2	2	2	2	3	1	2	2	3	2

PRACTICAL PHYSICAL CHEMISTRY-II: (MCH-166)

Course Objectives

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

Practical Description

Chemical kinetics:

1. Compare the strength of hydrochloric acid and sulphuric acid studying the rate of hydrolysis of methylacetate.
2. Study the kinetics of iodination of acetone in the presence of acid by the initial rate method.

Conductometry:

1. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in commercial sample of sodaash.
2. Study the conductometric titration of acetic acid vs. ammoniumhydroxide
3. Study the conductometric titration of sodium acetate vs.HCl

Potentiometry:

1. Prepare and test Calomelelectrode.
2. Titrate a mixture of strong and weak acids (Hydrochloric and aceticacids)
3. Titrate a mixture of weak acid (acetic acid) and dibasic acid (oxalicacid)
4. Titrate a mixture of strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodiumhydroxide.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	2	2	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2

ANALYTICAL CHEMISTRY-I (MCH-117)

Course Objectives:

1. The learners should be able to apply the conceptual understanding of the principles and implementation modes of several analytical instruments to chemical systems.
2. To know that mixtures are composed of constituents which are not combined
3. To apply methods of distillation, sublimation, chromatography, filtration (including buchner filtration), evaporation, decantation, using magnetism, sieving and skimming toseparate mixtures.
4. To understand the terms filtrate, residue, filtration, sediment, decant, distil, distillate, chromatogram and solventfront.

Course Outcomes:

1. Solve the problems based on various analytical concepts
2. Design experiments with improved sample preparation.
3. Understand new measurement procedures and tools, Quantify analytes with proper data handling and analysis.
4. Describe qualitatively and model quantitatively the operation and design of economically viable processes

Course A: Introduction to analytical chemistry:

Scope & objectives, Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bispartite classification), Data organization, Analytical validations, Limit of detection and limit of quantitation, The tools of analytical chemistry and good lab practices.

Errors in Chemical Analysis and Statistical Evaluation of Data:

Systematic and random errors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, Useful statistical test: test of significance, the F test, the student 't' test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least-square method for linear plots), statistics of sampling and detectionlimitevaluation.

Course B: Separation Methods:

(a) Multiple liquid-liquidextraction:

Countercurrent extraction, Craig's tube and Craig's apparatus, distribution of single solute, Gaussian treatment in describing distribution pattern of solute fraction in r^{th} tube after n- transfers.

(b) FractionalDistillation:

Temperature composition diagram of a binary system, concept of theoretical plates, HETP, Bubble-cap distillation column and derivation of Fenske equation.

(c) Chromatography:

General description of Chromatography, Principle of chromatography, Classifications of

chromatography, Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography.

Gas Chromatography:

Introduction, principle of gas chromatography, instruments for gas-liquid chromatography, detectors:- thermal conductivity detector, flame ionization detector, electron capture detector and others, gas chromatographic columns and stationary phases, factors affecting the efficiency of the column, Van-Deemter equation, resolution, retention time and other basic parameters. Interpretation of gas chromatograms. Qualitative analysis, Kovats retention index(I), Quantitative analysis, measurement of peak area, response factor; Temperature programming in gas chromatography, Applications of gas chromatography.

High Performance Liquid Chromatography (HPLC):

Basic difference between HPLC and conventional liquid chromatography with respect to sample applications, packing materials and equipments, detectors. Advantages and applications.

Reference Books:

1. Wilson, Ian D.; Adlard, Edward R.; Cooke, Michael; et al., eds. (2000).

2. Encyclopediaof separation science. San Diego: Academic Press. ISBN978-0-12-226770-3

3. D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 6th Edition, Brooks/Cole Cengage Course, Belmont, CA,2007

4. J. Wang, Analytical Electrochemistry, 3rd Edition, Wiley – VCH,2006

5. P.T. Kissinger and W. R. Heineman, Laboratory Techniques in Electroanalytical Chemistry, 2nd Edition, Marcel Dekker Inc.,1996.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	-	3	3	-	-	1	2	3	2	2

PRACTICAL ANALYTICAL CHEMISTRY-I (MCH-167)

Course Objectives:

1. Students will get acquainted with the analytical techniques of and characterization of inorganic compounds.

Course Outcomes:

1. The students have the detailed knowledge of synthesis of different inorganic compound
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of characterizing Inorganic compounds.

