Sharda School of Basic Sciences & Research

Department of Chemistry & Biochemistry

Programme Structure
Batch : 2023-25
AY: 2023-24

MSc. in Chemistry

Programme Code: SBR0101

Programme Structure
Sharda School of Basic Sciences & Research
M. Sc. Chemistry
Batch: 2023-25
TERM: I

S. No.	Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	MCH131	Inorganic Chemistry-I	4	-	-	4	Core
2.	MCH132	Organic Chemistry-I	4	-	-	4	Core
3.	MCH133	Physical Chemistry-I	4	-	-	4	Core
4.	MCH134	Analytical Chemistry-I	4	-	-	4	Core
5.	MMT129	Introduction to MATLAB & its application	3	-	-	3	GE
Practical							
6.	MCH171	Inorganic Chemistry Lab-I	-	-	3	2	Core
7.	MCH172	Organic Chemistry Lab-I	-	-	3	2	Core
8.	MCH173	Physical Chemistry Lab-I	-	-	3	2	Core
9.	RBL001	Research Based Learning-1	-	-	2	0	Qualifying
TOTAL CREDITS						**25**	

Programme Structure
Sharda School of Basic Sciences & Research
M. Sc. Chemistry
Batch: 2023-2025
TERM: II

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	MCH135	Inorganic Chemistry-II	4	-	-	4	Core
2.	MCH136	Organic Chemistry-II	4	-	-	4	Core
3.	MCH137	Physical Chemistry-II	4	-	-	4	Core
4.	MCH138	Analytical Chemistry-II	4	-	-	4	Core
5.	MPH115	Renewable Energy Sources: Solar And Hydrogen Energy	4	-	-	4	GE
6.	CCU401	Community Connect	2	-	-	2	SEEC-1
Practical							
7.	MCH174	Inorganic Chemistry Lab-II	-	-	3	2	Core
8.	MCH175	Organic Chemistry Lab-II	-	-	3	2	Core
9.	MCH176	Physical Chemistry Lab-II	-	-	3	2	Core
10.	RBL002	Research Based Learning-2	-	-	2	0	Qualifying
11.	VASXXX	Value Added Course-I	-	-	2	0	Qualifying
TOTAL CREDITS						**28**	

Programme Structure
Sharda School of Basic Sciences & Research
M. Sc. Chemistry
Batch: 2023-2025
TERM: III

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	MCH231	Molecular Spectroscopy	4	-	-	4	Core
2.	MCH232/MCH233/MCH234	Inorganic Chemistry-III/ Physical Chemistry-III/ Organic Chemistry-III	4	-	-	4	Core
3.	MCH235/MCH236/MCH237	Inorganic Chemistry-IV/ Physical Chemistry-IV/ Organic Chemistry-IV	4	-	-	4	Core
4.	MCE201/MCE202	Environmental Chemistry / Polymer Science and Technology	4	-	-	4	DSE
Practical							
5.	MCH271/ MCH272/MCH273	Organic Chemistry Lab-III/ Physical Chemistry Lab-III/ Inorganic Chemistry Lab-III	-	-	3	2	Core
6.	RBL003	Research Based Learning-3	-	-	6	2	Core
7.	VASXXX	Value Added Course-II	-	-	2	0	Qualifying
TOTAL CREDITS						**20**	

Programme Structure
Sharda School of Basic Sciences & Research
M. Sc. Chemistry
Batch: 2023-2025
TERM: IV

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	MCH238/MCH239/MCH240	Inorganic Chemistry-V/ Physical Chemistry-V/ Organic Chemistry-V	4	-	-	4	Core
2.	MCH241/MCH242/MCH243	Inorganic Chemistry-VI/ Physical Chemistry-VI/ Organic Chemistry-VI	4	-	-	4	Core
3.	MCE203/MCE204	Medicinal Chemistry/ Science and Technology of Nanomaterials	4	-	-	4	DSE
4.	OPEXXX	Open Elective	2	-	-	2	SEEC-2
Practical							
5.	RBL004	Research Based Learning-4	-	-	12	6	Core
TOTAL CREDITS						**20**	

Course Modules

2.1 Inorganic Chemistry-I (MCH131)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.		**Current Academic Year : 2023-24**	
Branch: Chemistry		**Semester I**	
1	**Course Code**	**MCH131**	
2	**Course Title**	**Inorganic Chemistry I**	
3	Credits	4	
4	Contact hours	4-0-0	
	Course Status	Compulsory	
5	Course Objectives	1.To provide an insight into bonding and structure of coordination compounds. 2.To explain the spectral and magnetic behaviour of coordination compounds. 3.To provide a thorough knowledge about the chemistry and application of inner transition metals. 4.To discuss about various spectroscopic methods for structure elucidation of inorganic compounds. 5.To explain the basics of radioactivity as well as various radio analytical techniques. 6.To impart knowledge about structure, bonding and application of inorganic compounds and radio chemistry.	
36	Course Outcome	CO1 : Explain the various theories of metal –ligand bonding CO2 : Explain the electronic spectra and magnetic properties of transition metal complexes. CO3 : Interpret the EPR and Mossbauer spectra CO4 : Illustrate the chemistry and uses of inner transition metals CO5 : Know about various radio-analytical techniques CO6 : Gain knowledge about of various aspects of modern inorganic chemistry	
7	Course Description	This course include basic concepts of metal –ligand bonding, magnetic and electronic properties of coordination compounds and their characterization techniques. Chemistry of inner transition metals and nuclear chemistry are also discussed in this course.	
8	Outline Syllabus		CO mapping
	Unit 1	**Metal-ligand Bonding**	
	A	Overview of crystal field and ligand field theories of 4-, 5-and 6-coordinated complexes, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral, square pyramidal, trigonal-bipyramidal and cubic complexes	CO1,CO6
	B	measurement of CFSE (d^1 to d^{10}) in weak and strong ligand fields, JahnTeller distortion, nephelauxetic series	CO1,CO6
	C	Molecular orbital theory (MOT) of coordination	CO1,CO6

		compounds: Composition of ligand group orbitals, molecular orbital energy diagrams of octahedral, tetrahedral, square planar complexes including both s and p bonding, angular overlap model	
	Unit 2	**Electronic Spectra and Magnetic Properties of Transition Metal Complexes**	
	A	Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states), calculations of Dq, B and β parameters	CO2, CO6
	B	charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information	CO2, CO6
	C	anomalous magnetic moments, magnetic exchange coupling, temperature independent paramagnetism (TIP) of complexes, spin cross over phenomenon. Effect of temperature on their magnetic properties	CO2, CO6
	Unit 3	**Chemistry of Inner Transition Elements**	
	A	General discussion on the properties of the f-block elements.	CO3, CO6
	B	Redox, Spectral and Magnetic properties.	CO3,CO6
	C	Use of Lanthanide compounds as shift reagents. Photophysical properties of Lanthanide complexes.	CO3,CO6
	Unit 4	**Characterization Techniques**	
	A	EPR spectroscopy-basic principle, hyperfine and superhyperfine lines, anisotropy, g values, application in selected inorganic compounds.	CO4,CO6
	B	Mossbauer Spectroscopy-Gamma ray emission and absorption by nuclei, Mossbauer effect — conditions, Doppler effect, instrumentation, chemical shift examples, quadrupole effect,	CO4,CO6
	C	Use of Mössbauer spectra in chemical analysis, typical spectra of iron and tin compounds.Optical rotatory dispersion (ORD) and circular dichroism (CD).	CO4,CO6
	Unit 5	**Nuclear Chemistry**	
	A	Nuclear structures and nuclear stability. Nuclear models ; radioactivity and nuclear reactions. Detection and measurement of radiation. Tracer techniques.	CO5,CO6
	B	Study of chemical reactions, isotope exchange reactions, kinetic isotope effect, nuclear activation analyses, Principle of nuclear detection, gas detector, ionization chamber, proportional and G. M. detector.	CO5,CO6
	C	*Radioactive Techniques:* Detection and measurement of radiation- GM ionization and proportional counters. Radiometric analysis: Isotope dilution analysis, age determination, neutron activation analysis (NAA) and	CO5,CO6

		their applications. Radiation hazards and safety measures.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1.Inorganic Chemistry, J.E. Huhey, Harper & Row.			
	Other References	1.Concise Inorganic Chemistry,J. D. Lee, Elbs with Chapman and Hall, London. 2.The Chemical bond, J.N.Murre l, SFA Kettle and JM. Tedder, Wiley, New York. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C131.1	3	1	1	1	3	3	1	1
C131.2	3	1	1	3	3	3	1	1
C131.3	3	1	1	3	3	3	3	1
C131.4	3	1	1	1	3	3	3	1
C131.5	3	1	1	3	3	2	1	1
C131.6	3	1	1	1	3	2	2	1

2.1 Organic Chemistry-I (MCH132)

School: SSBSR		**Batch 2023-25**
Programme: M.Sc.		**Current Academic Year : 2023-24**
Branch : Chemistry		**Semester I**
1	**Course No.**	**MCH132**
2	**Course Title**	**Organic Chemistry 1**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course status	Compulsory
5	Course Objective	1.To enhance the analytical ability of students about the basic and modern concepts of conjugation, resonance and aromaticity. 2. To impart knowledge of mechanistic, kinetic and thermodynamic aspects of i. nucleophilic and electrophilic substitution. ii. Reaction conditions, products formation and mechanisms of some named reactions. iii. addition reactions of C=C and C=O bonds and elimination reactions. 3.To teach the concepts and critical bond forming reactions and reaction intermediates in organic synthesis and molecular rearrangements 4. To make the student conversant with - the basic concepts in stereochemistry. 5.To discuss the Conformational analysis, reactivity, chirality, interconversion, resolution and asymmetric synthesis.
6.	Course Outcomes	The students will acquire the knowledge and analytical ability to CO1. Rationalize the concept of Aromaticity, nonaromaticity and antiaromaticity in carbocyclic and heterocyclic compounds CO 2. Solve the reactions and analyze the conditions, products formation and mechanisms of different reactions. CO3. Recognize the correct reaction intermediate formation and different aspects of their stability and reactivity. CO4. Critically examine the chirality/prochirality in the molecules and understand the enentio and diastereospecific/selective reactions. CO5. Conformational analysis of cycloalkanes, reactivity, chirality, interconversion, resolution and asymmetric synthesis,. CO6. The students will be able to acquire the skills for recognizing the reaction, rationalizing their mechanism, kinetic vs. thermodynamic considerations critical analysis of intermediates and correct stereochemical assignment and interpretation in rather simple organic molecules and reactions.
7	Course Description	This course tends to the build the foundation of Organic Chemistry that provides the insight of different aspects of organic reactions in terms of energy considerations, stereochemical implications, mechanistic

		approach and involvement of intermediates.	
8	Outline syllabus		CO Mapping
	Unit 1	**Nature of Bonding in Organic Molecules**	
	A	Delocalized chemical bonding: conjugation, cross conjugation, resonance, hyperconjugation, tautomerism;	CO1,CO6
	B	Criteria for aromaticity: Huckel's 4n+2 electron rule for benzenoid and non benzenoid aromatic compounds; Application in carbocyclic and heterocyclic systems, n-annulenes, heteroannulene, fullerenes, C-60, cryptates, azulenes.	CO1,CO6
	C	Current concepts of aromaticity: Anti-aromatic, non-aromatic and homoaromatic compounds, Effect of tautomerism and hyperconjugation on aromaticity.	CO1,CO6
	Unit 2	**Reaction Mechanism - Structure and Reactivity**	
	A	Types of reaction mechanisms- substitutions, eliminations, additions, rearrangements, thermodynamic and kinetic requirements	CO2,CO6
	B	Hammond postulate, Curtin-Hammett principle, transition states and intermediates, catalysis: electrophilic catalysis, acid and base catalysis	CO2,CO6
	C	Libido rule; methods of determination of reaction mechanism methods of determining mechanisms, isotopic effects.	CO2,CO6
	Unit 3	**Reaction Intermediates**	
	A	Classical and non classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangement (Wagner Meerwein rearrangement, Demjonove rearrangement and Pinacol-pinacolone rearrangement);	CO3,CO6
	B	Carbanions: ambident ions and their reactions. HSAB principle and its applications;	CO3,CO6
	C	Free radicals: cage effects. Radical Cations and Radical Anions; Carbene: Synthesis, structure and reactions of singlet and triplet carbene, nitrenes, Benzyne.	CO3,CO6
	Unit 4	**Stereochemistry I**	
	A	Elements of symmetry, chirality (centre, axis and plane), molecules with more than one chiral center, threo and erythro isomers, optical purity	CO4,CO6
	B	Topicity of ligand and faces and their nomenclature, stereogenecity, chirogenicity and pseudosymmetry, stereospecific and stereoselective reactions	CO4,CO6
	C	Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic	CO4,CO6

	Unit 5	**Stereochemistry II**			
	A	Conformational analysis of cyclic systems: Cyclohexane and its derivatives (mono-,and di- substituted), fused (decalins) and bridged bicyclic systems, effect of conformation on the reduction of cyclic ketones,			CO5,CO6
	B	nucleophilic addition to carbonyl group (Cram, Franklin Ahn Model, Cieplak effect), nucleophilic substitution on cyclohexane substrates, cyclohexane epoxide formation and opening			CO5,CO6
	C	elimination reactions of cyclohexyl halides, de-amination of 2-aminocyclohexanols, elimination vs substitution competition and neighboring group participation reactions of acyclic and cyclic molecules.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text Book	1.Stereochemistry, P. S. Kalsi, New Age International. 2.Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall. 3. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.			
	Other references	1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley. 2.Stereochemistry of Organic Compounds By Ernest Ludwig Eleil, Samual H. Wilen. 3.Stereochemistry of Organic Compounds: Principles and Applications by D. Nasipuri			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C132.1	3	1	1	2	3	1	1	1
C132.2	3	1	1	1	3	1	1	1
C132.3	3	1	1	1	3	1	1	1
C132.4	3	1	1	2	3	1	1	1
C132.5	3	1	1	2	3	1	1	1
C132.6	3	1	1	1	3	1	1	1

2.1 Physical Chemistry-I (MCH133)

School: SSBSR		**Batch : 2023-25**
Programme:M.Sc.		**Current Academic Year: 2023-24**
Branch:Chemistry		**Semester:I**
1	**Course Code**	**MCH133**
2	**Course Title**	**Physical Chemistry I**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. To provide the understanding of physical states of matter and their practical applications. To define how the initially primitive models of real gases in physical chemistry are elaborated to take into account more detailed observations. 2. To understand the concept of partial molar quantities and their variation with temperature and pressure. 3. The concept of ensembles, partition function and their applications in studying gaseous molecules. 4. To understand the concept and different theories of ions and electrolyte interactions 5.To discuss the theoretical aspects of chemical kinetics and the importance of rate equations and different theories for studying the kinetics of complex reactions. 6. To provide an in-depth analysis of various phenomenon, laws and applications of States of Matter, Thermodynamics, Electrochemistry, Phase Equilibrium and Chemical Kinetics
6	Course Outcomes	CO1: Understand the detailed concept of liquid and gaseous state and the structural features of solid state material by having complete knowledge of X-ray diffraction and its analysis. CO2: Understand the application of second law of thermodynamics and the concept of third law of thermodynamics. CO3: Familiarize with the applications of partition function and statistics in understanding the thermodynamics of molecules. CO4: Understand the concept of electrical double layer at the electrode electrolyte interface by studying different proposed models of it. CO5: Understand the detailed concepts of kinetics and its applications, Influence of physical and chemical parameters on reaction rates in solutions CO6: Do the in-depth analysis of various phenomenon and laws of States of Matter, applications of Thermodynamics, Electrochemistry and Chemical Kinetics and different functions of statistical thermodynamics.
7	Course Description	The course is framed to give broad view of states of matter, chemical potential, concepts of electrical double layer in solutions and various models to explain it. Concept of existence of different phases in the form

		of phase diagrams and their existence with changing variables.	
8	Outline syllabus		CO Mapping
	Unit 1	**States of Matter**	
	A	(a) Gaseous State : Maxwell–Boltzmann distribution of molecular velocities of gases (b) Liquid State: Structure of liquids, Radial distribution functions	CO1,CO6
	B	Monte–Carlo method, Molecular dynamics.(c) Solid State: Types of solids, Debye- Scherrer method of X-ray structure analysis of crystals, indexing of reflections,	CO1,CO6
	C	structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, Rietveld analysis, particle size of crystallites.	CO1,CO6
	Unit 2	**Thermodynamics**	
	A	Essentials of thermodynamics, fugacity, standard state of real gases, the relation between fugacity and pressure, Partial molar quantities, chemical potential and Gibbs-Duhem equation,	CO2,CO6
	B	Classius – Clayperon equation; law of mass action and its thermodynamic derivation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, determination of partial molar volume,	CO2,CO6
	C	thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), third law of thermodynamics, residual entropy, meaning and scope of irreversible thermodynamics.	CO2,CO6
	Unit 3	**Statistical Thermodynamics**	
	A	Concept of distribution, Thermodynamic probability and most probable distribution. Ensembles, Canonical, grand canonical and microcanonical ensembles.	CO3,CO6
	B	Partition function - Translational, Rotational, Vibrational and Electronic partition functions, calculation of thermodynamic properties in terms of partition function. Applications of partition functions.	CO3,CO6
	C	Heat capacity behaviour of solids - Chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law, Bose-Einstein statistics - distribution law, Evaluation of Lagrange's undetermined multipliers.	CO3,CO6
	Unit 4	**Electrochemistry**	
	A	Debye-Huckel theory of ion- ion interactions, Debye-Huckel limiting law of activity coefficients and its limitations,	CO4,CO6
	B	Debye - Huckel -Onsager treatment for aqueous solutions and its limitations, Wein effect, Debye – Falkenhagen	CO4,CO6

		effect.			
	C	The electrode-electrolyte interface: The electrical double layer -The Helmholtz-Perrin parallel plate model, the Gouy-Chapman diffuse-charge model and the Stern model, excess function			CO4,CO6
	Unit 5	**Chemical Kinetics**			
	A	Simple collision theory of reaction rates, Arrhenius equation and activated complex theory (ACT), thermodynamic treatment, chain reactions (hydrogen-halogen reactions) decomposition of N_2O_5			CO5,CO6
	B	Theory of unimolecular reactions: Lindemann – Hinshelwood mechanism of unimolecular reactions, RRKM and Slater treatment,			CO5,CO6
	C	Factors affecting rate of chemical reactions in solution Effect of solvent and ionic strength (Primary salt effect) on rate constants, secondary salt effect.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1.Physical Chemistry, P. W. Atkins, Oxford University Press, New York. 2.Textbook of Physical Chemistry by K. L. Kapoor (Volume 1) 3.Textbook of Physical Chemistry by K. L. Kapoor (Volume 3) 4.Textbook of Physical Chemistry by K. L. Kapoor (Volume 5)			
	Other References	1. Physical Chemistry, I.N. Levine, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 2. Comprehensive Physical Chemistry by N.B.Singh, N.S.Gajbhiye and S.S.Das , New Age publishers, New Delhi 3. Chemical Kinetics, K. J. Laidler, Harper & Row, New York. 4. Physical Chemistry by D.A.McQuarrie and J.D.Simon			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C133.1	3	1	1	2	3	1	1	1
C133.2	3	2	1	1	3	1	1	1
C133.3	3	1	1	1	3	1	1	1
C133.4	3	1	1	1	3	1	1	1
C133.5	3	2	1	1	3	1	1	1
C133.6	3	1	1	1	3	1	1	1

2.1 Analytical Chemistry-I (MCH134)

School: SSBSR		**Batch : 2023-25**
Programme: M.Sc		**Current Academic Year: 2023-24**
Branch: Chemistry		**Semester: I**
1	**Course Code**	**MCH134**
2	**Course Title**	**Analytical Chemistry I**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1.Provide and enrich the students to analytical techniques, various types of errors knowingly/ unknowingly introduced, accuracy and confidence limit in analytical process. 2.Provide detailed insight of chemical equilibrium and its effect in chemical analysis of analyte. 3.Provide detailed technical knowledge of various chromatogaraphic separation techniques based on physical state, contact and separation mechanism. 4.Provide detailed technical knowledge of gas, thin layer chromatographic, integrated LC-MS and GC-MS separation techniques for qualitative and quantitative analysis. 5.Enable the students to study the thermal behaviour of different compounds and study temperature dependent decomposition process and structural elucidation of unknown analyte. CO6:Estimate the temperature dependent weight loss in compound and model and optimize suitable temperature condition for further chemical processing.
6	Course Outcomes	CO1: Apply the knowledge of analytical techniques to minimize the error and report the outcomes of analysis with high precision and accuracy, CO2: Understand the role of different analytical techniques used for the separation of compounds present in very small quantity, CO3:Understand the role of chemical equilibrium in chemical analysis, CO4: Segregate and select the suitable indicator for measurement of pH, CO5: Purify the various compounds for their further detailed structural elucidation and molecular mass analysis, CO6. To learn analytical tools involving Chromatographic methods and thermo-analytical instruments of a lab for the identification of equilibrium process.
7	Course Description	Analytical chemistry I emphasizes on various factors as - types of errors, accuracy and precision in chemical analysis, concepts of chemical equilibrium and its effects on qualitative and quantitative estimation, Chromatographic separation and Thermal analysis.
8	Outline syllabus	CO Mapping