Practical Description

1. Determination of accuracy, precision, mean deviation, standard deviation, coefficient of variation, normal error curve and least square fitting of certain set of experimental data in an analysis.
2. Composition of two sets of results in terms of significance (Precision and accuracy) by (I) student's t-test, (ii)F-test.
3. Determination of Fe (III) by chloride extraction inether.
4. Determination of Fe (III) as the 8-hydroxy quinolate (oxinate) by extraction inchloroform.
5. Separation of Cd^{+2} and Zn^{+2} quantitativelythrough an anion exchanger.
6. Separation of nickel, manganese, cobalt and zinc and determination of $R_f$values by thin layer or paper striptechniques.
7. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and backtitration).

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	2	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2

SEMESTER-III

HETEROCYCLIC COMPOUNDS (MCH-212)

Course Objectives:

1. Rationalization of the reactivity of heteroaromatic compounds.
2. Knowledge of methods to prepare some heterocyclic compounds with Five and Six members, fused rings and heterocyclic compounds two or more heteroatom's.
3. Improving the students' knowledge of the methods of preparation followed by the Reaction Mechanism.
4. Application for the Synthesis and Design of some biologically active compounds derivedfrom heterocyclic compounds.

Course Outcomes:

1. Be familiar with the structures of important classes of heterocyclic aromatic organic compounds.
2. Classify simple heterocyclic aromatic compounds as electron deficient or electronrich and explain their reactivity based on these properties.
3. Know how selected organometallic reactions can be applied in heterocyclic chemistry.
4. Explain on a mechanistic level, reactions and synthesis of important electrondeficient nitrogen containing heterocycles.

Unit-I Introduction toheterocycles:

Nomenclature, spectral characteristics, reactivity and aromaticity

Unit-II Synthesis and reactions of three and four membered heterocycles:

Aziridine, azirine, azetidine, oxiranes, thiarines, oxetanes and thietanes.

Unit-III Five-membered rings with two heteroatoms:

pyrazole, imidazole, oxazole, thiazole, isothiazole, benzofused analogs.

Unit-IV Chemistry of bicyclic compounds containing one or more heteroatoms.

Bezofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolones, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines,pteridines.

Unit-V Seven and large membered heterocycles:

azepines, oxepines, thiepines. Chemistry of porphyrins and spiro heterocycles.

Recommended Texts:

1. "Heterocyclic Chemistry" by J A Joule and KMills
2. "Name Reactions in Heterocyclic Chemistry" by Jie JackLi
3. "Advances in Heterocyclic Chemistry" by Alan RKatritzky
4. "Synthesis of some heterocyclic compounds by advanced techniques" by Sandip Sadaphal

and MurlidharShingare
5. “Heterocyclic Chemistry” by Raj KBansal
6. “Heterocyclic Chemistry” byGILCHRIST
7. “HETEROCYCLIC CHEMISTRY” by Ahluwalia VK
8. “Heterocyclic Chemistry” by John A Joule and KeithMills

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	1	-	-	2	1	1	1	2	2	2

Organic Chemistry –III Practical: (MCH-261)

Course Objectives:

1. Students will get acquainted with the unifying principles of spectroscopy.
2. Students will learn atomic absorption spectroscopy, its basic principle, instrumentation and applications.

Course Outcomes:

1. The students have the detailed knowledge of analytical ore analysis of different element, quantitativeorganic compound analysis and also have the spectroscopic determination method.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of synthesizing Organic compounds.