	Unit 1	**Introduction to Analytical Chemistry**	
	A	Scope & objectives of Analytical chemistry and chemical analysis, Classification of analytical methods. Errors in chemical analyses- Accuracy and precision	CO1,CO6
	B	Types of error-determinant, indeterminate and gross. Nature of random errors, statistical treatment of random errors, standard deviation of calculated results, reporting of calculated data	CO1,CO6
	C	ways of expressing accuracy and precision. variance and confidence limit. Comparison of mean with true values, regression analysis (least-square method for linear plots)	CO1,CO6
	Unit 2	**Concept of Equilibrium**	
	A	General treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases	CO2,CO6
	B	Activity and activity coefficient; Effect of electrolytes on chemical equilibria, Calculation of pH	CO2,CO6
	C	Constructing titration curves from charge balance and mass balance equations, Acid-base titrations and theory of pH indicators.	CO2,CO6
	Unit 3	**Chromatographic Methods-I**	
	A	General principle, classification of chromatographic methods based on physical state, contact and separation mechanism	CO3,CO6
	B	Nature of partition forces. Chromatographic behavior of solutes. Chromatographic resolution, selectivity factor and column efficiency.	CO3,CO6
	C	Column chromatography**:** Nature of column materials, Preparation of the column, Solvent systems, detection methods and applications.	CO3,CO6
	Unit 4	**Chromatographic Methods-II**	
	A	**Gas chromatography-** principle, experimental technique, carrier gas, sample injection, column, detector and application	CO4,CO6
	B	High Performance Liquid Chromatography (HPLC): instrumentation- solvent and reservoirs, pumping system, sample injection, Column, detectors	CO4,CO6
	C	**Thin layer chromatography:** coating of materials, preparation of TLC, Solvents, methods of detection and applications. Theory and application of LC-MS, Pyrolysis GC-MS, Thermal Desorption GC-MS.	CO4,CO6
	Unit 5	**Thermal Analysis**	
	A	Principle, different methods of thermal analysis, i) Thermo gravimetric methods of analysis(TG/DTG): Instrumentation, thermogram and information from	CO5,CO6

		thermogram, factors affecting thermogram, applications TGA for quantitative analysis (TG analysis of $CaC_2O_4.H_2O$, $CuSO_4.5H_2O$, dolomite ore, etc.)	
	B	Problems based TGA, ii) Differential Thermal Analysis (DTA): Instrumentation, general principles, differential thermogram, DTA and TG curve together, Applications (DTA analysis of mixture of polymers, DTA of CaC_2O_4 H_2O, DTA of $CuSO_4$ $5H_2O$).	CO5,CO6
	C	Differential Scanning Calorimetry (DSC): Principle, Instrumentation, and Applications (DSC curve of polyethylene terphthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetein), thermometric titrations, Evolved gas analysis.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 15% / MTE: 10% / ETE: 75%	
	Text book/s*	1.Analytical Chemistry-An Introduction, 7th Edition,D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Saunders College Publishing, Philadelphia, London.	
	Other References	1. Modern Methods of Chemical Analysis, 2nd Edition,R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, John Wiley, New York. 2. Analytical Chemistry, 5th Edition,G. D. Christian, John Wiley & Sons, New York. 3. Analytical Chemistry: Principles, 2nd Edition,J. H. Kennedy, Saunders Holt, London.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C134.1	3	2	1	2	3	1	1	1
C134.2	3	2	1	3	3	1	1	1
C134.3	3	2	1	1	3	1	1	1
C134.4	3	3	1	3	3	1	1	1
C134.5	3	3	1	3	3	1	1	1
C134.6	3	3	1	3	3	1	1	1

2.1 INTRODUCTION TO MATLAB AND ITS APPLICATIONS (MMT129)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: I**	
1	Course Code	MMT129	
2	**Course Title**	**Introduction to MATLAB and its Applications**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for MATLAB and cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc.	
6	Course Outcomes	• CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) • CO2: Demonstrate with strings and matrices and their uses. (K2, K3) • CO3: Illustrate basic flow controls (if-else, for, while). (K3) • CO4: Create plots and export this for use in reports and presentations. (K3, K5) • CO5: Develop program scripts and functions using the MATLAB development environment. (K4, K5) • CO6: Write the program for evaluates linear system of equations, ordinary differential equations in MATLAB. (K5,K6)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus	**Introduction to MATLAB**	CO Mapping
	Unit 1	**Introduction**	
	A	Vector and matrix generation, Subscripting and the colon notation.	CO1
	B	Matrix and array operations and their manipulations,	CO1
	C	Introduction to some inbuilt functions.	CO1
	Unit 2	**Relational and Logical Operators**	
	A	Flow control using various statement and loops including If-End statement, If-Else –End statement	CO1, CO3
	B	Nested If-Else-End Statement,	CO3

	C	For – End and While-End loops with break commands.			CO3
	Unit 3	**m-files**			
	A	Scripts and functions			CO2,CO5
	B	concept of local and global variable			CO2,CO5
	C	Few examples of in-built functions, editing, saving m-files.			CO2,CO5
	Unit 4	**Two dimensional Graphics**			
	A	Basic Plots, Change in axes and annotation in a figure			CO4
	B	multiple plots in a figure			CO4
	C	saving and printing figures			CO4
	Unit 5	**Applications of MATLAB**			
	A	Solving a linear system of equations,			CO5, CO6
	B	Curve fitting with polynomials using inbuilt function such as polyfit, solving equations in one variable,			CO5, CO6
	C	Solving ordinary differential equations using inbuilt functions			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book	An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for Engineering and Scientists by Steven Chapra, Mcgraw Hill. 2. Getting started with Matlab: Rudra Pratap			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C129.1	2	2	1	2	3	1	1	2
C129.2	2	2	1	2	3	1	1	2
C129.3	2	2	1	2	3	1	1	2
C129.4	2	2	1	2	3	1	1	2
C129.5	2	2	1	2	3	1	1	2
C129.6	2	2	1	2	3	1	1	2

2.1 Inorganic Chemistry-II (MCH135)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch:Chemistry		**Semester: II**	
1	**Course Code**	**MCH135**	
2	**Course Title**	**Inorganic Chemistry II**	
3	**Credits**	**4**	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.To introduce the basics concept of molecular symmetry and group theory 2.To demonstrate the various application of group theory in spectroscopy 3.To provide an introduction to basic concepts of organometallic chemistry 4.To explain to the student the various application of organometallic chemistry in industry 5.To provide information various industrially important organometallic compounds. 6.To provide structure, bonding and reactivity of transition metal carbonyls, nitrosyls and phosphin complexes.	
6	Course Outcomes	CO1:Understand the various basics concept of molecular symmetry and group theory. CO2:Apply their knowledge of group theory to understand the principles of spectroscopy. CO3:Know the basic concepts of organometallic chemistry and its application in industry. CO4: Explain the structure and reactivity of transition metal alkyl, aryl, alkene, alkynes, allyls, dienyl and arene and carbine complexes. CO5: Gain insight about transition metal carbonyls, nitrosyls and phosphin complexes. CO6: Gain knowledge about advanced topics like organometallic chemistry and group theory.	
7	Course Description	The course includes the basic concept of group theory and its application in chemistry; as well as organometallic chemistry of transition metals.	
8	Outline syllabus		CO Mapping
	Unit 1	**Molecular symmetry**	
	A	Introduction, Meaning and examples of different symmetry elements and generated operations; and general rules, Derivation of matrices for rotation;	CO1,CO6

		reflection; rotation ; reflection and inversion operations;	
	B	Symmetry operations of all the molecular point groups (C_n, D_n, C_{nh} , $D_{nb}C_{nv}$, D_{nd}, S_n, T, T_d, T_h, O, O_h, I and I_h); Determination of the classes of operations by similarity transform method (only C_{2v}, C_{2h}, C_{3v}, S_4) and general rules	CO1,CO6
	C	Defining properties of 'group'; Types of groups (Isomorphic, Cyclic and Abelion); Subgroups; reducible and irreducible representations;	CO1,CO6
	Unit 2	**Application of Group Theory**	
	A	Great Orthogonality Theorem, construction of character table for C_{2v} and C_{3v} point group	CO2,CO6
	B	Optical activity and dipole moment	CO2,CO6
	C	Application of group theory to electronic and vibrational spectroscopy	CO2,CO6
	Unit 3	**Organometallic Chemistry-I**	
	A	General Characteristics oforganometallic compounds, Ligand hapticity, electron count for different types of organometallic compounds, 16 and 18 electron rule and exceptions, Fluxionality in organometallic complexes. Stereochemical non-rigidity in organometallic compounds.	CO3,CO6
	B	Synthesis, structure and bonding of organolithium and organomagnesium compounds	CO3,CO6
	C	Organometallic reagents in organic synthesis and in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation, polymerisation and metathesis).	CO3,CO6
	Unit 4	**Organometallic Chemistry-II**	
	A	General synthetic routes, nature of bond and structural characteristics of alkyl, aryl, alkene, alkynes, allyls, dienyl and arene complexes of transition metals.	CO4,CO6
	B	Structure and bonding of metallocenes.	CO4,CO6
	C	Synthesis, structure and reactivity of metal carbene and carbynes	CO4,CO6
	Unit 5	**Organometallic Chemistry-III**	
	A	Ligand behavior of CO, General methods of preparation, structures, bonding, and vibrational spectra of metal (Fe, Ru, Os, Cr, Ni) carbonyls.	CO5,CO6
	B	Ligand behavior of NO (NO^+, NO^- and bridging NO), preparation, structures, bonding and important reactions of nitrosyls of Cr, Fe and Ru	CO5,CO6
	C	Preparation, structure, bonding and reactivity of metal phosphines. Comparison of phosphine and carbonyl	CO5,CO6

		ligands in terms of bonding.		
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
	Text book/s*	1. Inorganic Chemistry, J.E. Huhey, Harper & Row. 2.Organometallic Chemistry, R.C.Mehrotra and A.Singh, New Age International.		
	Other References	1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley 2. Introduction to Ligand fields, B.N. Figgis, Wiley, New York. 3. The Organometallic Chemistry of the Transit ion Metals, R.H. Crabtree, John Wiley. 4. Transition metal chemistry, Fundamental concept and applications, A.Yamamoto, John Wiley, 1986.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C135.1	3	1	1	1	3	1	1	1
C135.2	3	1	1	1	3	1	1	1
C135.3	3	1	1	1	3	3	2	1
C135.4	3	2	1	1	3	3	2	1
C135.5	3	1	1	1	3	3	2	1
C135.6	3	1	1	1	3	2	1	1

2.1 Organic Chemistry-II (MCH136)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: II**	
1	**Course No.**	**MCH136**	
2	**Course Title**	**Organic Chemistry II**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To conceptualize the critical C-C bond forming reactions and in organic synthesis and molecular rearrangements using enolates/ enamines/ metal catalyst or orgaganometallic compounds.. 2. To develop the critical thinking to analyze the conditions required for C=C bond formation 3. To discuss the mechanism of various famous name reactions. 4. To elaborate the process of oxidation and reduction in organic reactions by giving the example of suitable name reactions and develop understanding of the functional mode of different oxidation reduction reagents. 5. To recognize the factors that drives a reactant to undergo rearrangement reaction and understand the different name reactions involving rearrangement.	
6	Course Outcomes	The students will be able to- 1. compile the different ways to form C-C bond and associated name reactions. 2. formulate his/her own reasoned opinions in the mechanistic side of C=C bond forming organic reactions 3. enlist a number of oxidizing reagents and analyze the change in oxidation state during the oxidation reaction. 4. understand the functional mode of various reducing reagents. 5. various name reactions and popular rearrangement reactions. 6. develop critical thinking and deep understanding of mechanistic pathways of vast variety of reactions involving new formation, reduction, oxidation and rearrangement reactions.	
7	Course Description	This course utilizes the basics developed in organic chemistry to understand the mechanism and in-depth understanding of bond forming (C-C or C=C), Redox, Rearrangement and important name reactions.	
8	Outline syllabus		CO Mapping
	Unit 1	**Single bond (C-C) formations**	
	A	Chemistry of enolates (kinetic and	CO1,CO6

		themodynamic) and enamines, lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates,	
	B	Knoevenagel, Claisen, Dieckmann, Perkin, Stobbe, Darzen, Acyloin condensations, organolithium, organomagnesium (Grignard), organozinc, organocopper (Gilman & Normant) reagents in synthesis	CO1,CO6
	C	epoxidations (Sharpless, Jacobsen and Shi), Metal catalyzed C-C bond formations (Negishi, Heck, Stille, Suzuki, Sonogashira, Buchwald-Hartwig and Ullmann	CO1,CO6
	Unit 2	**Double bond (C=C) formations**	
	A	Dehydration of alcohols, β-eliminations (Hoffman & ester pyrolysis), Cope elimination, Phospohorus, nitrogen and sulfur ylids,	CO2,CO6
	B	Wittig reaction, Wittig-Horner reaction, Tebbe olefination, Julia olefination, Mannich reaction, Robinson annulation, Peterson olefination, McMurry reaction, Shapiro reaction, selenoxide elimination	CO2,CO6
	C	Corey-Winter reaction, olefins from epoxides, olefin metathesis (Schrock's catalyst, Grubbs' catalyst), ring closing metathesis, enyne metathesis, Thorpe reaction	CO2,CO6
	Unit 3	**Oxidation**	
	A	Oxidations of hydrocarbons (alkanes, alkenes and aromatic), alkenes to epoxides (peroxides/per acids based), alkenes to diols, Sharpless asymmetric dihydroxylation,	CO3,CO6
	B	Prevost reaction and Woodward modification, alkenes to carbonyls with bond cleavage, alkenes to alcohols/carbonyls without bond cleavage (Wacker oxidation),	CO3,CO6
	C	ketones to α-hydroxy ketones, α,β-unsaturated ketones and ester/lactones, alcohols to carbonyls, alcohols to acids or esters, phenols (Fremy's salt, silver carbonate), Swern oxidation.	CO3,CO6
	Unit 4	**Reduction**	
	A	Catalytic reduction (Pt, Pd, Ni), Dissolving metal reductions (alkali metals in Liq. NH_3 and Zn, Sn), Reduction by hydride transfer reagents (Complex hydrides of Li, B, Si and Na);	CO4,CO6
	B	Steroeselectivity of reduction with small hydride donors; Electroreduction with metals, Reduction	CO4,CO6

		with non-metals (HI, Diimides and hydrazine),	
	C	Reduction of epoxides, Reduction with enzymes-Bakers yeast, microbial reductions (NADH model etc.)	CO4,CO6
	Unit 5	**Name Reactions and Molecular Rearrangements**	
	A	Mechanism of Hoffmann Curtius, Schimidt, Lossen rearrangement, Beckmann rearrangement, Nef reaction	CO5,CO6
	B	Mechanism of Baeyer Villiger Favorskii and Sommelet-Hauser rearrangement, Brook rearrangement	CO5,CO6
	C	Baylis-Hillman reaction, Henry reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction, Ugi reaction	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 15% / MTE: 10% / ETE: 75%	
	Text Book/s*	1.Organic reactions and their mechanisms, P.S. Kalsi, New Age International. 2.Stereochemistry, P. S. Kalsi, New Age International. 3.Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall. 4.Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.	
	Other references	1.Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C136.1	3	2	1	2	3	1	1	2
C136.2	3	1	1	1	3	1	1	2
C136.3	3	2	1	2	3	1	1	2
C136.4	3	2	1	2	3	1	1	2
C136.5	3	2	1	2	3	1	1	2
C136.6	3	1	1	1	3	1	1	1

2.1 Physical Chemistry-II (MCH137)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.		**Current Academic Year: 2023-24**	
Branch:Chemistry		**Semester:II**	
1	**Course Code**	**MCH137**	
2	**Course Title**	**Physical Chemistry II**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To familiarise students with theoretical and mathematical aspects of quantised energy levels of particle in box, 2. To introduce the theoretical concept of Hydrogen atom and hydrogen molecule and hydrogen molecule ion. 3. To infer the concept of Charge on colloids, electro kinetic phenomenon's and different theories on colloids 4. To prioritise the surface phenomenon's and different equations and theories to explain them. 5. To describe equilibrium processes of one and more than one component systems such as congruent, Peritectic and Monotectic Systems.	
6	Course Outcomes	CO1:The concepts of quantum mechanics and its mathematical interpretation for atoms and molecules possessing single electron. CO2:The results and their analysis obtained on the basis of MOT and VBT for hydrogen atom, molecule and ion. CO3:The nomenclature of particles on the basis of particle size and different theories and results related to stability of colloids. CO4:The concept of surface tension, micellization and solubilisation. CO5: The concept of existence of different phases with change in different variables by visualizing the phase diagrams CO6: The concept of quantum mechanics, their application to MOT and VBT, how to draw phase diagrams and importance of colloids and surface chemistry in daily life, their concepts, phenomenon and mathematical equations.	
7	Course Description	Concept of Quantum mechanics and its applications in MOT and VBT were shared with students. Theories of colloids and concepts of surface chemistry were discussed. The phase diagram of different component systems were discussed and explained how to plot them.	
8	Outline syllabus		CO Mapping
	Unit 1	**Quantum Mechanics**	
	A	Matter waves, The Uncertainty principle, The wave nature of the electron, Interpretation of wave function, Normalized and orthogonal wave functions, Linear and	CO1,CO6

		Hermitian operators, Commutation of operators, Eigen value and Eigen function	
	B	The wave equation, Particle in one dimensional box, particle in three dimensional box, particle in a ring, Degeneracy.Angular momentum operator, Ladder operator,	CO1,CO6
	C	Hydrogen atom: Schrodinger wave equation, Transformation of coordinates, separation of variable in polar spherical coordinates and its solution, principal, azimuthal and magnetic quantum numbers and their magnitude, probability distribution function, radial distribution function and shape of atomic orbital's (s,p & d), Virial theorem.	CO1,CO6
	Unit 2	**Chemical Bonding**	
	A	Born Oppenheimer Approximation, The ionic bond, The variation method, Ground state energy of the hydrogen atom,	CO2,CO6
	B	Huckel molecular orbital theory of conjugated systems, delocalisation energy and Secular equations , Molecular orbital theory – Hydrogen molecule ion,	CO2,CO6
	C	Valence bond theory- Hydrogen molecule, Simple homo and hetero nuclear diatomic molecules, Electronic spectra, effect of substituent on spectra.	CO2,CO6
	Unit 3	**Colloids**	
	A	Introduction, Origin of the charges, electro-kinetic phenomena, electrophoresis, electro osmosis, sedimentation and streaming potential.	CO3,CO6
	B	The concept of electrical double layer and various models to explain its structure and properties,	CO3,CO6
	C	DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates. Organic and inorganic gels and clay colloids.	CO3,CO6
	Unit 4	**Surface Chemistry and Micelles**	
	A	**Surface** tension and surface free energy; Pressure across an interface: Laplace equation, Kelvin equation; Wetting: Young-Dupre equation;	CO4,CO6
	B	Adsorption in liquid systems: Gibbs adsorption isotherm; Adsorption on solids: Langmuir isotherm, BET isotherm, transition state theory of surface reactions: rates of chemisorption and desorption.	CO4,CO6
	C	Micelles-Surface active agents and their classification, micellization, hydrophobic interaction, critical micellar concentration (cmc), factors affecting cmc of surfactants, counter ion binding to micelles, thermodynamics of	CO4,CO6

		micellization-phase separation and mass action models, solubilization, micro emulsions, reverse micelles.			
	Unit 5	**Phase Equilibria**			
	A	Statement and meaning of the terms in Gibbs phase rule; Thermodynamic derivation of Gibb's phase rule, phase equilibria of water, Hellium and carbon systems;			CO5,CO6
	B	Two component solid-liquid equilibria (example of Cu-Ni alloy,Bi - Cd system and $CuSO_4 – H_2O$ System): simple eutectic; congruent melting type; peritectic type and monotectic type phase diagrams,			CO5,CO6
	C	concept of Phase equilibria of three component systems - CaO-Al_2O_3-SiO_2 and Acetic acid-water-Butanol system, Phase-Transformations in Solids: Thermodynamic Classifications of Phase Transitions			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1.Physical Chemistry, P. W. Atkins, Oxford University Press, New York. 2.Physical Chemistry, I.N. Levine, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 3. Physical Chemistry of Surfaces by A. W. Adamson, John Wiley and Sons.			
	Other References	1.Theoretical Inorganic Chemistry by M.C.Day and J.Selbin 2. Applied Colloid and Surface Chemistry by R. M. Pashley and M. E. Karaman, Wiley Publications. 4.Comprehensive Physical Chemistry by N.B.Singh, N.S.Gajbhiye and S.S.Das , New Age publishers, New Delhi 5.Physical Chemistry by D.A.McQuarrie and J.D.Simon			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C137.1	3	1	1	1	3	1	1	1
C137.2	3	1	1	1	3	1	1	1
C137.3	3	2	1	2	3	1	1	2
C137.4	3	2	1	2	3	1	1	2
C137.5	3	2	1	2	3	1	1	2
C137.6	3	1	1	1	3	1	1	1

2.1 Analytical Chemistry-II (MCH138)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: II**	
1	**Course Code**	**MCH138**	
2	**Course Title**	**Analytical Chemistry II**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Understand the theories and principles of qualitative and quantitative analysis through optical and spectroscopic technique. 2.Analyse the textural information of bulk materials and particle dimension. 3.Carry out qualitative and quantitative analysis employing descriptive knowledge of electrochemistry and electrochemical titration. 4.Separate and estimate macromolecule (proteins, enzymes, blood and natural products) electroanalytically. 5.Effectively use various sensors for estimation and gain idea about developing technologically potent sensor materials. 6. To learn the advance spectroscopic and microscopic methods for the analysis of molecular materials.	
6	Course Outcomes	CO1: Understand various optical and spectroscopic methods for qualitative and quantitative analysis of metals and non metal to trace level. CO2: Evaluate the properties of materials such as porosity, density and microstructure of materials. CO3: Develop new synthetic routes involving electrochemical redox process. CO4: Understand principles of Cyclic Voltammetry and Electrophoresis. CO5: Develop quick, sensitive and selective sensory materials for qualitative and quantitative estimation of analyte. CO6: Investigate the molecular materials using advanced spectroscopic and microscopic techniques.	
7	Course Description	Analytical chemistry II emphasizes on various parts of analytical methods as - Atomic Spectroscopy comprises of AAS, AES and ICPMS, Electron Microscopic techniques comprises of SEM, TEM and FESEM, Polarography and amperometry, Cyclic voltammetry and electrophoresis Chemical sensors	
8	Outline syllabus		CO Mapping
	Unit 1	**Atomic Spectroscopy**	
	A	Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission and absorption, Instrumentation for AES and AAS, standard	CO1,CO6

		addition and internal standard method of analysis	
	B	Comparison of atomic absorption and emission methods, Applications of AAS and AES Features of atomic mass spectroscopy, Atomic weight in mass spectroscopy, mass to charge ratio	CO1,CO6
	C	Types of atomic mass spectroscopy, quadruple mass analyzer, time of flight mass analyzer, Inductively coupled mass spectroscopy (ICPMS), Instrumentation for ICPMS, Applications of ICPMS	CO1,CO6
	Unit 2	**Electron Microscopic Techniques**	
	A	Basic principle, instrumentation and application of Transmission Electron Microscope (TEM) and HRTEM	CO2,CO6
	B	Basic principle, instrumentation and application of Scanning Electron Microscope (SEM)	CO2,CO6
	C	Basic principle, instrumentation and application of FESEM	CO2,CO6
	Unit 3	**Electroanalytical Technique I**	
	A	**Polarography** Introduction, Instrumentation, Ilkovic equation and its verification	CO3,CO6
	B	Derivation of wave equation, Determination of half wave potential, qualitative and quantitative applications	CO3,CO6
	C	**Amperometry:** Basic principles, instrumentation, nature of titration curves and analytical principles	CO3,CO6
	Unit 4	**Electroanalytical Technique II**	
	A	**Cyclic Voltammetry** Cell design, instrumentation, current-potential relation for linear sweep voltammetry (LSV), cyclic voltammetry, interpretation of voltammograms.	CO4,CO6
	B	**Electrophoresis:** Separation by adsorption-Affinity techniques, affinity elution from ion exchangers and other adsorbents	CO4,CO6
	C	Pseudo affinity adsorbents, polyacrylamide get electrophoresis, isoelecrictric focusing, isotachophoresis	CO4,CO6
	Unit 5	**Chemical Sensors**	
	A	Principles, types of chemical sensors based on the modes of transductions, Types of chemical sensor based on the chemically sensitive materials	CO5,CO6
	B	solid electrolyte, gas, semiconductor, Humidity sensors, Biosensors sensors	CO5,CO6
	C	Electrochemical sensors (Potentiometric sensors, Ion-selective electrodes, Membrane electrodes, Amperometric sensors)	CO5,CO6
	Mode of	Theory	

	examination			
	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
	Text book/s*	Principles of Instrumental Analysis, Skkog, Holler, Nieman, (Sixth Ed.)		
	Other References	1) Introduction to Instrumental Analysis by R. D. Broun, Mc Graw Hill (1987) 2) Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986) 3) Fundamentals of Analytical Chemistry, 6th edition, D.A. Skoog, D.M. West and F.J. Holler, Saunders college publishing. 4) Principles of Instrumental Analysis, Skkog, Holler, Nieman, (Sixth Ed.) 5) Introduction to instrumental analysis by R. D. Braun, MC. Graw Hill-International edition. 6) Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH 7) Electron microscopy in the study of material, P. J Grundy and G. A Jones, Edward Arnold.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C138.1	3	2	1	2	3	1	1	2
C138.2	3	2	1	2	3	1	1	2
C138.3	3	2	1	2	3	1	1	2
C138.4	3	2	1	2	3	1	1	2
C138.5	3	2	1	2	3	1	1	2
C138.6	3	2	1	2	3	1	1	2

2.1 Renewable Energy Resources (MPH115)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: II**	
1	**Course Code**	**MPH115**	
2	**Course Title**	**Renewable Energy Sources**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. 1. To know the importance of Physics and Materials Science. 2. To utilize the various synthesis procedure to develop materials. 3. To explain the practical application of materials in various area	
6	Course Outcomes	CO1: Learn the basics of Materials/Technology CO2: Understand the correlation between Applied science and Technology CO3: Apply the concept of materials and technology at certain levels. CO4: Develop devices using materials. CO5: Create the path to handle materials. CO6: Expertise in various tools will make a bridge between industry and students and find out the platform for employment in high tech industries	
7	Course Description	This course is based on renewable energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services	
8	Outline syllabus		CO Mapping
	Unit 1	**Natural and Renewable Energy Resources**	
	A	Natural resources and associated problems, Forest, Water, Mineral, Food, Energy and Land resources	CO1, CO2,CO3
	B	Use and over-exploitation, Concept of an ecosystem, Environmental Pollution, Nuclear hazards	CO1,CO2
	C	Renewable Energy sources: Definition and types of renewable sources, Wind, Ocean, Geothermal, Biomass, Hydro as renewable energy resources	CO3
	Unit 2	**Solar Energy: Fundamental and Material Aspects**	
	A	Fundamentals of photovoltaic Energy Conversion Physics and Material Properties, Types of solar energy conversion	CO2,CO4
	B	solar thermal: basics and design of water heaters, solar	CO1, CO3

		ponds, Basic to Photovoltaic Energy Conversion: Optical properties of Solids	
	C	Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.	CO3,CO5
	Unit 3	**Solar Energy: Different Types of Solar Cells**	
	A	Types of Solar Cells, p-n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current	CO1,CO4
	B	Brief description of single crystal silicon and organic and Polymer Solar Cells, Elementary Ideas of Advanced Solar Cells e.g. Tandem Solar cells, Solid Liquid Junction Solar Cells	CO3,CO4,CO6
	C	Nature of Semiconductor, Principles of Photo-electrochemical Solar Cells.	CO1,CO5
	Unit 4	**Hydrogen Energy: Fundamentals, Production and Storage**	
	A	Hydrogen as a source of energy, Solar Hydrogen through Photoelectrolysis, Physics of material characteristics for production of Solar Hydrogen	CO1, CO4
	B	Brief discussion of various storage processes, special features of solid hydrogen storage materials	CO1,CO3
	C	Structural and electronic characteristics of storage material, New Storage Modes.	CO4,CO6
	Unit 5	**Hydrogen Energy: Safety and Utilization**	
	A	Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation	CO2,CO6
	B	Fuel Cells, Various type of Fuel Cells, Applications of Fuel Cell	CO6
	C	Elementary concepts of other Hydrogen- Based devices such as Hydride Batteries	CO4,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 15% / MTE: 10% / ETE: 75%	
	Text book/s*	1.Fundamentals of Solar Cells Photovoltaic Solar Energy :Fahrenbruch&Bube	
	Other References	1.Solar Cell Devices-Physics :Fonash 2. Phoptoelectrochemical Solar Cells: Chandra 3. Hydrogen as an Energy Carrier Technologies Systems Economy : Winter &Nitch (Eds.) 4. Hydrogen as a Future EngeryCarrier : Andreas Zuttel, Andreas Borgschulte and Louis Schlapbach	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C115.1	2	2	1	2	1	1	1	2
C115.2	2	2	1	2	1	1	1	2
C115.3	2	2	1	2	1	1	1	2
C115.4	2	2	1	2	1	1	1	2
C115.5	2	2	1	2	1	1	1	2
C115.6	2	2	1	2	1	1	1	2

2.1 Molecular Spectroscopy (MCH231)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:III**	
1	**Course No.**	**MCH231**	
2	**Course Title**	**Molecular Spectroscopy**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.To know the principle and applications of molecular spectroscopy. 2.To understand the theories of UV, FT-IR, Raman, NMR, and Mass spectroscopic techniques. 3.Analyze and identify simple organic molecules by using UV, IR, Mass, ^{1}H NMR and ^{13}C NMR data. 4.To evaluate the application of NMR and Mass spectroscopic techniques to different molecules. 5.To know the principle and instrumentation of different spectrophotometric techniques. 6.To impart the knowledge of electronic, rotation, vibration. NMR, FTIR, ESR, spectroscopy and their applications..	
6	Course Outcomes	CO1:Explain the general principles and theory of spectroscopy, distinguish the specialities and applications of various types of spectroscopic methods. CO2:Describe the concept and instrumentation of atomic uv-visible absorption, infrared NMR and Mass spectrometers. CO3:Apply Woodward Fieser Rules. CO4:Understand first and second order ^{1}HNMR spectra. CO5:Solve analytical science problems involving uv-visible absorption, infrared ^{1}H, ^{13}C and mass techniques. CO6:Predict UV, IR, Proton chemical shift, spin-spin coupling, coupling constants and apply ^{13}C resonance spectroscopy and mass spectroscopy to chemical structures.	
7	Course Description	The course is framed to give fundamental concepts of UV-Visible, IR, ^{1}HNMR, ^{13}CNMR and Mass spectroscopy. Applications of these spectroscopic techniques to organic/inorganic systems will be discussed.	
8	Outline syllabus		CO mapping
	Unit 1	**UV-Visible Spectroscopy**	
	A	Lamberts–Beers law, Electronic spectra, Frank-Condon Principle, predissociation spectra, Fortrat diagram,	CO1,CO6
	B	conjugated polyene and enone systems, and different types of charge transfer transitions and their basis	CO1,CO6

	C	Charge transfer spectra in organic and inorganic systems	CO1,CO6
	Unit 2	**Infrared Spectroscopy**	
	A	Basic principle and sample handling. Modes of stretching and bending, bond properties and absorption trends,	CO2,CO6
	B	Survey of vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds.	CO2,CO6
	C	Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.	CO2,CO6
	Unit 3	**Nuclear Magnetic Resonance Spectroscopy-I**	
	A	^{1}H NMR - Effect of magnetic field strength on sensitivity and resolution, chemical shift δ, inductive and anisotropic effects on δ, chemical structure correlations of δ, chemical and magnetic equivalence of spins, spin-spin coupling, structural correlation to coupling constant J	CO3,CO6
	B	first order and second order spectra, examples of AB, AX, ABX, AMX and AA′BB′ systems, simplification of second order spectrum, selective decoupling, double resonance; classification of splitting pattern; spin; de coupling; chemical exchange; effect of deuteration	CO3,CO6
	C	Structural elucidation of organic compounds using ^{1}H NMR technique	CO3,CO6
	Unit 4	**Nuclear Magnetic Resonance Spectroscopy-II**	
	A	^{13}C NMR- Introduction, interpretation of ^{13}C NMR spectra, Chemical shifts and its calculation,	CO4,CO6
	B	proton coupled and decoupled spin-spin splitting; Application of DEPT technique to the analysis of CH multiplicities in ^{13}C NMR spectroscopy. Correlation spectroscopy - Illustration of practical applications of ^{1}H-^{1}H COSY, ^{1}H-^{13}C COSY.	CO4,CO6
	C	Nuclear overhauser enhancement (NOE).Basic concept of Heternonuclear (F, P, Si) NMR.	CO4,CO6
	Unit 5	**Mass Spectrometry**	
	A	Measurement technique (El; FAB); Resolution; exact masses of nucleides; molecular ions; isotope ions; fragment ions of odd and even electron types; rearrangement ions	CO5,CO6
	B	factors affecting cleavage patterns; simple cleavage; cleavage at a hetero atom; multi centre fragmentation	CO5,CO6
	C	Structure elucidation of organic compounds employing mass spectroscopy; Special methods of GCMS; High	CO5,CO6

		resolution MS.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text Book/s*	1.Spectroscopy of Organic Compounds – P.S.Kalsi, 6th edition, 2004. 2.Molecular Spectroscopy – Banwell, 5th Edition, 2013			
	Other References	1.Applications of Absorption Spectroscopy of Organic Compounds – Dyer, 1st Edition, 2009. 2.Spectroscopic Methods in Organic Chemistry by D.H. Williams and I. Fleming, 4th edition, Tata McGraw-Hill Publishing company Ltd., New Delhi. 3.Spectrometric Identification of Organic Compounds- R. M. Silverstein, F. X. Webster, D. Kiemle, 7th Edition, 2005. 4.Physical Methods in Inorganic Chemistry by R. S. Drago, Affiliated East-West Press, 1st Edition. 5.Spectroscopic identification of organic compounds by Kiemle Webster Silverstein, 7 2nd Edition, 2005			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C231.1	3	1	1	1	3	1	3	2
C231.2	3	2	1	1	3	2	3	2
C231.3	3	1	1	3	3	1	3	2
C231.4	3	1	2	3	3	1	3	2
C231.5	3	1	2	3	3	1	3	2
C231.6	3	1	1	3	3	1	3	2

2.1 Inorganic Chemistry-III (MCH232)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch: Chemistry		**Semester III**	
1	**Course No**	**MCH232**	
2	**Course Title**	**Inorganic Chemistry III**	
3	Credits	4	
4	Contact hours(L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objectives	1.To explain the reaction mechanism of an inorganic reaction. 2.To discuss factors affecting stability of complexes. 3.To explain the route of addition of molecules in a reaction. 4.To have an overview of chemistry of CO complexes. 5.To explain the concept of stereoisomerism in inorganic complexes. 6.To demonstrate mechanisms of substitution reaction and compare it with associative reaction.	
6	Course Outcome	CO1: Explain the trends of rate constants and its determination with different methods. CO2: Provide explanation for substitution in octahedral and square planar complexes. CO3: Explain ligand replacement reactions under different conditions. CO4: Distinguish between oxidative addition and reductive elimination mechanisms. CO5: Analyze the chemistry of carbonyl compounds and metal hydrides. CO6: Gain knowledge about various aspects of inorganic reaction mechanism	
7	Course Description	The course gives a detailed view of reaction mechanism, electron transfer mechanisms, oxidative addition and insertion reactions of transition metal complexes.	
	Unit 1	**Reaction Mechanism of Transition metal complexes-I**	
	A	Rate Law, Steady state, Activated complex theory. Stepwise and overall formation constants, their interaction	CO1,CO6
	B	determination of formation constant by pH-meter, Job's method and spectrophotometery. Trends in stepwise constants	CO1,CO6
	C	factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Chelate effect and its thermodynamic origin	CO1,CO6
	Unit 2	**Reaction Mechanism of Transition metal complexes-II**	
	A	Inert and labile complexes, mechanisms of substitution	CO2,CO6

		reactions (dissociative, associative interchange mechanism), the conjugate mechanism,			
	B	direct and indirect evidence in favour of conjugate mechanism, substitution in cis and trans complexes, isomerism of chelate rings, *trans* effects, explanation for *trans* effect			CO2,CO6
	C	Ligand replacement reactions of square planar and octahedral complexes: their factors and mechanism of substitution, Anation reactions.			CO2,CO6
	Unit 3	**Electron Transfer Mechanisms**			
	A	Inner sphere and outer sphere reactions and their mechanisms			CO3,CO6
	B	Racemization and Isomerization, Effect of ligand field on reaction rates			CO3,CO6
	C	Mixed valence complexes, Marcus-Husch theory, Thermal and optical electron transfer reactions.			CO3,CO6
	Unit 4	**Oxidative-Addition and Migration (Insertion Reactions)**			
	A	Introduction: Acid base behaviour of metal atoms in complexes, Protonation and Lewis Base behaviour, acceptor properties of Lewis acidity of complexes			CO4,CO6
	B	oxidative addition and reductive elimination, addition of specific molecules, Hydrogen addition, HX additions, Organic halides addition of some other molecules productive elimination, migration (Insertion) reaction			CO4,CO6
	C	promotion of alkyl migration, insertion of CO into M-H bonds, other aspects of CO insertion reactions, Insertion of alkenes and C-C unsaturated compounds, Cleavage of C-H bonds; alkane activation, Cyclometallation reactions.			CO4,CO6
	Unit 5	**Metal Hydride Complexes**			
	A	Synthesis, structure and reactions of hydrido complexes, characterization of complexes, molecular hydrogen compounds-synthesis and reactions			CO5,CO6
	B	Mononuclear polyhydrides, homoleptic polyhydride anions; carbonyl hydrides and anion			CO5,CO6
	C	MH interactions; synthetic applications of metal hydrides			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1.J.E.Huheey. Inorganic Chemistry: Principles of Structure and Reactivity. Harper Inter science.			
	Other References	1.William L. Jolly, Modern Inorganic Chemistry, 2nd Edn, Tata McGraw Hill.			

		2.E. A. V. Ebsworth, D. W. H. Rankin and S. J. Cradock. Structural methods in Inorganic Chemistry, Blackwell Scientific Oxford. 3.I. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver and Atkins. Inorganic Chemistry, Oxford University Press. 4.T. Moeller. Inorganic Chemistry: A Modern approach, John Wiley. 5.F. Basalo and R.G.Pearson, Mechanism of Inorganic reactions,2nd Edn ,Wiley Eastern Ltd., New Delhi

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C232.1	3	1	1	1	3	3	2	2
C232.2	3	1	1	1	3	3	2	2
C232.3	3	2	1	2	3	3	2	2
C232.4	3	1	1	1	3	3	2	2
C232.5	3	1	1	1	3	3	1	2
C232.6	3	1	1	1	3	3	2	2

2.1 Physical Chemistry-III (MCH233)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course Code**	**MCH233**	
2	**Course Title**	**Physical Chemistry III**	
3	Credits	4	
4	Contact hours	4-0-0	
	Course Status	Compulsory	
5	Course Objectives	The main objectives of this program is to: 1: To provide deep knowledge on advanced quantum chemistry. 2: To provide a thorough proficiency in approximate methods in quantum chemistry. 3: To enable students to interpret many electron systems quantum mechanically. 4: To impart knowledge on kinetics of complex reactions. 5: To make the student understand the kinetics of reaction in solution . 6: Apply the knowledge about quantum chemistry and kinetics to solve real life problems .	
6	Course Outcome	After successful completion of the course, the students will be able to: CO1: understand different polynomials and their application. CO2. apply the knowledge of time dependent perturbation theory and variational method for quantum mechanical problems. CO3 apply the quantum chemistry knowledge to analyse the behaviour of multi electron systems. CO4. explain the kinetics of various types of complex reactions CO5. Apply the knowledge of kinetics of reactions in solution to solve kinetics problems. CO7.Apply knowledge quantum chemistry to solve real life problems and kinetics to understand mechanism of reactions.	
7	Course Description	The course provides in-depth knowledge about advanced quantum chemistry and kinetics of complex reactions.	
8	Outline Syllabus		CO mapping
	Unit 1	Advanced Quantum chemistry: Prerequisite	
	A	Legendre, associated Legendre polynomials; Hermite polynomials; Lagurre and associated Lagurre polynomials; polynomials as orthonormal functions, their properties; step-up and step-down operators, application	CO1, CO6

		to single electron and multi-electron atom,	
	B	eigen-ket-ladder and formulation of spherical harmonics from angular momentum rules, finite rotation operation vs. angular momentum operators, spin angular momentum, Pauli spin matrices — spin eigenfunctions and their properties.	CO1, CO6
	C	coupling of angular momentum for many electron system, spin-orbit coupling, Molecular term symbols. Quantum tunnel effect. Fermi and Bose gases.	CO1, CO6
	Unit 2	Approximate methods	
	A	Time dependent perturbation theory, semi classical treatment of radiation-matter interaction, transition probability and rates, Einstein's A and B coefficients, selection rules; Oscillator strength,	CO2, CO6
	B	Variation theorem and variational methods: principles of linear and non-linear variation methods,	CO2, CO6
	C	stationary perturbation theory for non-degenerate and degenerate states - applications to rotator, Stark effect.	CO2, CO6
	Unit 3	Many electron systems	
	A	Antisymmetry of many electron wave function, spin and spatial orbitals, Slater determinant; closed-shell and open-shell electron configurations; multi-electron pure-spin state wave functions - examples with 2- and 3-electron systems,	CO3, CO6
	B	formulation of a multi-electron closed-shell electron configuration energy, introduction of core, Coulomb and exchange integrals with their properties - example of He atom, independent particle model, multi-electron atomic Hartree Hamiltonian and related SCF equations solution,	CO3, CO6
	C	Roothaan-Hartree-Fock method vertical ionization potential and Koopman's theorem; Problems with open-shell systems. Restricted and unrestricted HF methods (elementary idea). discussion of electron correlation.	CO3, CO6
	Unit 4	Kinetics of complex reactions	
	A	Application of statistical mechanics to transition state theory, comparison of transition state theory with experimental results, Kinetics of complex reactions (reversible, simultaneous and consecutive),	CO4, CO6
	B	chain reactions; branched and non-branched kinetic rate equations, population explosion, upper and lower ignition/explosion limits; thermal ignition and ignition temperature; chemical oscillation: conditions for oscillation, chemistry of BZ reaction (Brusselator model); autocatalysis,	CO4, CO6
	C	Fast reactions, experimental techniques for fast reactions	CO4, CO6