PRACTICAL DESCRIPTION

1. QualitativeAnalysis:

   a) Less common metal ions- Tl, Se, Te, Mo, W, Ti, Zr, U&V

   b) Insolubles- Oxides(WO_3, Silica, Alumina); Sulphates(Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate);

   Halides(Calcium fluoride and silver halides)

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

2. QuantitativeAnalysis:

   a) Separation and determination of two metal ions such as Ag- Cu, Cu- Ni, Cu- Zn, Ni- Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	1	-	-	2	2	1	1

PHYSICAL CHEMISTRY-III (MCH-213)

Course objectives:

1. Student is able to determine the (most important) quantum states of a given material (atoms, small molecules).
2. Student is able to determine which quantum state(s) belong(s) to the ground state.
3. Student can rationalize which transitions between quantum states as a result of an absorption, emission or scattering event have a more than zero probability of taking place.

Course Outcomes:

1. Discuss the basics of Spetroscopy.
2. Study the principles of NMR, UV, Raman and Mass spectroscopy.
3. Able to characterize and interpret various organic compounds through IR NMR spectroscopy,.
4. Explain about elemental analysis technique, working basic and using of elemental analysis device.

Unit I-Rotational spectroscopy:

Introduction to molecular spectroscopy, Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, Determination of bond lengths and/ or atomic masses from microwave data, effect of isotopic substitution, non-rigid rotator, classification of polyatomic molecules, energy levels and spectra of symmetric top molecules and asymmetric top molecules, First order Stark effect.

Unit II-Vibrational spectroscopy:

Normal coordinate analysis of mononuclear and heteronuclear diatomic molecules, Extension to polyatomic linear molecules, Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation, Force constants and amplitudes, Anharmonic oscillator, Overtones and combination bands, Dissociation energies from vibrational data, Vibration- rotation spectra, P, Q and R branches, Breakdown of the Born-Oppenheimer approximation,Nuclear spin effect.

Unit III-Raman Spectroscopy:

Stokes and anti-stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy. Selection rules, Polarization of Raman lines.

Unit IV-Atomic Spectra:

(i) Characterization of atomic states, Microstate and spin factoring methods, Hund's rules,Derivation of spin and orbital selection rules (based on recursion relations of Legendre polynomials), spectra of complex atoms. Zeeman and Stark effect, Atomic photoelectronspectroscopy.

(ii) Electronic spectroscopy: Diatomic molecules, Selection rules. Breakdown of selection rules, Franck-Condon factors, Dissociation energies, Photoelectron spectroscopy ofdiatomic (N_2) and simple polyatomic molecules (H_2O, formaldehyde), Adiabatic and vertical ionization energies, Koopmans'theorem.

Unit V-NMR spectroscopy:

Larmor precession. Mechanism of spin-spin and spin-lattice relaxation and quantitative treatment of relaxation, Quantum mechanical treatment of the AB system, Selection rules and relative intensities of lines.

Recommended Texts books:

1. Hollas. J.M Modern Spectroscopy 4th Ed. Wiley &Sons(2004)
2. Barrow. G. M. introduction to Molecular Spectroscopy Mc Graw-Hill(1962)
3. Brand. J.C.D. & Speakman. J.C. Molecular Structure the Physical Approach 2nd Ed. Edward Arnold London(1975)
4. Chang. R. Basic Principles of Spectroscopy McGraw- Hall. New York, N.Y.(1970)
5. Moore, W.J. Physical Chemistry 4th Ed. Prentice-Hall(1972)
6. Warren, B.E. X-Ray Diffraction Dover Publications(1990)

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	2	-	-	-	2	2	2	2
CO4	-	1	1	1	-	1	2	2	1	2

PRACTICAL PHYSICAL CHEMISTRY-III: (MCH-263)

Course Objectives

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

Practical Description

1. Titrate a moderately strong acid (salicylic/mandelic acid) by the
(a) Salt-line method
(b) Double alkali method

2. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.
3. Titrate a tribasic acid (phosphoric acid) against NaOH and Ba(OH)2 conductometrically.
4. Titrate

(i) Magnesium sulphate against BaCl2 and its reversetitration
(ii) HCl Vs NH4OH
(iii) Sodium oxalate Vs HCl

5. Estimate the concentration of each component of a mixture of AgNO3 and HNO3 byconductometric titration against NaOH.
6. Determine the degree of hydrolysis of aniline hydrochloride.
7. Determine the critical micelle concentration of a surfactant (sodium lauryl sulphate) by the conductivity method.
8. Study the effect of dielectric constant on the nature of the conductometric titration between maleic acid and sodium methoxide using different mixtures of benzene and methanol as solvents.
9. Determine the velocity constant for the saponification of ethyl acetate conductometrically.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	1	1	1	1	-	2	-	1	1
CO3	1	2	1	-	-	-	2	1	2	2

Nuclear & Radio Chemistry (MCH-219)

Course Objectives:

1. Improve their knowledge of the basic information of Radiation and Nuclear chemistry; requirements, methods of preparation, uses of radio-elements series, nuclear models, nuclear properties, Mass energy, relationships, nuclear reactions, rates of radioactive decay, interaction of radiation with matter.
2. Improve their knowledge of instrumentation and Introduction to health – physical applications in nuclear and radiochemistry.

Course Outcomes:

1. Know the significance of Radio Chemical Techniques
2. Apply the basic principle and methodology of Radio Chemical Techniques
3. Understand the applications of Radio Chemical Techniques.
4. Analyze and calculate the half life and decay rates of various radioactive elements

Section-A:

Nuclear Binding Energy:
Justifications and applications; nuclear stability rules and decay of unstable nuclei. Nuclear Structure: Nuclear force, Liquid drop model, shell model andcollective mode.

Section-B:

Interaction of Radiation with matter

Physical and chemical effects of radiation on matter (photoelectric effect, Compton effectand pair production).

Radiochemical Techniques:

NAA: Principle, Application and Limitation

IDA: Principle, Application and Limitation, Radiometric titrations.

Section-C:

Detection of Nuclear Radiation:
Various methods of detecting nuclear radiations, Gas-filled counters –Ionization chamber;Proportional counter and G.M. counters, Scintillation detectors; Solid state detectors.

Section-D:

Nuclear Reactions:
Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

Nuclear fission:
Fission probability; energy release; theories of fission.

Nuclear Fussion:
Brief idea about breeder reactors,; accelerators and cyclotron.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	3	2	2	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	2	2	2	2	2	2	2	2
CO4	1	1	2	1	1	1	1	2	2	2

Bioinorganic & Environmental Chemistry (MCH-220)

Course Objectives:

1. Students will demonstrate the ability to plan and execute experiments that demonstrate the use and understanding of modern instrumentsand appropriate use of Bioinorganic Chemistry.
2. Students will demonstrate their ability to communicate effectively about environmental chemistry, demonstrating the ability to create an awareness about environment.
3. Students will develop a sense of community responsibility by becoming aware of scientific issues in the larger social on text.

Course Outcomes:

1. Acquire broad knowledge of the field of Environmental Chemistry including basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.
2. Use technical and analytical skills to quantify the level and effects of Bioinorganic Chemistry.
3. Understand relationships between chemical exposure and effects on physiologicalsystem
4. Design strategies for study of harmful effects of different pollutants.

Section-A:

Metal Ions in Biological Systems:

General survey of essential and trace metals, Disturbing factors in metabolicprocess and causes of diseases, different classes of drugs.

Alkali and alkaline earth metals in biological systems:

Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, bloodclotting and hormones.

Interaction of metal ions with Nucleotides:

metal ions in nucleotide systems, effect of metal ions on nuclei acids.

Section-B:

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier modelsystems.