		(stopped-flow, temperature- jump and flash photolysis			
	Unit 5	Reactions in solution			
	A	Reaction between ions, effect of solvent (single & double sphere models), interpretation of frequency factor and entropy of activation, influence of ionic strength, salt effect, reactions involving dipoles,			CO5, CO6
	B	influence of pressure and volume on reaction rates in solution. Intermolecular potential and centrifugal barrier, impact parameter, collision cross section and rate, energy threshold, opacity function and reaction cross section			CO5, CO6
	C	Discussion of physicochemical techniques for kinetic study.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1. Quantum Chemistry, I.M. Levine, Prentice Hall. 2. Chemical Kinetics, K. J. Laidler, Harper & Row, New York.			
	Other References	1. Quantum Chemistry by D.A.McQuarrie Viva Books *2.Quantum Chemistry*, H. Eyring, J. Walter and G.E. Kimball, (1944) John Wiley, New York. 3.Foundations of Chemical Kinetics – S.W. Benson			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C233.1	3	1	1	1	3	3	2	2
C233.2	3	1	1	1	3	3	2	2
C233.3	3	2	1	2	3	3	2	2
C233.4	3	1	1	1	3	3	2	2
C233.5	3	1	1	1	3	3	1	2
C233.6	3	1	1	1	3	3	2	2

2.1 Organic Chemistry-III (MCH234)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course No.**	**MCH234**	
2	**Course Title**	**Organic Chemistry III**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.Oxidation and reduction reagents and their application for functional group conversion in organic synthesis. 2.Explain retro-synthesis of aromatic, alicyclic and aliphatic compounds and synthons. 3.The ability to recognize reagents for functional group transformations. 4.Retrosynthetic simplification of target molecules and to provide forward synthetic proposals. 5.Designing a retrosynthetic approach for the synthesis of a target molecule.	
6	Course Outcomes	CO1:Role of various reagents used in organic chemistry. CO2:Have a thorough grounding in protection and deprotection chemistry. CO3:Identify the components of retrosynthesis. CO4:Understand the synthesis and properties of metallocenes, non-benzenoids and polycyclic aromatics. CO5: Design a green synthesis using principles of prevention of waste/by-products/toxic products, atom economy. CO6: Gain in-depth knowledge in synthetic organic chemistry.	
7	Course Description	The aim of this organic chemistry course is to provide an in-depth overview of retrosynthetic analysis and the disconnection approach. These are fundamental concepts used by organic chemists in designing the synthesis of target molecules in sectors such as pharmaceuticals, agrochemicals and fine chemicals.	
8	Outline syllabus		CO mapping
	Unit 1	**Reagents in Organic Synthesis**	
	A	Use of the following reagents in organic synthesis and functional group transformations; Gilman's reagent, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide(DCC)	CO1,CO6
	B	1,3-dithiane (reactivity Umpoloung), trimethylsilyl iodide, tri-n-butyltin hydride, DDQ,	CO1,CO6

	C	Phase transfer catalysts, crown ethers and Merrifield resin, Wilkinson's catalyst, Baker yeast.			CO1,CO6
	Unit 2	**Protection and Deprotection of Functional Groups**			
	A	Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy groups			CO2,CO6
	B	Protection and deprotection of amino groups and carbon-carbon multiple bonds			CO2,CO6
	C	chemo- and regioselective protection and deprotection, illustration of protection and deprotection in multi-step synthesis			CO2,CO6
	Unit 3	**Retrosynthetic Analysis**			
	A	Basic principles and terminology of retrosynthesis, guidelines, synthesis of aromatic compounds			CO3,CO6
	B	one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis			CO3,CO6
	C	important strategies of retrosynthesis, functional group transposition, important functional group interconversions, reversal of polarity (umpolung)			CO3,CO6
	Unit 4	**Metallocenes, Non-benzenoid Aromatics and Polycyclic Aromatic compounds**			
	A	General considerations, synthesis and reactions of some representative compounds - tropone, tropolone, azulene,			CO4,CO6
	B	General considerations, synthesis and reactions of some representative compounds - ferrocene, fluorene,			CO4,CO6
	C	General considerations, synthesis and reactions of some representative compounds - phenanthrene and indene.			CO4,CO6
	Unit 5	**Green Chemistry**			
	A	Principles of Green Chemistry, Concept of atom economy, Tools of Green Chemistry: Alternative feedstocks/starting materials, Reagents, Solvents, Product/target molecules, Catalysis and process analytical chemistry.			CO5,CO6
	B	Evaluation of chemical product or process for its effect on human health and environment, Evaluation of reaction types and methods to design safer chemicals. Evaluating the effects of Chemistry:			CO5,CO6
	C	Toxicity to humans, Toxicity to wildlife, Effects on local environment, Global environmental effects. Planning a green synthesis.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	

	Text Book/s*	1.Organic reactions and their mechanisms, P.S. Kalsi, New Age International. 2.Reagents for Organic Synthesis, L.F. Fieser and M. Fieser. 3.Organic Synthesis: The Disconnection Approach, Stuart Warren, Paul Wyatt. 4. Organic Chemistry, I.L. Finar Volumes I & II.
	Other references	1. Anastas, P., and Williamson, T. C., Green Chemistry Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1999). 2.Ahluwalia, V. K., and Kidwai, M., New Trends in Green Chemistry, Anamaya Publishers (2004). 3.Protective Groups in Organic Synthesis, Peter G. M. Wuts, T.W. Greene. 4.Sheldon, R.A., Arends, I., and Hannefed, U., Green Chemistry and Catalysis, Wiley-VCH Verlag GmbH and Co. (2007).

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C234.1	3	2	1	2	3	1	1	2
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C234.3	3	2	1	2	3	1	1	2
C234.4	3	1	1	1	3	1	1	2
C234.5	3	2	1	2	3	1	1	3
C234.6	3	2	1	2	3	1	1	2

2.1 Inorganic Chemistry-IV (MCH235)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch:Chemistry		**Semester:III**	
Course Code		**MCH235**	
Course Title		**Inorganic Chemistry IV**	
1	Credits	4	
2	Contact Hour	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.To describe about the structure, properties and uses of inorganic chains. 2. To provide information about inorganic ring compounds. 3. To introduce the basic concepts about cluster structure and their reactivity. 4.To illustrate the basic concepts of inorganic photochemistry. 5.To describe the various photochemistry of various inorganic metal complexes. 6. To know about the application of photochemistry.	
6	Course Outcome	CO1: Explain the structure, properties and uses of inorganic cages and chains. CO2: Describe the structure and properties of inorganic rings. CO3: Predict the structure of inorganic clusters using Wade's rule. CO4: Understand photochemical reactions of various coordination compounds. CO5: Apply the knowledge of photochemistry in real life problems. CO6: Gain knowledge about advanced topics like inorganic photochemistry and inorganic clusters	
7	Course Description	The course is designed to appraise the chemistry of inorganic chains, cages, rings, clusters. The photochemistry of inorganic compounds is also covered in detail.	
8	Outline syllabus		CO mapping
	Unit 1	**Chains and Cages**	
	A	Structural aspects of silicate minerals and silicones, Zeolites-Structure, applications and synthesis, Intercalation Chemistry, One dimensional conductors, (SN)x chains.	CO1,CO6
	B	Cages: Electron deficient bonding in higher boranes and its derivatives, Types of heteroboranes with special reference to carboranes, structure, bonding and IUPAC nomenclature.	CO1,CO6
	C	Metallaboranes, metal σ and μ bonded borane/carborane clusters. Resemblance of Metallaboranes with ferrocene and related compounds. Applications of Metallaboranes.	CO1,CO6
	Unit 2	**Rings and Clusters**	

	A	Rings : Synthesis, structure and chemical application of borazine, Phosphazene, phosphazene polymers, Metal-Metal bonds. Concept of quadrupolar bond and its comparison with a C-C bond.			CO2,CO6
	B	Clusters: Types of metal clusters and multiplicity of M-M bonds. Simple and condensed metal carbonyl clusters-types, calculation of number of M-M bonds using 18/16 electron rule in low and high nuclearity metal clusters, capping rule.			CO2,CO6
	C	Application of Wade's rule over metral carbonyl clusters. Metal halide and metal chalcogenide clusters.			CO2,CO6
	Unit 3	**Photo Inorganic Chemistry-I**			
	A	Introduction, Absorption, excitation, photochemical laws, quantum yield, electronically excited states, Photochemical laws; Jablonski Diagram			CO3,CO6
	B	radiative and non-radiative processes, Franck-Condon principle, photochemical stages-primary and secondary processes, Kasha's rule, Thexi state			CO3,CO6
	C	Types of photochemical reactions in transition metal complexes–substitution, decomposition, fragmentation, rearrangement and redox reactions.			CO3,CO6
	Unit 4	**Photo Inorganic Chemistry-II**			
	A	Photo substitution reactions of Cr(III)- ammine complexes : Adamson's rules,			CO4,CO6
	B	Photochemistry of Co(III) and Rh(III) Ammine Complexes,			CO4,CO6
	C	Photochemistry of Ru- Polypyridyl complexes, comparison of Fe(II) and Ru(II) complexes. Ligand photoreactions, photoredox reactions			CO4,CO6
	Unit 5	**Applications of Photochemistry**			
	A	Solar Cells, semiconductor supported metal oxide systems, water photolysis.			CO5,CO6
	B	Applications of quenching and sensitization techniques in the identification of reactive state in coordination complexes. Photoreactions and solar energy conversions.			CO5,CO6
	C	Photochromism, Photocalorimetry, application of photochemistry in lasers.			CO5,CO6
	Mode of Examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text Book/s*	1.J.E.Huheey. Inorganic Chemistry: Principles of Structure and Reactivity. Harper Inter science. 2.F. A. Cotton and G. Wilkinson. Advanced Inorganic Chemistry, Wiley InterScience.			

		3.Concepts of Inorganic Photochemistry, A. W. Adamson and P. D. Fleischauer, Wiley. 4. Advanced Inorganic Chemistry Vol-1 & 2, Gurdeep Raj, Krishna Prakashan.
	Other References	1.G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd edition, Pearson Education.

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C235.1	3	1	1	1	3	1	1	2
C235.2	3	1	1	1	3	1	1	2
C235.3	3	1	1	1	3	1	1	2
C235.4	3	2	1	2	3	1	1	2
C235.5	3	2	1	2	3	1	1	2
C235.6	3	1	1	1	3	1	1	2

2.1 Physical Chemistry-IV (MCH236)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course Code**	**MCH236**	
1	**Course Title**	**Physical Chemistry IV**	
3	**Credits**	**4**	
4	**Contact hours**	**4-0-0**	
	Course Status	**Compulsory**	
5	Course Objectives	The main objectives of this course is to: 1: To provide the details of advanced topics of spectroscopy. 2. To provide the detailed understanding of Rotational spectroscopy. 3. To provide the structure elucidation methods using IR spectroscopy. 4. To provide the detailed knowledge of the electric structure of molecules. 5. To provide the knowledge of the phenomenon associated with photoelectron spectroscopy. 6. To enrich the student level of understanding of molecular spectroscopy.	
6	Course Outcome	After successful completion of the course, the students will be able to: CO1: Analyse the essential parameters from absorption and emission spectrum. CO2: Analyse the microwave spectrum of a molecule. CO3: Analyse the IR spectrum and obtain the bond strength parameters. CO4: Analyse the ground and excited state Absorption and emission spectrum of the molecules. CO5: Investigate the photoelectron spectrum of the molecules. CO6: Correctly predict the molecular structure and associated properties using various spectroscopic techniques.	
7	Course Description		
8	Outline Syllabus		CO mapping
	Unit 1	**Principles of Spectroscopy**	
	A	Electromagnetic radiation, Born-Oppenheimer approximation, Heisenberg's Uncertainty Principle,	CO1, CO6
	B	Jablonski Diagram, Fourier Transform, Time dependent perturbation, Einstein coefficients. Lambert-Beer's law, Integrated absorption coefficients, Transition dipole moments and general selection rules based on symmetry ideas,	CO1, CO6

	C	Transition probability, oscillator strength, the integrated absorption coefficient.	CO1, CO6
	Unit 2	**Introduction to Rotational Spectroscopy**:	
	A	Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, Determination of bond lengths and/or atomic masses from microwave data,	CO2, CO6
	B	Effect of isotopic substitution, Non-rigid rotator, Classification of polyatomic molecule	CO2, CO6
	C	Energy levels and spectra of symmetric top molecules and asymmetric top molecules, First order Stark effect, FC principle.	CO2, CO6
	Unit 3	**Vibrational Spectroscopy:**	
	A	Force constant and amplitudes, zero potential energy, Morse Potential, Normal coordinates analysis of homonuclear and heteronuclear diatomic molecules, Extension to polyatomic linear molecules,	CO3, CO6
	B	Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. 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.	CO3, CO6
	C	**Raman Spectroscopy:** Classical and quantum theories, Stokes and anti-Stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy, pure rotational Raman Spectrum of a linear molecules. Selection rules-Mutually Exclusion Principle, Polarization of Raman lines.	CO3, CO6
	Unit 4	**UV-Visible Absorption and Emission Spectroscopy:**	
	A	Basic principle, Instrumentation and application of absorption and emission spectroscopy, Electronic spectra, Frank-Condon Principle, predissociation spectra, conjugated polyene and enone systems, different types of charge transfer transitions and their basis, Charge transfer spectra in organic and inorganic systems, solvent effects.	CO4, CO6
	B	Steady-state fluorescence spectroscopy,	CO4, CO6

		Mirror-image symmetry and its violation, Radiative and radiationless deactivation, Fluorescence Quenching (static and Dynamics), Room Temperature Phosphorescence, Time-resolved (Time correlated single photon counting-TCSPC) fluorescence spectroscopy, Fluorescence lifetime measurement,			
	C	Introduction to Single molecule fluorescence and fluorescence imaging, Photometric titration, comparison of Luminescence and UV Absorption Methods, Limitation of absorption and emission measurement.			CO4, CO6
	Unit 5	**Photoelectron Spectroscopy:**			
	A	The photoionization processes, Auger and autoionization processes, de-excitaion by fluorescence,			CO5, CO6
	B	outlines of UPS, XPS and Auger techniques and their applications in interpretation of valence and core shell spectra of atoms and molecules,			CO5, CO6
	C	Laser Spectroscopy.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1. Fundamentals of Molecular Spectroscopy, Banwell, 3rd Edition, 2018. 2. Pavia, D. L.; Lampmann, G. M.; Kriz, G. S.; Vyvyan, J. R. Introduction to Spectroscopy Cengage Learning (2014). 3. Barrow, G. M. Introduction to Molecular Spectroscopy McGraw-Hill (1962). 4. Hollas. J. M. Modern Spectroscopy 4th Ed., John Wiley & Sons (2004). 5. Chang, R. Basic Principles of Spectroscopy McGraw-Hill, New York, N.Y. (1970).			
	Other References	-			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C236.1	3	1	1	1	3	3	2	2
C236.2	3	1	1	1	3	3	2	2
C236.3	3	2	1	2	3	3	2	2
C236.4	3	1	1	1	3	3	2	2
C236.5	3	1	1	1	3	3	1	2
C236.6	3	1	1	1	3	3	2	2

2.1 Organic Chemistry-IV (MCH237)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.			
Branch:Chemistry		**Semester : III**	
1	**Course No.**	**MCH237**	
2	**Course Title**	**ORGANIC CHEMISTRY IV**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course status	Compulsory	
5	Course Objective	1.Define the photochemistry and distinguish absorption and emission process 2.Describe the nature of light. 3.Distinguish between electric and magnetic fields, describe the action of light with matter. 4.Compare between spontaneous and simulated emission. h) Describe the electronic transition i) State photochemistry laws 5.Understanding of some important aspects of pericyclic reactions, to learn the orbital interactions (Woodward Hoffmann rules) in concerted reactions 6.Apply concerted and stepwise reactions in organic synthesis	
6	Course Outcomes	CO1:Define types of photochemical reactions, list the factors determining reactivity, describe Franck Condon Principle. CO2:Compare between Norish type I and Norish type II, distinguish inter & intra molecular cyclo addition, describe photodissociation reaction. CO3:Learn photorearrangement reactions and compare between types of singlet oxygen reactions. CO4: Know what are pericyclic reactions, learn about classification of pericyclic reactions, identify electrocyclic reaction and evaluate application of Woodward-Hoffmann rules to pericyclic reactions. CO5: identify various theories/rules governing electrocyclic reaction, cycloaddition and sigmatropic shifts and analyze which type of pericyclic mechanism is operative in a reaction. CO6:Understand the concepts involved in organic photochemical reactions, their mechanisms and applications in organic synthesis.	
7	Course Description	The course is framed to make students familiar with the concepts and applications in two important topics in advanced organic chemistry, namely concerted organic reactions and organic photochemistry. Different methods of analysis of pericyclic reactions to arrive at the Woodword-Hoffmann rules are discussed. This course will uncover all the major topics in pericyclic reactions and organic photochemistry.	
8	Outline syllabus		CO mapping
	Unit 1	**Photochemistry Part I**	

	A	Introduction, Primary photophysical process of atoms and diatomic molecules, spectroscopic notations, Frank condon principle and its applications, rates of absorption and emission, quantum efficiency/quantum yield	CO1,CO6
	B	quenching of excited states species, radiationless transition and predissociation, energy transfer processes, Wigner's spin rule	CO1,CO6
	C	Woodward Hoffman's rule, mechanistic analysis of photochemical reactions by spectroscopic techniques, sources of high energy radiation, chemical dosimetry, comparison between photo and radiation chemistry.	CO1,CO6
	Unit 2	**Photochemistry Part II**	
	A	Photochemistry of Olefins- Cis-trans isomerism, cycloaddition, rearrangements. Reaction of conjugated olefins; di-π-methane rearrangements (including oxa- and aza-).	CO2,CO6
	B	Photochemistry of Ketones: Excited state of C=O, Norrish type-I and type-II cleavages.	CO2,CO6
	C	Paterno-Buchi reaction, α,β-unsaturated ketones, Rearrangement of cyclohexadienones.	CO2,CO6
	Unit 3	**Photochemistry Part III**	
	A	Photochemistry of Aromatic compounds - Photorearrangement of benzene and its derivatives, Photo-Fries reactions of anilides, cycloaddition of benzene, Photo-Fries rearrangement	CO3,CO6
	B	Barton reaction, Hunsdiecker reaction, Photochemical oxidations and reductions	CO3,CO6
	C	Cycloaddition of singlet molecular oxygen, Oxidative coupling of aromatic compounds, photoreduction by hydrogen abstraction	CO3,CO6
	Unit 4	**Pericyclic Reactions I**	
	A	Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.	CO4,CO6
	B	Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams. FMO and PMO approach, transition state (ATS) theory, generalized orbital symmetry (GOS) rule.	CO4,CO6
	C	Electrocyclic reactions – conrotatory and disrotatory motions, [4n], [4n+2] and allyl systems, torquoselectivity.	CO4,CO6
	Unit 5	**Pericyclic Reactions II**	
	A	Cycloadditions – antarafacial and suprafacial additions, 4n and 4n+2 systems. Regio, enantio and Endo selectivities in Diels-Alder reactions.	CO5,CO6
	B	Hetero Diels-Alder reaction, 2+2 addition of ketenes,	CO5,CO6

		Dipolar cycloadditions, retrocycloadditions.		
	C	Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties. [i, j] - sigmatropic rearrangements (including Walk, Claisen, Cope, oxy and aza-Cope rearrangements).		CO5,CO6
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
	Text book/s*	1. Reaction Mechanism in Organic Chemistry; S. M. Mukherji and S. P. Singh. 2.Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee		
	Other References	1. Modern Synthetic reaction by H. O. House, W.A. Benjamin 2. Advanced Organic Chemistry part B, F.A. Carey & R.J. Sundberg, Plenum Press.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C237.1	3	1	1	1	3	1	2	2
C237.2	3	1	1	1	3	1	1	2
C237.3	3	2	1	2	3	1	1	2
C237.4	3	2	1	2	3	1	1	2
C237.5	3	2	1	2	3	1	1	2
C237.6	3	1	1	1	3	1	1	2