Nitrogen fixation**:**

Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2complexes, photosynthesis and chlorophyll.

Metal transport and storage:

Transferrin, Ferritin, Siderophores

Section-C:

Environmental Chemistry:

Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog , air quality standards, depletion of ozone, particulate matter in atmosphere ,mechanism of aerosol formation in air, Noise pollution and their health hazards.

Reference Books:

1. "Advances in Inorganic Biochemistry: Metal Ions in Genetic InformationTransfer v. 3" by Luigi G Marzilli and Gunther L Eichhorn.
2. "Mechanisms of Metallocenter Assembly (Advances in inorganic biochemistry)" by Luigi G Marzilli and Gunther LEichhorn.
3. "Molecular Design in Inorganic Biochemistry (Structure and Bonding)" by Daniel Rabinovich.
4. "Fundamental Concepts of Environmental Chemistry" by G S Sodhi, Narosa Book Distributors PvtLimited.
5. "Environmental Chemistry" by Anil Kumar De, NEW AGE; 7Edition.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	2	3	-	2	1	1	1
CO2	3	2	1	2	2	-	3	-	1	2
CO3	2	2	2	3	3	2	3	2	2	2
CO4	2	2	2	3	3	2	3	2	2	2

Inorganic Chemistry –III Practical: (MCH-260)

Course Objectives

1. Students will get acquainted with the unifying principles of synthesis and characterizationof metal complexes.

Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

Practical Description

Preparation of selected Inorganic compounds/complexes and their characterization using techniques/methods such as elemental analysis, conductance measurement, molecular weight determination, magnetic susceptibility measurements, infrared, UV, visible, Mossbauer and ESR spectra etc. Handling of air and moisture sensitive compounds.

i) Chromous Acetate
ii) $Hg[Co(SCN)_4]$
iii) $Ni(dmg)_2$
iv) $[Cu(NH_3)_4]SO_4.H_2O$
v) $[Ni(NH_3)_6]Cl_2$
vi) $K_3[Fe(C_2O_4)_3]$
vii) $VO(acac)_2$
viii) $Mn(acac)_3$
ix) Prussianblue
x) $[Co(NH_3)_5Cl]Cl_2$; $[Co(NH_3)_5NO_2]Cl_2$;$[Co(NH_3)_5ONO]Cl_2$
xi) $K_3[Al(C_2O_4)_3]$
xii) $[Ni(en)_3]S_2O_3$etc.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	2	3	-	2	1	1	1
CO2	3	2	1	2	2	-	3	-	1	2
CO3	2	2	2	1	2	2	1	1	2	2

Semester-IV

ORGANO-TRANSITION METAL CHEMISTRY: MCH-221

Course Objectives:

The objective of this course is that students will gain the detailed knowledge of synthesis, bonding, Reaction and application of transition metals compounds in organometallic chemistry.

Course Outcome:

1. The students can gain the knowledge of synthesis of alkyl and aryl transition metals
2. Students can learn the synthesis, bonding and reactions of transition metal complexes.
3. Students can utilize the knowledge of different types of carbine complexes.
4. Students can learn the application of transition metal organometallic compounds as catalysts.

Section-A:

Organo metallic Compounds: Introduction and Classification of organometallic compounds by bond types viz.covalent, ionic, electron deficient and cluster compounds.

Alkyls and Aryls of Transition Metals:

Types, routes of synthesis, stability and d decomposition pathways, organo copper in organic synthesis.

Section-B:

Transition Metal –Complexes:

Transition metal –complexes with unsaturated molecules- alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.

Section-C:

Compounds of Transition Metal-Carbon Multiple Bonds:

Transition metal-carbenecomplexes: Fischer type and Schrock type carbene complexes, their synthesis, reactionsand structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.

Section-D:

Fluxional Organometallic Compounds:

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes, -bonded and –bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

Applications of Transition metal Organometallics as Catalysts:

Zeigler-Natta polymerization ; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process.