2.1 Environmental Chemistry (MCE201)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.			
Branch:Chemistry		**Semester: III**	
1	**Course Code**	**MCE201**	
2	**Course Title**	**Environmental Chemistry**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Elective	
5	Course Objective	1.To introduce the basics knowledge of chemistry of environment. 2.To describe the chemistry of hydrosphere. 3.To provide an introduction to chemistry of soil. 4.To explain to the student the causes of industrial pollution. 5.To provide information environmental toxicology. 6.To illustrate the infamous cases of environment related disasters.	
6	Course Outcomes	CO1:Understand the chemistry of atmosphere. CO2:Understand the chemistry of hydrosphere. CO3:Explain the chemistry of soil. CO4: Know about adverse effect of industrialization and possible prevention method CO5:Know about environmental toxicology and a few example of environmental disaster. CO6: Gain knowledge about the chemistry of atmosphere, factors affecting it and possible prevention methods	
7	Course Description	This course describes the chemistry of earth atmosphere, soil and water bodies. It also describes the adverse effect of industrial pollution and its possible prevention method.	
8	Outline syllabus		CO Mapping
	Unit 1	**Earth's Atmosphere**	
	A	Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere	CO1,CO6
	B	Bio-distribution of elements. Reactions in atmosphere, Stratospheric chemistry. Chemistry of photochemical smog, Precipitation, Acid rain, Production and removal of nitric acid, Sulphuric acid	CO1,CO6
	C	Atmospheric aerosols-Sources, Concentrations, Control. Chemistry of global climate. Air sampling techniques, Sources, effects and monitoring of air pollutants by Instrumental methods, Control of air pollution	CO1,CO6
	Unit 2	**Hydrosphere**	

	A	Chemical composition of water bodies – lakes, streams, rivers and wetlands etc Hydrological cycle. Aquatic pollution-inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants	CO2,CO6
	B	water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms, water quality standards, Analytical methods for measuring BOD, DO, COD, F, OILS, METALS (As, Cd, Cr, Hg, Pb, Se), Residual chloride and chlorine demand, purification and treatment of water.	CO2,CO6
	C	Distribution of species in aquatic systems: Single variable diagrams, Two variable diagrams, Method of calculating pE^o	CO2,CO6
	Unit 3	**Soils**	
	A	Chemical composition of the soil, micro and macronutrients, the exploitation of the mineral resources and abuse of the earth	CO3,CO6
	B	soil pollution due to natural and artificial agencies and its effects, remedial measures to check the pollution. pollution-fertilizers, pesticides, plastics and metals, waste treatment.	CO3,CO6
	C	Humic material–Formation, Composition, Structure determination using spectroscopy, Properties. Radioactive pollution, disposal of radioactive waste	CO3,CO6
	Unit 4	**Industrial Pollution**	
	A	Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers, drugs etc	CO4,CO6
	B	radionuclide analysis, disposal of wastes and their management. Waste Water, Treatment of Industrial Waste Water,	CO4,CO6
	C	Environmental Impact Assessment process in India.	CO4,CO6
	Unit 5	**Environmental Toxicology**	
	A	Chemical solutions to environmental problems, biodegradability,	CO5,CO6
	B	principles of decomposition, better industrial processes. Bhopal Gas Tragedy, Chernobyl Disaster, Three Mile Island, Sewozo and Minamata disasters**.**	CO5,CO6
	C	Occupational safety Hazard Assessment, MSDS	CO5,CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
	Text book/s*	1.Environmental Chemistry, A.K.Das. 2.Environmental Chemistry, Samir K. Banerji. 3.Environmental Chemistry H. Kaur, 6th Edn, Pragathi Prakashan, Meerut, 2011. 4.Environmental Pollution Analysis, S. M. Khopkar, New Age International (P) Ltd, 1993.		
	Other References	1.Analysis of Industrial Waste Water, K.H.Mancy and W,.J.Weber Jr. Wiley, Interescience New York, 1971. 2.Environmental Chemistry, L.W. Moore and E. A. Moore, McGraw Hill Publication, New York 3.Environmental Chemistry, Colid Baird. W. H. Freemand and Company, 1995.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C201.1	3	2	1	2	3	2	2	3
C201.2	3	1	1	2	3	2	2	3
C201.3	3	2	1	3	3	2	2	3
C201.4	3	1	1	2	3	2	2	3
C201.5	3	2	1	1	3	2	1	3
C201.6	3	2	1	1	3	2	1	3

2.1 Polymer Science and Technology (MCE202)

School: SSBSR		**Batch: 2023-25**
Programme: M.Sc.		
Branch:Chemistry		**Semester:III**
1	**Course Code**	**MCE202**
2	**Course Title**	**Polymer Science and Technology**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Elective
5	Course Objective	1. To impart knowledge on synthesis of polymers using different polymerization methods/techniques and their characterization. 2. To provide basic understanding on the synthesis and characterization of different types of copolymers and preparation of polymer blends and IPNs. 3. To elaborate on the end-uses of polymers as matrix resins for composites, coatings and adhesives. 4. To disseminate information on advanced polymeric systems and speciality polymers. To describe different processing techniques of polymers and to discuss degradation of polymers and the effect of use of polymers on environment.
6	Course Outcomes	CO1:Basic understanding on synthesis of polymers, determination of molecular weight and characterization of polymers using chemical methods and different instruments. CO2:Concept on the factors influencing the copolymerization of monomers and their microstructure, use of block copolymers as thermoplastic elastomers and compatibilizers for polyblends and knowledge on IPNs and Semi-IPNs. CO3:Knowledge on broad spectrum of end-use of polymers as matrix resins for composites, coatings and adhesives and their applications. CO4:Exposure to advanced polymeric systems such as shape memory polymers, self healing polymers, engineering plastics and inorganic polymers. CO5:Understanding of different polymer processing techniques. CO6:Understanding the synthetic pathways and functional polymers along with factors influencing the degradation of polymers and gaining knowledge on the management of plastics and the environmental impact.
7	Course Description	This elective course on Polymer Science and Technology covers the synthesis and characterization of homopolymers and copolymers, thermoplastic elastomers, polymer blends, interpenetrating polymer network (IPN) structures, polymer matrix composites, adhesives and coatings. This course also covers certain advanced/speciality polymer systems such as shape memory polymers, dentrimers, hyperbranched

		polymers and inorganic polymers. An insight into polymer processing techniques, polymer degradation and recycling also forms part of this course.	
8	Outline of syllabus		CO Mapping
	Unit 1	**Synthesis and Characterization of Polymers**	CO1,CO6
	A	Atom Transfer polymerization, Group Transfer Polymerization, Ring Opening Polymerization. Molecular weight: number average, weight average, viscosity average molecular weight, z-average molecular weight, molecular weight distribution.	CO1,CO6
	B	Measurement of molecular weight and size: Colligative property measurement, Light scattering, ultracentrifuge, viscosity, Gel Permeation Chromatography, Fractionation of polymers by solubility.	CO1,CO6
	C	Characterization of polymers: chemical methods, spectroscopic methods, X-ray diffraction, microscopy and thermal analysis.	CO2,CO6
	Unit 2	**Copolymers, Thermoplastic elastomers, polymer blends and IPNs**	CO2,CO6
	A	Copolymers: Radical copolymerization - monomer reactivity ratios, Q-e factor, Formation of random, alternating and block copolymers in radical copolymerization based on monomer reactivity. Monomer sequencing (diad and triad structures) in copolymers using NMR spectroscopy.	CO2,CO6
	B	Thermoplastic elastomers: ABA and $(AB)_n$ type block copolymers as thermoplastic elastomers, their microstructure and applications.	CO2,CO6
	C	Role of block copolymers as compatibilizers Interpene-trating Polymer Networks (IPNs): Semi-IPNs and full IPNs – Synthesis, characterization and applications.	CO2,CO6
	Unit 3	**Polymer matrix composites (PMCs), Adhesives and Coatings**	CO3,CO6
	A	Polymer matrix composites: Matrix resins-epoxy resins, phenolic resins and polyimides, Reinforcement-particulate, short fiber, continuous fiber-glass fibre and carbon fibre, characterization techniques and mechanical properties. Polymer Nano Composites, Aerospace and defence applications of PMCs.	CO3,CO6
	B	Adhesives: Theory of adhesion, an overview of polymers used as adhesives, high temperature adhesives, evaluation of adhesive properties. Applications of adhesives.	CO3,CO6
	C	Coatings: Water-borne and solvent based coatings, polymers as binders in paints. Self cleaning coatings.	CO3,CO6

		Applications of coatings.			
	Unit 4	**Advanced Polymers/Speciality Polymers**			CO4,CO6
	A	Shape Memory Polymers, Self-Healing Polymers, Dentrimers and hyper-branched polymers, Conducting polymers, Liquid Crystalline Polymers.			CO4,CO6
	B	Engineering thermoplastics: Polyetherimide, Poly-carbonate.			CO4,CO6
	C	Inorganic polymers: Polyphosphazene, polysilane, polycarbosilane, polysiloxane and polymetallosiloxanes.			
	Unit 5	**Polymer Processing, Polymer degradation and the environment**			CO5,CO6
	A	Basic processing operations: Extrusion, Molding, Coating, Vulcanization and Fiber drawing.			CO5,CO6
	B	Polymer degradation: Thermal degradation, Oxidative and UV stability, Chemical and hydrolytic stability, Effects of radiation.			CO5,CO6
	C	Environment: Management of plastics in the environment-recycling, incineration and biodegradation.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1. Text book of Polymer Science, Third Edition, F.W. Billmeyer, Jr. Wiley-Intersciene, 2003. 2. Polymer Science & Technology, J. R. Fried, Prentice-Hall Inc., USA (Indian Reprint) 2005. Polymers: Chemistry and Physics of Modern Materials, 3rd edition, by J.M.G. Cowie and V. Arrighi, New York, CRC Press, 2008.			
	Other References	1. Macromolecules: An Introduction to Polymer Science, F. A. Bovey and F. H. Winslow, Academic Press, New York, 1979. 2. Inorganic Polymers, 2nd Edtition, J. E. Mark, H. R. Allcock and R. West, Oxford University Press, 2005. 3. Adhesives Technology Handbook, 3rd Edition, Sina Ebnesajjad and Arthur H. Landrock (Imprint: William Andrew) Elsevier, 2014. 4. Processing of Polymer Matrix Composites, P.K. Mallick, CRC Press, 2017. 5. Engineering Thermoplastics: Properties and Applica-tions, Margolis, CRC Press, 1985.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C202.1	3	1	1	1	3	1	3	2
C202.2	3	1	1	1	3	1	3	2
C202.3	3	1	1	1	3	1	1	2
C202.4	3	2	1	2	3	1	1	2
C202.5	3	2	1	2	3	1	1	2
C202.6	3	1	1	1	3	1	1	3

2.1 Inorganic Chemistry-V (MCH238)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.			
Branch:Chemistry		**Semester: IV**	
1	**Course Code**	**MCH238**	
2	**Course Title**	**Inorganic Chemistry V**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To describe about basic principles and importance of various metals in natural systems. 2. To describe various ion transport through biological membrane. 3.To explain the importance of Iron and Copper containing metallo-biomolecule. 4.To illustrate the chemistry of bio molecules like DNA and RNA. 5.To describe the bioinorganic chemistry of Molybdenum, Tungsten and Zinc containing Enzymes. 6. To describe the bioinorganic chemistry of Vitamin B_{12}.	
6	Course Outcomes	CO1:Explain the transport of ions through membrane CO2: Predict the structure and mechanism of Fe and Cu containing metalloproteins. CO3:Learn about structure and chemistry of DNA and RNA. CO4: Understand the importance of Molybdenum, Tungsten and Zinc containing Enzymes. CO5 : Illustrate biologically important processes like photosynthesis CO6:Understand the role and importance of metal ions in biology.	
7	Course Description	This course includes details discussion about various bio molecules and metal containing enzymes with special reference to iron, copper, zinc, tungsten and molybdenum.	
8	Outline syllabus		CO Mapping
	Unit 1	**Bioinorganic Chemistry of Metals**	
	A	Essential and trace elements in biological systems,	CO1,CO6
	B	structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump, role of calcium in muscle contraction, blood clotting mechanism and biological calcification.	CO1,CO6
	C	Structure and functions of amino acids, proteins, peptides and comparative study of structures and functions of these biomolecules	CO1,CO6

	Unit 2	**Bioinorganic Chemistry of Iron and Copper**	
	A	Iron-sulphur proteins: rubredoxin and ferredoxins;	CO2,CO6
	B	Metalloporphyrins; Heme proteins: hemoglobin, myoglobin. Cytochrome P-450, Cytochrome c-oxidase and cytochrome c;	CO2,CO6
	C	Synthetic oxygen carrier and model systems. Thermodynamic and kinetics of oxygenation; Non-heme proteins: hemerythrin and hemocyanin.	CO2,CO6
	Unit 3	**Bioinorganic Chemistry in Biological Systems**	
	A	Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA and RNA).	CO3,CO6
	B	Stability of DNA and melting temperature.	CO3,CO6
	C	Role of metal ions in replication and transcription process of nucleic acids. Metal deficiency and disease	CO3,CO6
	Unit 4	**Molybdenum, Tungsten and Zinc containing Enzymes**	
	A	Enzymes and their classification ; Importance of Zn in nature, carbonic anhydrase, carboxypeptidase, alcohol dehydrogenase.	CO4,CO6
	B	Biological nitrogen fixation (Nitrogenase) and abiological nitrogen fixation	CO4,CO6
	C	tungsten containing formate dehydrogenase and tungsten bearing hyperthermophilic and thermophilic enzymes.	CO4,CO6
	Unit 5	**Biologically Important Processes**	
	A	Photosynthetic electron transport chain, chlorophyll, PS-I and PS-II,	CO5,CO6
	B	Vitamin B 12 coenzyme, its function and application in organic synthesis.	CO5,CO6
	C	Availability of iron and iron toxicity.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 15% / MTE: 10% / ETE: 75%	
	Text book/s*	1. S. J. Lippard & J. M. Berg. Principles of Bioorganic Chemistry; Panima Publ. Corpn. (2005). 2. E. -I. Ochiai. Bioinorganic Chemistry; An Introduction; Allyn and Bacon Inc. (1977).	
	Other References	1.M. N. Hughes. The Inorganic Chemistry of Biological Processes; Wiley (1981). 2.R. P. Hanzlik. Inorganic Aspects of Biological and Organic Chemistry; Academic Press (1976). 3.H. Kraatz & N. Metzler-Nolte (Eds.). Concepts and Models in	

		Bioinorganic Chemistry; Wiley (2006). 4.Bertini; H. B. Gray; S. J. Dippard & J. S. Valentine; Bioinorganic Chemistry; Viva Books Pvt. Ltd. (2004). 5.A. W. Addison; W.R. Cullen; D. Dolphin & B.R. James (eds.). Biological Aspects of Inorganic Chemistry; John Wiley (1977).

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C238.1	3	1	1	1	3	3	1	1
C238.2	3	1	1	1	3	3	1	2
C238.3	3	1	1	2	3	3	1	2
C238.4	3	1	1	2	3	3	1	1
C238.5	3	1	1	2	3	3	1	1
C238.6	3	1	1	1	3	3	1	2

2.1Physical Chemistry-V (MCH239)

School: SSBSR		**Batch : 2023-2025**	
Programme: M. Sc			
Branch: Chemistry		**Semester:IV**	
1	Course Code	MCH 239	
2	Course Title	**PHYSICAL CHEMISTRY-V**	
3	Credits	4.0.0	
4	Contact Hours (L-T-P)	(4 0 0)	
	Course Status	Compulsory	
5	Course Objective	1. To provide the understanding of Quantum mechanical aspect of Band gap and Band theory in semi conductors. 2. To understand the various techniques for the preparation of nanomaterial and properties of nanomaterials. 3. To extend the concept of X-Ray diffraction, their generation and different experiments to study X-Ray diffraction. 4. To provide the understanding of physical aspects in Biological phenomenon. 5. To provide the indepth concept of polymers and their properties.	
6	Course Outcomes	CO1: Direct and indirect band gap in semiconductors, types and analysis of p-n junctions. CO2: Students will be able to prepare nanomaterials and will be able to characterize their optical, electronic and structural properties. CO3:Students will be able to understand the generation of X-rays and diffraction patterns and will be able to refine the X-ray patterns. CO4: Students will be able to understand the energy Transformation and Thermodynamic principles and their applications in biological system. CO5: Student will be able to calculate the molecular weights of polymers using different techniques and will able to identify different physical and rheological properties of polymers. CO6: In depth knowledge of semiconductors, nanomaterials and polymers with application of X-rays, their generation and refinement of structure, application of physical phenomenons in biological system.	
7	Course Description	Course emphasizing on the application part of Solid state chemistry and analysis of structure using X-Ray diffraction, materials chemistry, Biophysical aspects and applications and properties of polymers.	
8	Outline syllabus		CO Mapping
	Unit 1	**Solid State Chemistry**	
	A	Free electron theory of metals, Quantum mechanical treatment explaining the origin of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective	CO1,CO6

		mass of charge carriers,	
	B	Semiconductors: Direct and indirect band gap semiconductors, hole concept, temperature dependence of mobility and electrical conductivity, free carrier concentration in intrinsic and extrinsic semiconductors, mass active law,	CO1,CO6
	C	Generation of carriers and their recombination in semiconductors. Types of junctions (metal-semiconductor, semiconductor-semiconductor, junctions in organic materials), Analysis of p-n junction including I-V characteristics.	CO1,CO6
	Unit 2	**Materials Chemistry**	
	A	Definition of nanomaterials, various techniques for the preparation of nanomaterials, Thermodynamics and Kinetics of Nucleation, Thin Films and	CO2,CO6
	B	Langmuir-Blodgett films - Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, sol-gel. Langmuir-Blodgett (LB) film growth techniques,	CO2,CO6
	C	photolithography, properties and applications of thin and LB films. Electronic structure and properties of nanomaterials, optical, electrical and magnetic properties, Chemical behaviour, applications of nanomaterials.	CO2,CO6
	Unit 3	**X-Ray Diffraction and Crystal Structure**	
	A	Generation of X-rays**,** diffraction of X-rays by crystals, systematically absent reflections, multiplicities,	CO3,CO6
	B	X-ray diffraction experiments: the powder method-Bragg condition, Laue method, Bragg method and single crystal method, scattering of X-rays by atoms and a crystal,	CO3,CO6
	C	Patterson Synthesis, the Rietveld Refinement of $BaTiO_3$, ZnO and $BaSnO_3$, R-factor.	CO3,CO6
	Unit 4	**Biophysical Chemistry**	
	A	Energy Transformation and Distribution of Energy, Thermodynamic principles in biological systems; Osmotic pressure, membrane equilibrium,	CO4,CO6
	B	muscular contraction and energy generation in mechanochemical system.Cell Membrane and Transport of Ions: Structure and functions of	CO4,CO6

		cell membrane.		
	C	Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.		CO4,CO6
	Unit 5	**Polymers**		
	A	Introduction, Classification of polymers, Concept of Mass and Number average molecular weights, Methods of Determining molecular weights (osmometry,		CO5,CO6
	B	diffusion and light scattering), Physical properties of polymers (glass transition temperature, crystalline melting point),		CO5,CO6
	C	Rheological Properties, Biodegradable and Biomedical polymers, Liquid crystal polymers.		CO5,CO6
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
	Text book/s*	1.Polymer Chemistry, Billmayer 2.Polymer Chemistry, Gowarikar 3. Biological Thermodynamics, Donald T. Haynie, Cambridge. 4.Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel 5.Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalaya Publishing House 6.Introduction to Biophysical chemistry, R. Bruce Martin, McGraw-Hill, NY, 1964. 7. Solid State Chemistry and its Applications(1984), A.R. West, John Wiley and Sons, Singapore 8. Introduction to Solids(1977), L.V. Azaroff, Tata McGraw-Hill, New Delhi 9. Solid State Chemistry(1992), L. Smart and E Moore, Chapman & Hall, Madras 10. Principles of Solid State(1993), H. V. Keer, Wiley Eastern 11. Instrumental methods of chemical analysis: Braun		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C239.1	3	1	1	1	3	3	2	2
C239.2	3	1	1	1	3	3	2	2
C239.3	3	2	1	2	3	3	2	2
C239.4	3	1	1	1	3	3	2	2
C239.5	3	1	1	1	3	3	1	2
C239.6	3	1	1	1	3	3	2	2