Reference Books:

1. Principles and Applications of Organotransition Metal Chemistry by James, P. Collman , University Science Book, First Edition.
2. Transition Metals in the Synthesis of Complex Organic Molecules 2nd Edition by Louis , S. Hegedus, Hegedus, Bjorn C. G. Soderberg, University Science Book, Third Edition.
3. Organo-transition metal chemistry: from bonding to catalysis by John Hartwig , University Science Books; 2010 edition.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	1	1
CO2	1	2	1	-	-	2	3	2	1	2
CO3	1	2	-	-	-	2	3	3	2	2
CO4	2	2	2	-	-	2	3	3	2	2

ELECTRO ANALYTICAL CHEMISTRY: MCH-222

Course Objectives:

The objective of this course is that students will gain the detailed knowledge of electrochemical reaction, stability, polarography and their applications along with different types of voltammetry.

Course Outcome:

1. To understand the detailed concept of electrochemical reactions and different electrodes.
2. To know about the principle of polarography and their applications.
3. To study the different types of polarography and coulometry.
4. To know about various techniques of voltammetry and their application in inorganic system.

SECTION –A:

Electrons at and across interfaces, Electro-chemical and chemical reactions**,** Basic principles, residual current, migration current, diffusion current and limiting current, saturated calomel electrode(SCE) and dropping mercury electrode(DME). Ilkovic equation, Koutecky equation for diffusion current, Polarographic waves (anodic and cathodic), Half wave potentials. Oxygen interference, maxima function of supporting electrolytes.

SECTION-B:

Determination of stability constant complex by D.C.Polarography, Catalytic hydrogen

wave. Principles of Amperometric titrations, types of titration curves, apparatus and techniques.Hanging mercury drop electrode, rotating droping mercury electrode, platinum electrodes(RPE), Gold electrode, carbon paste electrode, glassy carbon electrode and graphite electrode.

Section-C:

Super imposed a.c. Polarography, voltametry in quiet and stirred solution with electrode other than mercury, square-wave polarography, normal and differential pulse polarography, chronopotentiometry, chronoamperometry and coulometry.

Section-D:

Theory of anodic stripping voltametry, concentration process, rest period, stripping process, Cathodic stripping voltametry, Anodic deposition, Cathodic redissolution, Experimental and applications of above system to Inorganic systems. Theory of ion selective electrodes, Experimental and applications of ISE to Inorganic systems.

Reference Books:

1. "Electrochemical Methods: Fundamentals and Applications" by A J Bard

2. "Fundamentals of Electroanalytical Chemistry" by P S Monk

3. "Electrochemical Reactions: The Electrochemical Methods of Analysis" by Gaston Charlot

4. "Modern Modified Electrochemical Methods for Pharmaceutical Analysis" by Dar Riyaz Ahmad and Brahman Pradeep Kumar

5. "Electrochemical Methods of Process Analysis" by D E Smith

6. "Electrochemically Engineered Nanoporous Materials (Springer Series in Materials Science)" by Dusan Losic and Abel Santos

7. "Electroanalytical Methods: Guide to Experiments and Applications" by Fritz Scholz

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2
CO4	1	-	-	3	1	-	2	3	1	2

MEDICAL ASPECTS OF INORGANIC CHEMISTRY: MCH-223

Course Objectives:

1. To emphasize the importance of inorganic entities in pharmaceuticals
2. To provide knowledge about important inorganic pharmaceuticals in pharmacopoeia regarding their preparation, quality standard and pharmaceutical uses
3. To highlight the domain of radiopharmaceuticals used in the diagnostics and therapy
4. To describe typical therapeutic classes and inorganic agents associated with them

Course Outcomes:

1. Explain the sources of impurities and methods to determine the impurities in inorganic pharmaceuticals
2. Explain the method of preparation, assay, properties, and medicinal uses of acids, bases, buffers, extra and intracellular electrolytes.
3. Explain the method of preparation, assay, properties, and medicinal uses of dental products.