2.1 Organic Chemistry-V (MCH240)

School: SSBSR		**Batch : 2023-25**	
Programme: M.Sc.			
Branch:Chemistry		**Semester: IV**	
1	**Course No.**	**MCH240**	
2	**Course Title**	**Organic Chemistry V**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1.To impart knowledge on synthesis of five and six- member heterocyclic compounds with two or more hetero atoms. 2.To familiarize with the synthesis of larger ring heterocyclic compounds. 3.To impart knowledge on synthesis of natural products. 4.To familiarize with structure determination and stereochemistry of terpenoids and carotenoids. 6.To understand the structure and significance of alkaloids.	
6.	Course Outcomes	CO1: Understand the structure, properties, synthesis and reactions of five and six- member heterocyclic compounds with two or more hetero atoms. CO2: Propose syntheses and applications of heterocycles from the major classes. CO3:Describe the structure and synthesis of terpenoids and carotenoids. CO4:Formulate the synthesis of few important alkaloids. CO5:Identify medicinal properties of alkaloids. CO6: Acquire basic knowledge of natural product chemistry and understand the importance heterocycles in biological systems and in pharmaceuticals.	
7	Course Description	This course will provide a concise introduction to heterocyclic chemistry. Emphasis will be given on the most important heterocyclic systems particularly five, and six-membered heterocyclic systems with 2- or 3-heteroatoms as well as fused heterocyclic systems. Chemical synthesis, properties, characteristics and applications of these systems will be discussed in detail. The course provides a basic knowledge of natural products chemistry with emphasis on terpenoids, carotenoids and alkaloids.	
8	Outline syllabus		CO Mapping
	Unit 1	**Heterocycles I**	
	A	Introduction**,** synthetic approaches, reactions and important applications of five membered heterocyclic compounds with two or three hetero atoms - imidazole, oxazoles,	CO1,CO6
	B	synthetic approaches, reactions and important	CO1,CO6

		applications of - thiazoles, oxadiazoles,	
	C	synthetic approaches, reactions and important applications of - thiadiazoles, triazole.	CO1,CO6
	Unit 2	**Heterocycles II**	
	A	Introduction**,** synthetic approaches, reactions and important applications of condensed five and six membered heterocycles with one hetero atom – indole,	CO2,CO6
	B	synthetic approaches, reactions and important applications of – benzofuran, benzothiophene,	CO2,CO6
	C	Synthetic approaches, reactions and important applications of – quinoline and isoquinoline.	CO2,CO6
	Unit 3	**Heterocycles III**	
	A	Introduction**,** synthetic approaches, reactions and important applications of six membered heterocyclic compounds with two hetero atoms – pyridazine.	CO3,CO6
	B	synthetic approaches, reactions and important applications of pyrimidine	CO3,CO6
	C	synthetic approaches, reactions and important applications of pyrazine.	CO3,CO6
	Unit 4	**Terpenoids and carotenoids**	
	A	Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination and synthesis of the following representative molecules: Monoterpenoids - Citral, geraniol (acyclic), α-terpeneol, menthol (monocyclic). Sesquiterpenoids - Farnesol (acyclic), zingiberene (monocyclic), santonin (bicyclic), Diterpenoids - Phytol and abietic acid, β- carotene, lycopene and vitamin A.	CO4,CO6
	B	Structure determination and synthesis of the following representative molecules: Sesquiterpenoids - Farnesol (acyclic), zingiberene (monocyclic), santonin (bicyclic),	CO4,CO6
	C	Structure determination and synthesis of the following representative molecules: Diterpenoids - Phytol and abietic acid, β- carotene, lycopene and vitamin A.	CO4,CO6
	Unit 5	**Alkaloids**	
	A	Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.	CO5,CO6
	B	Occurence, synthesis and structure elucidation of alkaloids – Reserpine	CO5,CO6
	C	Occurence, synthesis and structure elucidation of alkaloids –morphine.	CO5,CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MTE	ETE
		15%	10%	75%
9	Text Book/s*	1.Heterocyclic Chemistry, T. L. Gilchrist. 2.An Introduction to the Chemistry of Heterocyclic compounds, R. M. Acheson. 3. Heterocylic chemistry, J. A. Joule & K. Mills. 4. Principles of Modern Heterocyclic Chemistry, A. Paquette. 5. Heterocyclic Chemistry, J. A. Joule & Smith. 6. Handbook of Heterocyclic Chemistry, A. R. Katritzky. 7.Natural Products : Chemistry and Biological significance, J. Mann, R. S. Davidson, J. B. Hobbs, D. V., Banthropde & J. B. Harborne. 8.Organic Chemistry, Vol-2, I. L. Finar		
10	References	1.Stereoselective Synthesis: A Practical Approach, M. Nogrudi. 2.Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey. 3. Chemistry, Biological and Pharmacological properties of Medicinal plants from the Americans, Ed. Kurt. Hostettmann, M. P. Gupta and A. Marston		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C240.1	3	2	1	1	3	1	2	2
C240.2	3	2	1	1	3	1	2	2
C240.3	3	2	1	1	3	1	2	2
C240.4	3	2	1	1	3	1	2	2
C240.5	3	1	1	1	3	1	3	2
C240.6	3	1	1	1	3	1	3	2

2.1 Inorganic Chemistry-VI (MCH241)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:IV**	
1	**Course Code**	**MCH241**	
2	**Course Title**	**Inorganic Chemistry VI**	
3	Credits	4	
4	Contact hours	4-0-0	
	Course Status	Compulsory	
5	Course Objectives	1.Understand the importance of superconductors in engineering applications. 2.Relate the supramolecular role in ion detections. 3.Understand the chemistry of glasses and ceramics and their application in daily routine. 4.Understand the role of superconductors in catalysis. 5.Describe the technique used in applications of nanomaterials. 6.Understand the importance of nanomaterial based device in daily. routine.	
6	Course Outcome	CO1:Understand the concept of molecular recognition in the application of supramolecules. CO2:Relate the applications of glass and ceramics on the basis of their structure. CO3:Explain the concept of superconductivity. CO4:Synthesis of nanomaterials. CO5:Identify the properties of nanomaterials and their applications in electronic applications. CO6:Gain knowledge about various advanced inorganic materials.	
7	Course Description	The course is framed to give broad view of supramolecular, smart inorganic materials, superconductors and nanomaterials. Physicochemical properties and applications of nanomaterials have been covered in this paper.	
8	Outline syllabus		CO Mapping
	Unit 1	**Supramolecular Chemistry**	
	A	Concepts of Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition	CO1,CO6
	B	Catenanes, Rotaxanes, Dendrimers and Supramolecular gels, Supramolecular reactivity in catalysis	CO1,CO6
	C	Transport processes and carrier design. Supramolecular devices. Some example of self-assembly in supramolecular chemistry	CO1,CO6
	Unit 2	**Inorganic Smart Materials**	

	A	Structure of Glass and Ceramics: Ceramics crystal structures,density computations, silicate ceramics			CO2,CO6
	B	Glass ceramics.Refractories with reference to preparation, Properties and applications.			CO2,CO6
	C	fibre reinforced Composites, microscopic composites, preparation procedure, special properties and applications			CO2,CO6
	Unit 3	**Superconductors**			
	A	Inorganic semiconductors, Electrical, magnetic, thermal and optical properties of superconductors,.			CO3,CO6
	B	Metallic bonds High temperature superconductors Structural features of cuprate superconductors:1-2-3 and 2-1-4 cuprates.			CO3,CO6
	C	Electrical and magnetic properties of superconductors			CO3,CO6
	Unit 4	**Nanomaterials**			
	A	Definition of nanomaterials, fullerenes**,** carbon nanotubes, graphene. Discovery of C_{60}, Superconductivity in C_{60}, Alkali doped C_{60}.			CO4,CO6
	B	Carbon nanotubes - Synthesis of Single walled carbon nanotubes. Synthesis methods - Arc discharge, Laser Abalation, Low temperature method, Chemical vapour deposition. Growth mechanisms on CNT.			CO4,CO6
	C	Structure and characterization techniques. Surface area measurement, determination of size and textural studies of nanotubes.			CO4,CO6
	Unit 5	**Physiochemical Properties and Applications of Nanomaterials**			
	A	Reactivity, effect of size and shape on nanocrystal reactivity, agglomeration and sintering, dispersibility and chemical stability in solution, surface modification of metallic and semiconductor nanoparticles, nanofabrication and nanomanipulation.			CO5,CO6
	B	Magnetism in nanomaterials, Doping, functionalizing nanotube.			CO5,CO6
	C	Applications of Graphene, CNTs and Fullerenes – sensing, organic transistor, odour sensor, electronics and optoelectronics and photovoltaics.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
9	Textbook/s*	1.Timp.G. , Ed.Nanotechnology, Springer-Verlag, N. Y 2.Supramolecular Chemistry by Jonathan W Steed; Jerry L. Atwood.			
10	Other References	1.Keer, H.V. Principles of the Solid State, Wiley Eastern Ltd., New Delhi.			

		2.West, A. R., Solid State Chemistry and its applications, John Wiley and Sons. 3.Supramolecular Chemistry: Concept and Perspective by Jean Marie Lehn 4.Mitchell, B. S. – An introduction to material engineering and Science.Wiley interscience.

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C241.1	3	1	1	1	3	2	2	2
C241.2	3	1	1	1	3	2	2	2
C241.3	3	2	1	1	3	3	2	2
C241.4	3	1	1	2	3	1	2	2
C241.5	3	1	1	1	3	2	2	2
C241.6	3	1	1	1	3	2	2	2

2.1 PHYSICAL CHEMISTRY VI (MCH242)

School: SSBSR		**Batch : 2023-2025**	
Programme: M. Sc			
Branch:Chemistry		**Semester: 04**	
1	**Course Code**	**MCH242**	
2	**Course Title**	**PHYSICAL CHEMISTRY VI**	
3	Credits	4	
4	Contact Hours (L-T-P)	(3 1 0)	
	Course Status	Compulsory	
5	Course Objective	6. To provide the understanding of photophysical and photochemical processes of atoms and diatomic molecules. 7. To understand various nonradiative relaxation processes. 8. To get familiar with high energy radiation with matter, radiation dosimetry and flash photolysis. 9. To understand the meaning, scope, laws of irreversible thermodynamics. 10. To provide information about various laws, parameters, and equations related to transport phenomenon. 11. To provide the conceptual knowledge of molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
6	Course Outcomes	CO1: To understand various photophysical and photochemical processes of atoms and diatomic molecules upon irradiation. CO2: To study the various radiationless relaxation pathways. CO3: To learn about mechanism of interaction of high energy radiation with matter; radiation dosimetry and principle and application of flash photolysis. CO4: To understand the fundamental meaning, scope, and laws of irreversible thermodynamics. CO5: To get familiarize with different parameters and laws related to transport phenomenon. CO6: To study molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
7	Course Description	Course emphasize on the basic concepts of molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
8	Outline syllabus		CO Mapping
	Unit 1	**Molecular photochemistry**	
	A	Introduction-primary photophysical process of atoms and diatomic molecules, the absorption and emission of light - spectroscopic notations, state mixing, spin-orbit coupling and spin forbidden radiative transitions,	CO1,CO6

	B	Absorption complexes, Franck-Condon principle, selection rules, laws of photochemical equivalence. Radiative transitions-classical model of radiative transitions. Transitions between states (chemical, classical and quantum dynamics, vibronic states).	CO1,CO6
	C	Potential energy surfaces; transitions between potential energy surfaces. Jablonski diagram, Fluorescence, phosphorescence, photosensitization, photosynthesis, and chemiluminescence.	CO1,CO6
	Unit 2	**Advanced photochemistry**	
	A	Wave mechanical interpretation of radiationless transitions between states, factors influencing the rate of vibrational relaxation. Fluorescence quenching: collisional quenching, Stern-Volmer equation, concentration quenching, quenching by excimer and exciplex emissio	CO2,CO6
	B	Energy transfer: Theory of radiationless energy transfer and energy transfer by electron exchange. Fluorescence resonance energy transfer between photoexcited donor and acceptor systems and dexter energy transfer.	CO2,CO6
	C	The Perrin formulation. Triplet-triplet, triplet-singlet, singlet triplet energy transfer. Multiphoton energy transfer processes, reversible energy transfer.	CO2,CO6
	Unit 3	**Radiation Chemistry, Dosimetry and Photolysis: An overview**	
	A	G-value. The mechanism of interaction of high energy radiation with matter, Photoelectric effect, Compton effect, Pair production, total absorption co-efficient, excitation and ionization, Stopping power and linear energy transfer.	CO3,CO6
	B	Radiation dosimetry: Radiation dose and its measurement, standard free air chamber method, chemical dosimeter (Frick's Dosimeter). Short lived intermediates (ions, excited molecules, free radicals: Various mechanisms of their formation and energy transfer processes)..	CO3,CO6
	C	Flash photolysis: Principle and its applications. Radiolysis of water and aqueous solutions. Radiolysis of molecules of biological interest (carbohydrates, amino acids, peptides, and nucleic acids).	CO3,CO6
	Unit 4	**Irreversible thermodynamics**	
	A	Meaning and scope of irreversible thermodynamics, Thermodynamic criteria for non-equilibrium states, Phenomenological laws- Linear laws, Gibbs equation,	CO4,CO6

	B	Onsager's reciprocal relations, Entropy production-specific examples of entropy production, Non-equilibrium stationary states,			CO4,CO6
	C	Prigogine's principle of maximum entropy production, Coupled phenomena. Some important applications.			CO4,CO6
	Unit 5	**Transport phenomena**			
	A	Diffusion coefficients, Fick's first and second laws, relation between flux and viscosity,			CO5,CO6
	B	relation between diffusion coefficient and mean free path, relation between thermal conductivity/viscosity and mean free path of a perfect gas, Einstein relation,			CO5,CO6
	C	Nernst-Einstein equation, Stokes-Einstein equation, Einstein-Smoluchowski equation.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text book/s*	1. Turro, N. J. Modern Molecular Photochemistry Univ. Science Books (1991). 2. Gilbert, A. & Baggot, J. Essentials of Molecular Photochemistry Blackwell Scientific (1990). 3. Sood, D.D., Reddy, A.V.R. and Ramamoorthy, N., "Fundamentals of Radiochemistry", IANCAS, BARC, Mumbai. 4. Mukherjee, K.K., "Fundamentals of Photochemistry", New Age International Pvt. Ltd., New Delhi. 5. Lakowicz, J.R., "Principles of Fluorescence Spectroscopy", Plenum Press, New York. 6. Wishart, J.F. and Nocera, D.G., "Photochemistry and Radiation Chemistry", Oxford University Press, USA. 7. Friedlander, G., Kennedy J.W., Miller, E.S. and Macais, J.M., "Nuclear and Radiochemistry", John Wiley and Sons, Inc. New York. 8. Atkin's Physical Chemistry, P. Atkins & Julio de Paula, Oxford University Press 9. Introduction to Thermodynamics of Irreversible Processes by I. Prigogine, Interscience 10. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee. 11. Katchalsky, A. & Curren, P. F. *Non Equilibrium Thermodynamics in Biophysics* Harvard University Press: Cambridge (1965). Kalidas, C. & Sangaranarayanan, M.V. Non-Equilibrium Thermodynamics: Principles & Applications, Macmillan India Ltd. (2002).			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C242.1	3	2	3	2	3	1	1	2
C242.2	3	2	3	2	3	1	1	2
C242.3	3	2	3	1	3	1	1	2
C242.4	3	1	3	1	3	1	1	2
C242.5	3	1	3	1	3	1	1	2
C242.6	3	2	3	1	3	1	1	2

2.1 Organic Chemistry-VI (MCH243)

School: SSBSR		**Batch 2023-25**	
Programme: M.Sc.			
Branch : Chemistry		**Semester IV**	
1	**Course No.**	**MCH243**	
2	**Course Title**	**Organic Chemistry VI**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course status	Compulsory	
5	Course Objective	1.To provide a comprehensive introduction to biochemistry. 2.To learn the chemistry of enzymes, structures of nucleic acids, proteins and carbohydrates. 3.To know the chemistry of selected steroids, cholesterol and hormones. 4.To familiarize the chemistry and structure of oxytocin. 5.To know the kinetics of enzymes. 6.To understand the chemistry of antibiotics.	
6	Course Outcomes	CO1:To introduce structure and functions of carbohydrates and their derivatives. CO2:Understand the structure, function, and folding of proteins. CO3:Analyze the double helical structure of DNA and its replication, RNA and transcription. CO4:Learn kinetics of enzyme catalyzed reactions and enzyme inhibition. CO5:Convert cholesterol to progesterone, estrone and testosterone and structure elucidation of cholesterol. CO6:Acquire knowledge of molecular structure and interactions present in proteins, nucleic acids and carbohydrates and enzymes, the organization and working principles of various components present in living cell.	
7	Course Description	The course is designed to give provide an ability to assess the significance of fundamental chemical properties on biomolecular structure, understanding of the connection between biomolecular structure and function, acquire knowledge of chemical synthesis of biomolecules and the chemical reactions of biomolecules.	
8	Outline Syllabus		CO Mapping
	Unit 1	**Carbohydrates**	
	A	Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars.	CO1,CO6
	B	N-acetylneuraminic acid, sialic acid disaccharides and polysaccharides. Structural polysaccharides - cellulose and chitin. Storage polysaccharides- starch and glycogen.	CO1,CO6

		Structure and biological functions of glucosaminoglycans or mucopolysaccharides.	
	C	Carbohydrates of glycoprotiens and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.	CO1,CO6
	Unit 2	**Amino acids and Proteins**	
	A	Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structures. A- helix, β-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure	CO2,CO6
	B	Amino acid metabolism- degradation and biosynthesis of amino acids, sequence determination: chemical/ enzymatic/ mass spectral, racemization/ detection	CO2,CO6
	C	Chemistry of oxytocin and tryptophan releasing hormone (TRH).	CO2,CO6
	Unit 3	**Nucleic Acids**	
	A	Introduction, chemical and enzymatic hydrolysis of nucleic acids, Structure physical and chemical properties of the heterocyclic bases – Adenine, Guanine. Cytosine, Uracil and Thiamine.	CO3,CO6
	B	Structure and synthesis of mono and poly – nucleosides and nucleotides. Deoxyribose nucleic acid (DNA): Primary, secondary, tertiary structure of DNA.Structure of RNA. Types of RNA – mRNA, rRNA and tRNA.	CO3,CO6
	C	The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code.	CO3,CO6
	Unit 4	**Enzymes**	
	A	Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation.	CO4,CO6
	B	Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis.	CO4,CO6
	C	Enzyme kinetics, Michaelis–Menten and Lineweaver Burk plots, reversible and irreversible inhibition, mechanism of enzyme action	CO4,CO6
	Unit 5	**Steroids and Hormones**	
	A	Occurrence, nomenclature, Diel's hydrocarbon and stereochemistry.	CO5,CO6

	B	Isolation, structure determination and synthesis of Cholesterol, bile acids			CO5,CO6
	C	Androsterone, testosterone, estrone, progesterone, vitamin D			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	Text Book/s*	1.A.L. Lehninger, Principles of Biochemistry, CBS Publishers, Delhi. 2.I.L. Finar Volume II.			
	Other references	1.D. Voet, J.G. Voet & CW Pratt, Fundamentals of Biochemistry, John Wiley & Sons, New York. 2.H.R. Mahler and E.H. Cordes, Biological Chemistry, 2nd Edition, Harper and Row Pub., New York. 3.T.C. Bruice and S. Bentkovic, Bioorganic Mechanisms, Vol. I & II, W. A. Benjamin, New York.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C243.1	3	1	1	1	3	1	2	2
C243.2	3	1	1	1	3	1	2	2
C243.3	3	1	1	1	3	1	2	2
C243.4	3	1	1	1	3	1	1	2
C243.5	3	1	1	1	3	1	2	2
C243.6	3	1	1	1	3	1	1	2

2.1 Medicinal Chemistry (MCE203)

School: SSBSR		**Batch : 2023-25**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:IV**	
1	**Course No.**	**MCE203**	
2	**Course Title**	**Medicinal Chemistry**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Elective	
5	Course Objective	1.To provide a comprehensive introduction to Pharmaceutical Chemistry. 2.To introduce the Quantitative structure activity relationship. 3.To introduce the software used in drug designing. 4.To explain the process of pharmacology. 5.To introduce the chemistry of antineoplastic drugs. 6.To throw light on the chemistry of Anti-HIV Drugs and AIDS and antibiotics.	
6.	Course Outcomes	CO1:Explain concept of Quantitative Structure Activity Relationship. CO2:Understand the process of pharmacokinetic and pharmacodynamics. CO3:Elucidate the mode of action of Antineoplastic drugs. CO4:Explain the chemistry and mode of action of Anti-HIV and AIDS drugs. CO5:Explain the chemistry and mode of action of NSAID drugs and review the chemistry of Antibiotic drugs. CO6:Have a thorough grounding in Pharmaceutical Chemistry and basic knowledge in drug designing.	
7	Course Description	The course is emphasises on physical interactions and chemical reactions and their mechanisms as applied to biological systems, how drugs are discovered and developed, classified, how they get to their site of action, what happens when they reach the site of action in their interaction with receptors, enzymes, and DNA. The approaches discussed are those used in the pharmaceutical industry and elsewhere for the discovery of new drugs.	
8	Outline Syllabus		CO Mapping
	Unit 1	**Drug Design and Development**	
	A	Procedures followed in drug design, concept of lead compound and lead modification	CO1,CO6
	B	structure-activity relationship (SAR), Quantitative structure activity relationship (QSAR). History and development of QSAR. Physicochemical parameters: lipophilicity, Hydrophobicity, Electronic effect Steric factors, Hansch equation (Mathematical derivations of equations excluded).	CO1,CO6

	C	Computer aided drug design. Software used in drug design.	CO1,CO6
	Unit 2	**Pharmacology**	
	A	Pharmacokinetics: various modes of administration of drug, distribution, metabolism (biotransformation) and drug excretion	CO2,CO6
	B	pharmacodynamic: Concepts of drug receptors interactions	CO2,CO6
	C	Definition of the following medicinal terms: Pharmacon, pharmacophore, soft drug, prodrug, half-life, efficiency, LD50, ED50, therapeutic index, drug toxicity, drug addiction, spurious drugs, misbranded drugs, adulterated drugs, pharmacopoeia	CO2,CO6
	Unit 3	**Antineoplastic Agents**	
	A	Introduction, cancer chemotherapy, special problems	CO3,CO6
	B	Role of alkylating agents and antimetabolites in treatment of cancer. Mode of action of mechlorethamine, cyclophosphamide, 5-Fluorouracil.	CO3,CO6
	C	Recent development in cancer chemotherapy.	CO3,CO6
	Unit 4	**Anti-HIV Drugs and NSAIDs**	
	A	Basic facts about HIV & AIDS, Structure of HIV cell, Anti HIV drugs and their classification	CO4,CO6
	B	NSAIDS & Mechanism of Action:Asprin	CO4,CO6
	C	NSAID-Induced Side Effects	CO4,CO6
	Unit 5	**Antibiotics**	
	A	Introduction, classification of antibiotics, β-lactam antibiotics & their mode of action - Amoxicillin, Chloramphenicol, Cephalosporin	CO5,CO6
	B	Tetracycline antibiotics & their mode of action, Aminoglycoside antibiotics & their mode of action - Streptomycin.	CO5,CO6
	C	Macrolide antibiotics & their Mode of action - erythromycin	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 15% / MTE: 10% / ETE: 75%	
	Text book/s*	1.Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley & Sons Ltd. 2A Text Book of Medicinal Chemistry, Vol-I and Vol-II, Surendra N. Pandeya, SG Publishers. 3.An Introduction to Drug Design, S.S. Pandeya and J. R. Dimmock, New Age International Publishers.	