4. Explain the method of preparation, assay, properties, and medicinal uses of astringent, poison and antidote.

Section-A:

Metals in Medicine:

Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Section-B:

Miscellaneous applications of Inorganic compounds as medicines:

Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.

Heavy metals in Biological systems:

Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs & metal ions in guts.

Section-C:

Ligand Therapy:

Ligand induced toxicity, interference with haemoglobin in oxygen transport system, intefererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and prodable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation,drugs where chelation and therapeutic activity are unrelated.

Section-D:

Hydrosphere:

Chemical composition of water bodies-lakes, streams & rivers; water quality parameters- dissolved oxygen, BOD, water quality standards; Purification and treatment of water.Radio pharmacology, nuclear medicines, radioiodine-131, technetium-99m, gallium and indium scan.

Reference Books:

1. Helmut Sigel (1973): Metal ions in biological system, Vol.9, Marcel Dekker INC, New York and Basel.

2. Helmut Sigel (1973): Metal ions in biological system (Concepts on metal ion toxicity), Vol.7 Marcel Dekker INC, New York and Basel.

3. Kaim, Wand Schewederski,B (1994):Bioinorganic Che mistry : Inorganic E l e m e n t s in the Chemistry of Life, John Wiley & Sons, NewYork, USA.

4. Guy Berthon (1995): Handbook of Metal-Ligand interactions in Biological fluid, Bioinorganic medicine, Vol.2, Marcel Dekker INC, New York and Basel.

5. Rosette M. Roat- Malone (2007): Bioinorganic Chemistry: A Short Course, Wiley.

6. Ivano Bertini (1994): Bioinorganic Chemistry, Mill Valley, CA: University Science Books.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	-	3	2	-	2	1	1	1
CO2	1	2	1	-	1	-	3	-	1	2
CO3	1	2	-	2	-	2	-	2	2	2
CO4	1	1	2	1	1	1	1	2	-	2

Industrial Chemistry: MCH-224

Course Objective:

The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

Course Outcomes:

1. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
2. Understand environmental regulatory legislations and standards and climate changes.
3. Understand about the quantification and analysis of wastewater and treatment.
4. Understand about analysis and quantification of hazardous and nonhazardous solid waste.

UNIT I Raw Materials for Chemical Industry:

Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations–integral utilization of raw materials. Energy for chemical industry–Fuels–classification of fuels–coal–fuel gases and liquid fuels–petroleum–cracking–Octane number–cetane number–composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.

UNIT II Explosive and Pesticides:

Explosives:

Classification, characteristics, preparation of nitrocellulose-T.N.T, Picric acid, Dynamite-

cordite and Gunpowder, Dynamite, HMX, PETN, Cyclonite, plastic explosives, gelatin, RDX, cordite and seismic explosives, propellants-manufacture of liquid and solid propellants-hydrazine, incendiaries and smoke screens. Industrial applications.

Pesticides:

Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, malathion, carbaryl) compounds family, Plant pesticides, Pesticide formulations.

UNIT III Cement, Ceramics, Polymeric Materials, Glass, Paints and Fertilizers

Cement:

Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India.

Ceramics:

Important clays and feldspar, glazing and verification.

Polymeric Materials:

Industrial polymers (Thermoplastics polymers and thermosetting Polymers) and composite materials–their constitutions, chemical and physical properties, Industrial applications.

Glass:

Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

UNIT IV Industrial Chemical Analysis:

Sampling procedures, sampling of bulk materials, techniques of sampling–solids, Liquids and gases. Collection and processing of data. Chromatography: Principles, working and applications of paper chromatography, TLC, GLC, HPLC.