		4.Medicinal Chemistry, Ashutosh Kar, New Age International Publishers. 5.Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
	Other References	1.Introduction to Medicinal Chemistry, A. Gringauge, Wiley-VCH. 2. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Edited by J.N. Delgado and W. A. Remers, J.B. Lipincott Company. 3.The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press. 4.Burger's Medicinal Chemistry and Drug Discovery, Vol. I-V, Edited by M.E. Wolff, John Wiley & Sons Ltd

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C203.1	3	1	1	1	3	1	1	2
C203.2	3	1	1	1	3	1	1	2
C203.3	3	1	1	1	3	1	1	2
C203.4	3	1	1	1	3	1	1	2
C203.5	3	1	1	1	3	1	1	2
C203.6	3	1	1	1	3	1	1	2

2.1 Science and Technology of Nanomaterials (MCE204)

School:SSBSR		**Batch:2023-25**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:IV**	
1	**Course Code**	**MCE204**	
2	**Course Title**	**Science and Technology of Nanomaterials**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Elective	
5	Course Objective	1.Teach the advanced methods towards the synthesis of functional materials. 2.Teach the advanced methods towards the synthesis of high-quality thin films. 3.Teach the mechanical and magnetic behaviour of functional materials. 4.Teach the basics and phenomenon associated with the electrical and optical behavior. 5.Teach modern spectroscopic and microscopic methods towards the characterization of functional materials. 6. To understand the novel materials from synthetic, analysis and application perspectives.	
6	Course Outcomes	CO1:Formulate the synthetic methods towards preparation of novel materials. CO2:Prepare the mechanistic pathway towards facile synthesis of thin films. CO3:Understand the diverse magnetic behaviour of materials CO4:Understand the various electro-optical phenomenon of the materials. CO5:Characterize the materials via spectroscopic and microscopic tools. CO6:Understand the advanced synthetic perspectives along with physical properties and the concept of Auger and X-ray Photoelectron Spectroscopy.	
7	Course Description	The elective course on Chemistry of Materials aims to teach the modern and advanced methods of synthesis, characterization and properties of novel materials.	
8	Outline syllabus		CO Mapping
	Unit 1	**Synthesis Methods: Physicochemical Techniques**	
	A	Preparation of materials by Ball milling, Attrition and Vibration milling, Cluster compounds, Preparation of nano particles, Preparation of nanostructured polymers/Conducting polymers, composites.	CO1,CO6
	B	Chemical precipitation and co-precipitation, Wet chemical methods, Metal crystals by reduction, Sol-gel	CO1,CO6

		synthesis			
	C	Microemulsions or reverse micelles, Hydrothermal & Solvothermal synthesis, Thermolysis routes, Microwave heating synthesis, Electrochemical synthesis.			CO1,CO6
	Unit 2	**Synthesis Methods: Deposition Techniques**			
	A	Physical Vapor Deposition; mass evaporation rate; evaporators, e-beam, reactive evaporation, ion beam assisted deposition, Sputtering techniques			CO2,CO6
	B	Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD			CO2,CO6
	C	Thermal CVD, laser & plasma enhanced CVD, Pyrolytic synthesis.			CO2,CO6
	Unit 3	**Unit 3: Properties: Mechanical and Magnetic**			
	A	**S**tress Strain diagram for different engineering materials, Ductile and brittle material, Tensile strength, Hardness, Impact strength			CO3,CO6
	B	Fracture (Types and Ductile to brittle transition), Fatigue, Creep, Factors affecting mechanical properties			CO3,CO6
	C	Classification of magnetic materials, Diamagnetism, Paramagnetism, Langevin theory of dia- and paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Structure of Ferrite.			CO3,CO6
	Unit 4	**Properties: Electrical and Optical**			
	A	Dielectric Materials: Basic concepts: complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant			CO4,CO6
	B	Ferroelectricity, Piezoelectricity, pyro-electric states, transition temperature, polarization catastrophe, antiferroelectricity, ferro electric domains.			CO4,CO6
	C	Optical Properties: Refractive index and dispersion, Transmission, Reflection and absorption of light, Optical material for UV and IR, Optical anisotropic, Non-linear optical crystals, Photoluminescence			CO4,CO6
	Unit 5	**Structural Analysis**			
	A	UV-visible, FT-IR, Raman and Atomic absorption spectroscopy; X-ray diffraction			CO5,CO6
	B	Glancing angle and wide angle, Debye-Scherer formula, Dislocation density, Micro strain			CO5,CO6
	C	AUGER Spectroscopy and X-ray photoelectron spectroscopy (XPS)			CO5,CO6
	Mode of examination	Theory			
	Weightage	CA	MTE	ETE	

	Distribution	15%	10%	75%
	Text book/s*	1.Characterization of materials (Vol. 1 and 2) by E.N. Kaufmann, John Wiley and Sons. 2.Structure and Properties of Materials', Volume III,by R. M., Rose Shepard L. A., Wulff J.,4th Edition, John Wiley, 1984		
	Other References	1.Pradeep T., "NANO the Essential, understanding Nanoscience and Nanotechnology". TataMcGraw-Hill Publishing Company Limited, 2007. 2.Charles P. Poole Jr. "Introduction to Nanotechnology", John Willey & Sons, 2003		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C204.1	3	2	1	2	3	1	2	2
C204.2	3	2	1	2	3	1	2	2
C204.3	3	1	1	2	3	3	2	2
C204.4	3	1	1	2	3	3	2	2
C204.5	3	1	2	2	3	1	2	2
C204.6	3	1	2	2	3	2	2	2

2.2 MCH171: Inorganic Chemistry Lab I

School: SSBSR		**Batch: 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: I**	
1	Course Code	**MCH171**	
2	Course Title	Inorganic Chemistry Lab I	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	• To perform the qualitative test on unknown inorganic compounds i.e. preliminary tests, tests for extra elements. • To understand the basic concept of separation of cations from a mixture. • To apply the gravimetric technique for separation of cations. • To learn the preparation of a given inorganic complex. • To analyze the prepared complexes with spectroscopic methods.	
6	Course Outcomes	After finishing the course the students will be able to CO1: Understand the technique of analysis of cations and anions in a given mixture. CO2: Identify and perform the confirmatory tests on the cations. CO3: Design the plan to identify the cations and anions in a given mixture. CO4: Able to estimate the elements in a given mixture by gravimetric / volumetric methods. CO5: Apply the techniques and theory behind gravimeteric and volumetric methods. CO6: Prepare and analyse the inorganic complexes by spectrophotometric techniques	
7	Course Description	Chemistry lab course is designed to make students understand the technique of analysis of cations and anions in a given mixture.The students also learn various techniques such as gravimeteric, volumetric methods and will also learn to synthesize and analyse the inorganic complexes by spectrophotometric techniques.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Quantitative analysis**	
		Sub unit – a, b, c	CO1, CO6
	Unit 2	**Practical related to Quantitative analysis gravimetrically**	
		Sub unit – a, b, c	CO2, CO6
	Unit 3	**Practical related to Quantitative analysis gravimetrically**	
		Sub unit – a, b, c	CO3, CO6

	Unit 4	**Practical related to Synthesis and characterization of Complexes**			
		Sub unit – a, b, c			CO4, CO6
	Unit 5	**Practical related to Synthesis and characterization of Complexes**			
		Sub unit - a, b, c			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.			
	Other References	NA			

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C171.1	3	1	1	1	3	3	1	1
C171.2	3	1	1	3	3	3	1	1
C171.3	3	1	1	3	3	3	3	1
C171.4	3	1	1	1	3	3	3	1
C171.5	3	1	1	3	3	2	1	1
C171.6	3	1	1	1	3	2	2	1

2.2 MCH172: Organic Chemistry Lab I

School: SSBSR		**Batch: 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: I**	
1	Course Code	**MCH172**	
2	Course Title	Organic Chemistry Lab I	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	Compulsory	
5	Course Objective	• To perform the qualitative test on unknown organic compounds i.e. preliminary tests, tests for extra elements. • To understand the basic concept of separation of organic compounds from a binary mixture. • To apply the Paper and Thin layer chromatography technique for separation of compounds • To learn the preparation of an organic compound.	
6	Course Outcomes	After finishing the course the students will be able to CO1: Understand the technique of separation of compounds in a binary mixture. CO2: Able to measure specific rotation of an optically active compound CO3: Estimation of aniline in a solution of unknown strength CO4: Prepare the organic compounds in one or two steps. CO5: Apply the techniques of Paper and Thin Layer chromatography CO6: Learn organic synthesis and qualitative organic analysis	
7	Course Description	Chemistry lab course is designed to make students understand the technique of qualitative analysis of a binary organic mixture.The students also learn various techniques such as paper chromatography, TLC, specific rotation measurement, synthesis of organic compounds	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Qualitative binary mixture analysis of organic compounds**	
		Sub unit – a, b, c	CO1, CO6
	Unit 2	**Practical based on measurement of specific rotation of an optically active compound**	
		Sub unit – a, b, c	CO2, CO6
	Unit 3	**Practical related to estimation of Aniline**	
		Sub unit – a, b, c	CO3, CO6
	Unit 4	**Practical related to Synthesis of Organic Compounds**	
		Sub unit – a, b, c	CO4, CO6
	Unit 5	**Practical related to Chromatography of Organic Compounds**	
		Sub unit - a, b, c	CO5, CO6

	Mode of examination	Practical/Viva		
	Weightage Distribution	CA	CE	ETE
		25%	25%	50%
	Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.		
	Other References	Qualitative Organic Chemistry by Vogel		

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C172.1	3	1	1	2	3	1	1	1
C172.2	3	1	1	1	3	1	1	1
C172.3	3	1	1	1	3	1	1	1
C172.4	3	1	1	2	3	1	1	1
C172.5	3	1	1	2	3	1	1	1
C172.6	3	1	1	1	3	1	1	1

2.2 MCH173: Physical Chemistry Lab I

School: SSBSR		**Batch:2023-25**	
Programme: M.Sc		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester:I**	
1	Course number	**MCH 173**	
2	Course Title	**Physical/Analytical Chemistry Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
5	Course Objective	1. To find the individual strengths of acids and salts via thermometric titrations, conductometric titrations, precipitation titrations and pH metric titrations. 2. Find the heat of neutralization using Calorimetry. 3. To calculate the dissociation tendency of the acids. 4. To constructs the phase diagrams of binary and ternary systems. 5. To learn software programming for chemistry problems.	
6	Course Outcomes	Students will be able to - 1. To imply various types of titrations for quantitative analysis. 2. Construct the phase change behaviour in graphical form. 3. To carry out conductometric and potentiometric titrations. 4. To find the acidity strength accurately. 5. Use programming for solution of chemistry based mathematical problems. 6. To imply titrations, Calorimetry, computational and phase change phenomenon towards appropriate quantitative and qualitative assessment of physical process.	
7	Outline syllabus		CO mapping
	Unit 1	**Quantitative Analysis - I**	
	A	To determine the concentration of two acid HCl and ethanoic acid by thermometric titration and use it to calculate enthalpy change of neutralization	CO1,CO6
	B	Calculate the heat of neutralization for NaOH and HCl mixture by Bomb Calorimeter.	CO1,CO6
	C	To study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine the strength of given solution of $AgNO_3$	CO1,CO6
	Unit 2	**Quantitative Analysis - II**	
	A	To determine dissociation constant of acetic acid using (a) pH meter and (b) conductivity meter and compare the results	CO2,CO6

	B	Study of the variation of mutual solubility temperature with concentration for the phenol-water system and determination of the critical solubility temperature (CST).	CO2,CO6
	C	To determine the strength of H_3PO_4 by titration with standard NaOH using pH meter	CO2,CO6
	Unit 3	**Quantitative/Qualitative assessment - I**	
	A & B	To determine the strength of strong acid and weak acid conductometrically by titrating against standard NaOH solution	CO3,CO6
	C	To estimate the amount of ferrous ions in a given solution potentiometrically.	CO3,CO6
	Unit 4	**Quantitative/Qualitative assessment -II**	
	A	To study the separation of dyes by thin layer chromatography	CO3,CO4,CO6
	B	To determine the amount of $BaCl_2$ in a given solution by conductometric titrations	CO3,CO4,CO6
	C	Study the conductometric titration of hydrochloric acid with sodium carbonate	CO3,CO4,CO6
	Unit 5	**Data Handling**	
	A & B	To calculate Mean, Median, Mode, Standard deviation, Variance, Range by using Microsoft Excel	CO5,CO6
	C	To calculate and draw the first and second derivative of given data on excel sheet.	CO5,CO6

	Mode of examination	Practical/Viva		
	Weightage Distribution	CA	CE	ETE
		25%	25%	50%
	Text book	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.		
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.		

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C173.1	3	1	1	2	3	1	1	1
C173.2	3	2	1	1	3	1	1	1
C173.3	3	1	1	1	3	1	1	1
C173.4	3	1	1	1	3	1	1	1
C173.5	3	2	1	1	3	1	1	1
C173.6	3	1	1	1	3	1	1	1

2.2 MCH174 : Inorganic Chemistry Lab II

School: SSBSR		**Batch:2023-25**			
Programme: M.Sc		**Current Academic Year: 2023-24**			
Branch: Chemistry		**Semester:II**			
1	Course Code	MCH174			
2	Course Title	Inorganic Chemistry Lab-II			
3	Credits				
4	Contact Hours (L-T-P)	0-0-2			
	Course Status	Compulsory			
5	Course Objective	To learn about types of titration and estimation of elements of alloys, and learn the techniques of jobs method and characterization of metal complexes			
6	Course Outcomes	After doing this course the student should be able to CO1: Prepare solutions of different strength and standardize them CO2: Analyse domomite sample CO3: Analyse various ferro-alloys and steel CO4: Estimate one metal ion in a mixture CO5: Understand the Job's method CO6: Analyse given compound spectrochemically and using different volumetric methods.			
7	Course Description	The course aims to appraise the students to learn basic methods of titration and characterisation of given material. It will enable students to analyse various materials like steel and alloys.			
8	Outline syllabus				CO Mapping
	Unit 1	**Practical related to analysis of samples**			
		Sub unit – a ,b, c			CO1, CO6
	Unit 2	**Practical related to determination of elements in a mixture**			
		Sub unit –a, b, c			CO2, CO6
	Unit 3	**Practical based to analysis of ferro alloys and steel**			
		Sub unit- a, b, c			CO3, CO6
	Unit 4	**Practical related to Applications of jobs method**			
		Sub unit – a, b, c			CO4, CO6
	Unit 5	**Practical based to synthesis and characterization of metal complexes.**			
		Sub unit - a, b, c			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	

	Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C174.1	3	1	1	1	3	1	1	1
C174.2	3	1	1	1	3	1	1	1
C174.3	3	1	1	1	3	3	2	1
C174.4	3	2	1	1	3	3	2	1
C174.5	3	1	1	1	3	3	2	1
C174.6	3	1	1	1	3	2	1	1

2.2 MCH175 : Organic Chemistry Lab II

School: SSBSR		**Batch : 2023-2025**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: II**	
1	Course Code	**MCH 175**	
2	Course Title	**Organic Chemistry lab-II**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-3	
	Course Status	**Compulsory**	
5	Course Objective	1. To learn methods for, purification like fractional, steam distillation. 2. To execute independently purification techniques to organic compounds column chromatography and Thin layer chromatography. 3. To perform the qualitative test on mixture of unknown organic compounds i.e separation , preliminary tests, tests for extra elements, functional group test. 4. To execute multistep organic synthesis procedures. 5. To record the spectrum of synthesized compounds and interpret their structure/Check the purity.	
6	Course Outcomes	Students are able to 1. Understand the Qualitative analysis of mixture of organic compounds 2. Understand the methods of separation and purification techniques of organic compounds 3. Execute the multistep organic synthesis procedures 4. Understand and interpret the structure of unknown compounds based on spectral analysis 5. Perform the extraction process of natural compounds 6. Will obtain the knowledge of independent organic synthesis, separation, purification and qualitative analysis.	
7	Course Description	This course involves the qualitative analysis, Organic synthesis process, purification and separation of organic compounds. It also involves extraction of organic compounds from natural products and characterization.	
8	Outline syllabus		CO Mapping
	Unit 1	**Qualitative analysis of organic compounds-I**	
	A	To analyze the mixture of two components.(Mixture 1)	CO1, CO6
	B	To analyze the mixture of two components. (Mixture 2)	CO1, CO6

	C	To analyze the mixture of two components. (Mixture 3)			CO1, CO6
	Unit 2	**Qualitative analysis of organic compounds-II**			
	A	To analyze the mixture of two. (Mixture 4)components.			CO2, CO6
	B	To analyze the mixture of two components. (Mixture 5)			CO2, CO6
	C	To analyze the mixture of two components. (Mixture 6)			CO2, CO6
	Unit 3	**Organic synthesis-I**			
	A	To prepare *m*-phenylenediamine form *m*-dinitrobenzene			CO3, CO6
	B	To prepare Methyl orange using aniline. Identify the product with M.P., UV and IR analysis.			CO3, CO6
	C	To extract the mustard oil from mustard seed using soxhlet extraction technique			CO3, CO6
	Unit 4	**Organic synthesis-II**			
	A	To prepare o-Chlorobenzoic acid from phthalic anhydride.			CO4, CO6
	B	To prepare 2,4-dihydroxy ethylbenzene using resorcinol. Identify the product with M.P. and IR analysis.			CO4, CO6
	C	To synthesize o-and p-nitro aniline by two step process			CO4, CO6
	Unit 5	**Separation of Organic compounds**			
	A	To separate Organic compounds with the help of Column Chromatographic technique and report the yield of pure component (sample1).			CO5, CO6
	B	To separate Organic compounds with the help of Column Chromatographic technique and report the yield of pure component(sample2)			CO5, CO6
	C	To separate Organic compounds with the help of Column Chromatographic technique and report the yield of pure component(sample3)			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	O.P. Pandey, D.N. bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.			
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.			