Particle size determination, rheological properties of liquids, plastics and their analysis. Modern Instrumental Methods of analysis–UV-visible spectroscopy-IR spectroscopy and non-dispersive IR- Raman spectroscopy-NMR Spectroscopy-Electron spin resonance spectroscopy-Atomic absorption spectroscopy-Flame photometry-Neutron diffraction-X-ray fluorescence-Ion chromatography

UNIT V Industrial Hygiene and Chemical Safety:

Classification of hazaradous chemicals, storage, transportation, handling, risk assessments, challenges/solutions (d) Eco-friendly effluents disposal: Water pollutants, health hazards, sampling and analysis of water, water treatment, different industrial and domestic effluents and their treatment and disposal, advanced waste water treatment, effluent quality standards and laws, chemical industries, tannery, dairy, textile effluents, common treatment.

Text Books:

1. Mukhlyonov (ed.) (1979): Chemical Technology, Vol.1, 3rd Edition, Mir publication, Moscow.
2. De.,A.K. (1989): Environmental Chemistry,WileyEasternLtd.,11th edn., Meerut.
3. Sharma, B.K (1997): Industrial Chemistry, Goel publishing house.

References:

1. Norris Shreve, R. and J.A. Brink (1977): Jr. Chemical Process Industries. 4thedn.McGrawHill, Tokyo.
2. Chakrabarty, B.N (1981): Industrial Chemistry, Oxford & IBH Publishing Co., New Delhi.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	1	1	-	2	2	1	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	2	-	2	3	2	2	2
CO4	1	-	2	1	1	-	1	2	2	2

Inorganic Chemistry IV-Practical: MCH-271

Course Objectives:

The objective of this course is that students can get the practical knowledge of atomic absorption spectrophotometry, flame photometry, polarograpgy and amperometric titrations.

Course Outcome:

1. The students can learn the experimental knowledge of metal ion estimation by atomic absorption spectrophotometry.
2. To learn the polarographic determination of metals.
3. To understand the amperometric titration for mixtures.

Practical Description:

1. Estimation of metal ions by atomic absorption spectrophotometry and Flame Photometry.
2. Spectrophotometric determination of Fe, Ni,Mn,Cr,V,Ti and fluoride, Nitrate and phosphate etc.
3. Determination of pK value of an indicator spectrophotometrically.
4. Study of Complexation (Stoichiometry and stability constant) between Fe- thiocynate, Fe-Phenanthroline and Cu- ethylenediamine by Job's method/ slope ratio method.
5. Polarographic determination of metal ions such as Zn, Cd,

6. Mg, Tl etc.(including mixtures). Amperometric titrations.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2

Inorganic Chemistry V-Practical: MCH-272

Course Objectives:

The laboratory component of the course will aim to develop skills in the handling of air-sensitive compounds and the purification of compounds using chromatographic techniques.

Course Outcomes:

1. The students have the detailed knowledge of analytical or analysis of different element, quantitative analysis
2. Learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Capable of synthesizing Inorganic compounds.

PRACTICAL DESCRIPTION

1. Quantitative estimation of aniline, phenol, ethyl methyleketone and glucose (by both Betrane's and Lane and Bynon methods).
2. Semi-micro Qualitative Analysis Analysis of mixtures containing two familar and two less familiar cations from among the following:
Ti, W, Se, Te, Mo, Ce,Th,Ti,Zr,V,B 0 e,U and Li.

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	1	-	-	1	-	2	1	1	1
CO2	3	2	1	-	1	-	3	-	1	2
CO3	1	2	-	-	-	-	3	2	-	2

Major Project/Dissertation:MCH:267

Description

Dissertation will carry marks for continuous assessment, dissertation write-up, its presentation and viva-voce. This will be evaluated at the end of fourth semester.

Students will work on a research topic assigned to him/her by their supervisor/mentor with a purpose to develop a collective approach to study, analyze and solve the problem. Students are required to collect, analyze the data, and submit their dissertation at the end of the semester.

S.No.	Course details
1.	Research work
2.	Seminar
3.	Evaluation by Research committee
4.	Thesis writing
5.	Research work by taking 260 credit hours