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C175.1	3	2	1	2	3	1	1	2
C175.2	3	1	1	1	3	1	1	2
C175.3	3	2	1	2	3	1	1	2
C175.4	3	2	1	2	3	1	1	2
C175.5	3	2	1	2	3	1	1	2
C175.6	3	1	1	1	3	1	1	1

2.2 MCH 176: Physical Chemistry II Lab

School: SSBSR		**Batch: 2023-25**	
Programme: M.Sc.		**Current Academic Year: 2023-24**	
Branch:Chemistry		**Semester:II**	
1	Course Code	MCH176	
2	Course Title	Physical Chemistry II Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	Compulsory	
5	Course Objective	Instruments like Spectrophotometer, conductometer polarimeter and potentiometer are widely used in research labs and industries. Hence, knowledge of basic instruments and the experiments and advanced techniques is very important for Master's students. The 'Physical Chemistry II Lab' course provides students an indepth exposure to handle and use various instruments and to draw Adsorption curves, thermometric titration curves and calculate atomic parameters computationally.	
6	Course Outcomes	1. Students will be able to understand the phenomenon of adsorption and how to determine concentration of a solution after adsorption. 2. Student will be able to learn to use instruments like conductometer, potentiometers, UV/V spectrophotometer, Polarimeter for determining the composition, strength and dissociation constants of different chemicals/solutions. 3. Student will understand the concept of thermometric titrations. 4. Students will be able to determine atomic parameters using computational studies. 5. Students will be able to understand the solubillty, solubility product, CMC and how to determine them practically. 6. Student will be able to understand the practical difference between the double alkali method and salt line method.	
7	Course Description	Physical Chemistry II lab course is designed to make students learn the basic experiments to handle and use different instruments. The students get to learn computational techniques and various experiments/techniques to draw different types of thermometric, conductometric and potentiometric titration curves and CMC etc.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based Conductometer and Potentiometer**	
	A& B	To estimate the normality of oxalic acid in given solutions conductometrically (a) Solution of pure oxalic acid (b) Solution having HCl and oxalic acid Solution having acetic acid and oxalic acid	**CO2**

	C	To find out the composition of Zinc ferrocyanide precipitate on adding $ZnSO_4$ potentiometrically.	**CO2**
	Unit 2	**Practical based on Adsorption and Thermometric Titration**	
	A& B	To verify the Freundlich and Langmuir adsorption isotherms by studying the adsorption of oxalic acid/acetic acid on activated charcoal.	**CO1**
	C	To determine the concentration of strong acid by thermometric titration and use it to calculate the enthalpy of neutralization.	**CO3**
	Unit 3	**Practical based on Solubility product and CMC**	
	A & B	Find out solubility and solubility product of the given sparingly soluble salt in water.	**CO5**
	C	Find cmc of a given surfactant and, hence, calculate ΔG_{mix} of the surfactant.	**CO5**
	Unit 4	**Practical based on Polarimeter and Spectrophotometer**	
	A	Find out the rate constant of acid-catalysed hydrolysis of sucrose by polarimeter. Study the rate equation for mutarotation of D-glucose in water using polarimeter.	**CO2**
	B & C	To determine the concentration of $KMnO_4$ solution after adsorption using UV/Visible spectrophotometer.	**CO2**
	Unit 5	**Computational Modeling, Salt line and Double Alkali Method**	
	A	To calculate the atomic parameters using density function calculations and molecular simulations.	**CO4**
	B & C	Titrate using conductometer a moderately strong acid (salicylic/mandelic acid) by the (a) salt-line method (b) double alkali method.	**CO6**
	Mode of examination	Practical and/or Viva	
	Weightage Distribution Text book/s	CA: 25% / CE: 25% / ETE: 50%	
	Other References	Practical Physical Chemistry by B. D. Khosla, R. Chand and Co., New Delhi	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C176.1	3	1	1	1	3	1	1	1
C176.2	3	1	1	1	3	1	1	1
C176.3	3	2	1	2	3	1	1	2
C176.4	3	2	1	2	3	1	1	2
C176.5	3	2	1	2	3	1	1	2
C176.6	3	1	1	1	3	1	1	1

2.2 MCH 271: Organic Chemistry III

School: SSBSR		**Batch:2023-2025**	
Programme: M.Sc			
Branch: Chemistry		**Semester III**	
1	Course number	**MCH271**	
2	Course Title	**Organic Chemistry Lab III**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
5	Course Objective	1.To learn methods for extracting organic compounds from natural products. 2.To separate and qualitatively identify organic mixture components. 3.To perform the qualitative test on unknown organic compounds i.e preliminary tests, tests for extra elements. 4.To understand the basic concept of quantitative analysis for organic compounds 5.To understand the concept of organic acid and perform the acid base titration to calculate their solubility in solvents at room temperature. 6.To apply principles of IR, 1HNMR and Mass spectroscopy and interpret structures of unknown compounds.	
6	Course Outcomes	Students will be able to 1.Understand principle of extraction of organic compounds(viz. alkaloids, pigments, tannins etc.) 2.Understand the methods of separation and qualitative analysis of organic compounds. 3.Quantify the amount of reducing sugar present in any unknown solution. 4.Understand the procedure and purpose of protection/deprotection chemistry. 5.To assign IR, ^{1}HNMR values to unknown compounds and together arrive at the structure of the compound with the help of mass fragmentation pattern and empirical formula. 6.Understand the basic practicals of organic chemistry – extraction, separation, synthesis, Thin Layer Chromatography/IR spectroscopy.	
7	Outline syllabus		CO Mapping
	Unit 1	**Extraction of Organic Compounds**	
	A	To study the extract caffeine from tea leaves and report its percentage yield and m.p.	CO1,CO6
	B	To study the extract piperine from black pepper and report its percentage yield and m.p.	CO1,CO6

	C	To extract plant pigments and then identify these pigments by chromatography.	CO1,CO6
	Unit 2	**Separation of Organic compounds in a ternary mixture**	
	A	To separate and identify the organic mixture containing 3 components.	CO2,CO6
	B	To separate and identify the organic mixture containing 3 components.	CO2,CO6
	C	To separate and identify the organic mixture containing 3 components.	CO2,CO6
	Unit 3	**Quantitative estimation of Organic compounds**	
	A	To determine the amount of Glucose by Fehling's solution.	CO3,CO6
	B	To determine the strength of amino acid in given unknown solution by Sorenson's formol titration.	CO3,CO6
	C	To determine the purity of synthesized aspirin by TLC and titration method.	CO3,CO6
	Unit 4	**Synthesis of Organic compounds**	
	A & B	To prepare *p*-nitroaniline from aniline using the three steps protecting group strategy.	CO4,CO6
	C	To prepare *m*-nitroaniline from nitrobenzene and confirm its identity with FTIR.	CO4,CO6
	Unit 5	**Structure elucidation of Organic compounds**	
	A	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5,CO6
	B	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5,CO6
	C	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5.CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA: 25%	CE: 25%	ETE: 50%
	Text book	O.P. Pandey, D.N. bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
	Other References	Vogel's "Textbook of Quanlitative Analysis", Pearson.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C271.1	3	2	1	2	3	1	1	2
C271.2	3	2	1	2	3	1	1	2
C271.3	3	2	1	2	3	1	1	2
C271.4	3	1	1	1	3	1	1	2
C271.5	3	2	1	2	3	1	1	3
C271.6	3	2	1	2	3	1	1	2

2.2 MCH272 Physical Chemistry Lab-III

School: SSBSR		**Batch:2023-2025**
Programme: M.Sc.		
Branch: Chemistry		**Semester III**
1	Course Code	MCH272
2	Course Title	Physical Chemistry lab-III
3	Credits	2
4	Contact hours	0-0-3
	Course Status	Compulsory
5	Course Objectives	To learn methods for determination of various physical properties of compounds using spectrophotometric, UV-Vis, FTIR and kinetic studies.
6	Course Outcome	Student will be able to: 7. Learn to use instruments like UV/Vis spectrophotometer, FTIR for determining the composition, charecteristics and dissociation constants of different chemicals/solutions. 8. Determine the parameters from enzyme kinetic reaction. 9. Explain the phase diagram of a two component system. 10. Measure the molecular weight of a polymer. 11. Correlate the concept of Chemical kinetics and its application in measuring rate constant and activation energy. 12. Design experiments, analyse experimental results and represent the data through writing.
7	Course Description	The course will make student learn the concept of various physical chemistry techniques from practical point of view. It will provide student to understand experiment related to spectrophotometric, UV-Vis and IR spectroscopic, kinetics, viscosity, Phase diagram of binary mixtures etc. This course is framed to explain the methods used in a physical experiments.

8	Outline Syllabus	CO mapping
Unit 1	**Practical related to Spectrophotometric analysis**	CO1, CO6
	Sub unit - a,b,c	
Unit 2	**Practical related to UV and IR Spectroscopy**	CO1, CO6
	Sub unit - a,b,c	
Unit 3	**Practical related to Phase diagram**	CO3, CO6
	Sub unit - a, b, c	
Unit 4	**Practical based on Polymer**	CO4, CO6

	Sub unit - a, b, c			
Unit 5	**Practical based on Kinetics**			CO2, CO5
	Sub unit - a,b,c			
Mode of examination	Practical/Viva			
Weightage Distribution	CA	CE	ETE	
	25%	25%	50%	
Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.			
Other References	Vogel's "Textbook of Quantitative Analysis", Pearson.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C272.1	3	1	1	1	3	3	2	2
C272.2	3	1	1	1	3	3	2	2
C272.3	3	2	1	2	3	3	2	2
C272.4	3	1	1	1	3	3	2	2
C272.5	3	1	1	1	3	3	1	2
C272.6	3	1	1	1	3	3	2	2

2.2 MCH 273 : Inorganic Chemistry Lab-III

School: SSBSR		**Batch : 2023-2025**	
Program: M.Sc.			
Branch: Chemistry		**Semester: III**	
1	Course Code	**MCH 273**	
2	Course Title	**Inorganic Chemistry lab-III**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	**Compulsory**	
5	Course Objective	The main objective of this course is : 1. To explain various types of titration 2. To illustrate gravimetric analysis 3. To provide information about analysis of ores and cement 4. To explain the analysis of alloys like brass, steel 5. To learn to synthesize and characterize inorganic compounds	
6	Course Outcomes	After doing this course the student should be able to 1. prepare solutions of different strength and standardize them 2. analyze steel and cement sample 3. analyze a sample of alloys and ores 4. understand the photochemical reactions 5. synthesize and characterize transition metal complexes	
7	Course Description	This course involves the analysis of industrially important materials like cement and steel. It also involves the analysis of ores and synthesis of transition metal complexes.	
8	Outline syllabus		CO Mapping
	Unit 1	**Analysis of industrially important materials-I**	
	A	Estimation of Copper in a sample of brass	CO1, CO6
	B	Estimation of Copper in a sample of brass	CO1, CO6
	C	Analysis of P in steel	CO1, CO6
	Unit 2	**Analysis of industrially important materials-II**	
	A	Analysis of P in steel	CO2, CO6
	B	Estimation of Fe_2O_3 in Portland Cement	CO2, CO6
	C	Estimation of CaO in Portland Cement	CO2, CO6
	Unit 3	**Analysis of ores**	
	A	Estimation of Mn(II) in pyrolusite	CO3, CO6
	B	Estimation of Mn(II) in pyrolusite	CO3, CO6

	C	Estimation of available oxygen in pyrolusite			CO3, CO6
	Unit 4	**Synthesis and characterization of transition metal complexes-I**			
	A	Synthesis and characterization of Salen ligand			CO4, CO6
	B	Synthesis and characterization of metal complex of salen			CO4, CO6
	C	Characterization of the complex ans study of crystallization methods			CO4, CO6
	Unit 5	**Synthesis and characterization of transition metal complexes-II**			
	A	Synthesis of Cis - $[Co(NH_3)_2(Cl)_2]Cl$ and its characterization			CO5, CO6
	B	Synthesis of trans $[Co(NH_3)_2(Cl)_2]Cl$ and its characterization			CO5, CO6
	C	Synthesis of $K_3[Fe(C_2O_4)_3]$ and to study its photochemical reaction			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	Vogel's "Textbook of quantitative Analysis", Pearson.			
	Other References	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C273.1	3	1	1	1	3	3	2	2
C273.2	3	1	1	1	3	3	2	2
C273.3	3	2	1	2	3	3	2	2
C273.4	3	1	1	1	3	3	2	2
C273.5	3	1	1	1	3	3	1	2
C273.6	3	1	1	1	3	3	2	2

2.3 Community Connect:CCU401

School: SSBSR		**Batch :2023-25**	
Program: M.Sc.		**Current Academic Year: 2023-24**	
Branch: Chemistry		**Semester: II**	
1	Course Code	CCU401	
2	Course Title	Community Connect	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To expose our students to different social issues faced by the people in different sections of society. 2. To connect their class-room learning with problem solving skills in real life scenario.	
6	Course Outcomes	After completion of this course students will be able to: 1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner. 2. Get practical exposure of all round development which complements their class room learning 3. These activities will add value to students, faculty members, school and university.	
7	Course Description	In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction to the Topic**	CO1,CO6
	Unit 2	**Drafting the questionairre**	CO2,CO6
	Unit 3	**Survey**	CO3,CO6
	Unit 4	**Data collection, Discussions and result interpretation**	CO4, CO6
	Unit 5	**Report writing and Presentation**	CO5,CO6
	Mode of	Presentation and Viva	

	examination			
	Weightage Distribution	CA	CE	ETE
		25%	25%	50%
	Text book/s*	-		
	Other References	*Journal article* Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z *Book* Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) *Book chapter* Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) *Online document* Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C401.1	1	1	3	1	2	1	1	1
C401.2	1	1	3	1	2	1	1	1
C401.3	1	1	3	1	2	1	1	1
C401.4	1	1	3	1	2	1	1	1
C401.5	1	1	3	1	2	1	1	1
C401.6	1	1	3	1	2	1	1	1

2.3 Research Based Learning-1 : RBL001

School: SSBSR		**Batch:2023-2025**	
Program: M.Sc.		**Current Academic Year: 2023-24**	
Branch:Chemistry		**Semester I**	
1	Course Code	**RBL001**	
2	Course Title	Research Based Learning 1	
3	Credits	Qualifying	
4	Contact Hours (L-T-P)	(0-0-2)	
	Course Status	Compulsory	
5	Course Objective	• Develop knowledge of a specific area of specialization. Develop research skills in project writing and oral presentation.	
6	Course Outcomes	CO1: Understand the objectives of research. CO2: Acquire the methodology of scientific work. CO3: Understand the reason behind scientific research. CO4: Prepare the model of research work. CO5: Prepare the roadmap for research work. CO6: Prepare students to face challenges in solving unsolved problems.	
7	Course Description	This course is designed for students to study topics not offered in regularly available courses. This course encourages reading a field of special interest and gain in-depth update knowledge about it.	
8	Outline		CO Achievement
	Unit 1	**Theoretical foundations of scientific and research work**- To learn the theoretical concept of research; be able to explain what research is and what it is not, and the different definitions of research; introduce the objectives of research, and set the motivation in research	**CO1**
	Unit 2	**General methodology of scientific creative work**- Be able to discuss the criteria of good research and the different types of research methods	**CO2, CO3**
	Unit 3	**The logic of scientific research process**- Be able to formulate the problem of research, to discuss how a research problem is delimited, and evaluated, to acquire knowledge about logic of scientific research process	**CO4**

	Unit 4	**The model of research**- Be able to choose the research problem, formulate research topic (thesis) work, to show the relevance of the problems investigated, to set goals and objectives, object and subject of study		**CO5**
	Unit 5	**Planning the Research**- Be able to plan the research in the rational way		**CO6**
	Mode of examination	1. Rubric assessment 2. Monthly Presentation to be audited by supervisor Mid Term Presentation and End Term Presentation		
	Weightage	CA	CE (Viva + PPT)	ETE
		25	25	50
	Text book/s*	10 Recent International Journal Articles of repute.		
	Other References	-		

Mapping of CO vs. PO

COs / POs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3
C001.1	2	3	3	3	1	1	3
C001.2	2	3	3	3	1	1	3
C001.3	2	3	3	3	1	1	3
C001.4	2	3	3	3	1	1	3
C001.5	2	3	3	3	1	1	3
C001.6	2	3	3	3	1	1	3

2.3 Research Based Learning-2 : RBL002

School: SSBSR		**Batch:2023-2025**	
Program: M. Sc.		**Current Academic Year: 2023-24**	
Branch:Chemistry		**Semester II**	
1	Course Code	**RBL002**	
2	Course Title	Research Based Learning 2	
3	Credits	Qualifying	
4	Contact Hours (L-T-P)	(0-0-2)	
	Course Status	Compulsory	
5	Course Objective	• This course will help to ensure that students are able to demonstrate advanced knowledge of the role of science and of its contribution to the disciplines related to the field of technology. Critically analyze and interpret the results of scientific and technological research, and evaluate its limits and possibilities with respect to knowledge and its implementation.	
6	Course Outcomes	CO1: To be able to identify and describe methods within the philosophy of science in general. CO2: Extract line of approach to overcome the research gap. CO3: To acquire an overview of important characteristics within technological research and development. CO4: To identify the relation between pure science on the one hand and applied research on the other, the relation between research and practice, and the relation between technology and society. CO5: To demonstrate an understanding of the limits and possibilities for research in science and technology. CO6: To acquire skills of presenting arguments and results of scientific and technological research.	
7	Course Description	This course will deepen the student's understanding of research in general, and with basic science and technological research in particular. The students are expected to apply knowledge of methodology, concepts, philosophical problems and arguments presented in this course to their own fields of exploration.	
8	Outline		CO Achievement
	Unit 1	**The Conceptual Framework**- Be able to build the conceptual framework of research, to identify the nature of hypothesis and describe its functions, describe the different kinds of hypothesis and what are good characteristics of hypothesis	**CO1**

	Unit 2	**The Research Problem and Objectives**- Be able to set problem specification and its objectives			**CO2, CO3**
	Unit 3	**Literature survey -** Be able to explain what the review of literature is; identify and describe the objectives and sources of the review of literature; describe how the review of literature should be reported			**CO4**
	Unit 4	**Techniques of thesis preparation and defense-** Be able to write the thesis according to the requirements			**CO5**
	Unit 5	**Presentation**			**CO6**
	Mode of examination	3. Rubric assessment 4. Monthly Presentation to be audited by supervisor Mid Term Presentation and End Term Presentation			
	Weightage	CA	CE (Viva + PPT)	ETE	
		25	25	50	
	Text book/s*	10 Recent International Journal Articles of repute.			
	Other References	-			

Mapping of CO vs. PO

COs / POs	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3
C002.1	2	3	3	3	1	1	3
C002.2	2	3	3	3	1	1	3
C002.3	2	3	3	3	1	1	3
C002.4	2	3	3	3	1	1	3
C002.5	2	3	3	3	1	1	3
C002.6	2	3	3	3	1	1	3

2.3 Research Based Learning-3 : RBL003

School: SSBSR		**Batch :2023-25**	
Program: M.Sc.			
Branch: Chemistry		**Semester: III**	
1	Course Code	RBL003	
2	Course Title	Research Based Learning-3	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	Compulsory/Elective	
5	Course Objective	1.To enhance the practical knowledge and result analysis skills. 2.To enable the students experience a real-life problem solving under the supervision of faculty members. 3.To prepare the students perform functions that demand higher competence in national/international organizations. 4.To train the students in scientific research. 5.To help the students find meaning in life by broadening their field of vision. 6.Develop deep knowledge of a specific area of specialization by literature search.	
6	Course Outcomes	CO1: Able to do literature search, develop deeper interest / inquisitiveness in chemistry and interdisciplinary subjects. CO2: Able to prepare stock solutions, buffers etc . CO3: Understand the basics of chemistry and become familiar with qualitative and qualitative estimations. CO4: Able to understand the chemistry of reactions. CO5: Able to analyse the results and understand the chemical reactions involved. CO6: Enhance the practical skills.	
7	Course Description	This course provides the applied knowledge of chemistry and gives confidence and a solid foundation for future learning.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction of subject / Literature search**	CO1,CO6
	Unit 2	**Concept building and Study designing**	CO2,CO6
	Unit 3	**Experimentation / Standardization of techniques**	CO3,CO6
	Unit 4	**Data collection, Discussions and result interpretation**	CO4, CO6

	Unit 5	**Report writing**			CO5,CO6
	Mode of examination	Presentation and Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	-			
	Other References	Pubmed Search (NCBI) Review and research articles of Indexed Journals			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C003.1	3	2	2	2	3	2	2	3
C003.2	3	2	2	2	3	2	2	3
C003.3	3	2	2	2	3	2	2	3
C003.4	3	2	2	2	3	2	2	3
C003.5	3	3	2	2	3	2	2	3
C003.6	3	1	1	2	3	2	2	3

2.3 Research Based Learning-4 : RBL004

School: SSBSR		**Batch :2023-25**	
Program: M.Sc.			
Branch: Chemistry		**Semester: IV**	
1	Course Code	RBL004	
2	Course Title	Research Based Learning-4	
3	Credits	6	
4	Contact Hours (L-T-P)	0-0-12	
	Course Status	Compulsory/Elective	
5	Course Objective	1.To enhance the practical knowledge and result analysis skills. 2.To enable the students experience a real-life problem solving under the supervision of faculty members. 3.To prepare the students perform functions that demand higher competence in national/international organizations. 4.To train the students in scientific research. 5.Develop research/ experimentation skills as well as enhancing project writing and oral presentation skills 6.Inculcate team spirit and time management.	
6	Course Outcomes	CO1: Able to use lab instruments independently. CO2:Cultivate the understanding of problem, study design, methodology/ experimentation, significance of reproducibility of results. CO3:Understanding of ethics of science and research for supporting higher studies. CO4:Learn effective project organizational skills along with discussions, result interpretation and paper writing. CO5: Able to analyse the results and understand the chemical reactions involved. CO6: Enhance the practical skills.	
7	Course Description	This course will help to develop knowledge and research skills applicable to a career in chemistry.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction of subject/ literature search**	CO1,CO6
	Unit 2	**Concept building and study design**	CO2,CO6
	Unit 3	**Experimentation/ Standardization of techniques**	CO3,CO6
	Unit 4	**Data collection, Discussions and result interpretation**	CO4, CO6

	Unit 5	**Report writing**			CO5, CO6
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	-			
	Other References	Pubmed Search (NCBI) Review and research articles of Indexed Journals			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
C004.1	3	2	2	2	3	2	2	3
C004.2	3	2	2	2	3	2	2	3
C004.3	3	2	2	2	3	2	2	3
C004.4	3	2	2	2	3	2	2	3
C004.5	3	3	2	2	3	2	2	3
C004.6	3	1	1	2	3	2	2	3