SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

SYLLABUS FOR

Master of Science (Chemistry)

School of Basic and Applied Sciences

(W.E.F 2023-2024)

Revised on 12th August 2025

Master of Science (Chemistry)

OUTCOME BASED EDUCATION

Programme outcome (POs)

PO 1	Scientific exploration: Capability of comprehending basic scientific principles, and theories to propose solutions.
PO2	Conduct experimentation: Use explorative aptitude and analytical methods for design of experiments, analysis and interpretation of data and synthesis of information to provide effective conclusions.
PO3	Ethics: Apply ethical principles and commit to professional ethics and responsibilities for societal benefits.
PO4	Communication: Communicate effectively scientific findings, and to be able to assimilate, write and present effective reports to give and receive clear instruction.
PO5	Societal Impact: Acquire and apply advanced knowledge of concepts and participate in sustainable development.
PO6	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7	Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of upcoming scientific change.
PO8	Research Problem Solving: Ability to assimilate, evaluate and present research results objectively.
PO9	Master of Science offers theoretical as well as practical knowledge about different area of chemistry subject.
PO10	The qualities of a science – observation, precision, analytical mind, logical thinking, clarity of thought and expression, systematic approach, qualitative and quantitative decision making are enlarged.
PO11	The program also empowers the Post graduates to appear for various competitive examinations or choose the PhD programme of their choice.
PO12	Think critically, follow innovations and developments in science and technology.

Program Specific Outcome (PSOs)

PSO 1	Understand the advanced concepts of organic and inorganic synthesis, Molecular and Interpretative spectroscopy and quantum chemistry.
PSO2	Perform procedures as per laboratory standards in the areas of analytical chemistry, organic and inorganic synthesis and structure interpretation.
PSO3	Exhibit the ability of comprehending the problem and building research oriented solutions.
PSO4	Understand and apply applications of organic and inorganic synthesis in pharmaceutics.

Eligibility for admission

Undergraduate degree in any branch of Science/Engineering/Equivalent discipline after completion of 10+2 scheme with minimum qualifying marks 45%.

Duration of the Programme:2 years

STUDY & EVALUATION SCHEME

Choice Based Credit System

Master of Science (Chemistry)

First Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core Paper	MCHC101	Inorganic Chemistry I	3	0	0	3	40	60	100
2	Core Paper	MCHC102	Organic Chemistry I	3	0	0	3	40	60	100
3	Core Paper	MCHC103	Physical Chemistry I	3	0	0	3	40	60	100
4	Core Paper	MCHC104	Spectroscopy and Group theory	3	0	0	3	40	60	100
Practical										
1	Core	MCHL105	Laboratory Course I	0	0	4	4	40	60	100
2	Core	MCHL106	Laboratory Course II	0	0	4	4	40	60	100
			Total				20			600

Second Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MCHC201	Inorganic Chemistry II	3	0	0	3	40	60	100
2	Core	MCHC202	Organic Chemistry II	3	0	0	3	40	60	100
3	Core	MCHC203	Physical Chemistry II	3	0	0	3	40	60	100
4	Core	MCHC204	Spectroscopy and separation methods	3	0	0	3	40	60	100
Practical										
1	Core	MCHL205	Laboratory Course I (Based on Paper MCHC201 and MCHC202)	0	0	4	4	40	60	100

2	Core	MCHL206	Laboratory Course II	0	0	4	4	40	60	100
Total							20			600

Third Semester

S. No.	**Course Category**	**Course Code**	**Course Name**	**Periods**				**Evaluation scheme**		**Subject Total**
				L	**T**	**P**	**C**	**Sessional (Internal)**	**External (ESE)**	
Theory										
1	Core	MCHC301	Organic Synthesis & Photochemistry	3	0	0	3	40	60	100
2	Core	MCHC302	Heterocyclic Chemistry	3	0	0	3	40	60	100
3	Elective I	MCHE313	Bioinorganic, Bioorganic & Biophysical Chemistry	3	0	0	3	40	60	100
4	Elective II	MCHE315	Polymers	3	0	0	3	40	60	100
5	Elective II	MCHE317	Medicinal Chemistry	3	0	0	3	40	60	100
6	Elective IV	MCHE322	Instrumental methods of analysis	3	0	0	3	40	60	100
7	Self Study	MCHS320	Pesticide Chemistry	0	0	0	3	40	60	100
Practical										
1	Core	MCHL303	Laboratory Course I	0	0	4	4	40	60	100
2	Core	MCHL304	Laboratory Course II	0	0	4	4	40	60	100
Total							20			600

***Students have to study any two elective papers in IIIrd Semester**

Total credits=20 (14 core credits + 06 elective credits) and 03 credits of MCHS320 self study paper.

Fourth Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MCHC401	Chemistry of Natural Products.	3	0	0	3	40	60	100
2	Core	MCHC403	Dissertation				10			300
3	Elective I	MCHE410	Computer and Biostatistics	3	0	0	3	40	60	100
4	Elective II	MCHE411	Environmental Chemistry	3	0	0	3	40	60	100
Practical										
1	Core	MCHL402	Laboratory Course I	0	0	4	4	40	60	100
			Total				20			600

***Students have to study any one elective papers in IV th Semester**

Total credits=20 (17 core credits + 03 elective credits)

Examination Scheme:

Components	Ist internal	IInd Internal	External (ESE)
Weightage (%)	20	20	60

MSc Chemistry (Ist Semester)

Course code	**: MCHC101**
Course Name	**: Inorganic Chemistry I**
Semester/Year	**: Ist**

	L	T	P	C
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to make students familiarize with stereochemistry, bonding in main group compounds, stability of complexes, theories and structure of coordination compounds and reaction mechanism of transition metal complexes.

Unit I

Stereochemistry and Bonding in Main Group Compounds

VSEPR model, applications of VSEPR theory and its shortcomings. Hybridization and three-center bonds. Bents rule. Walsh's diagrams for tri and tetra atomic molecules. pπ-pπ and pπ- dπ bonding.

Unit II

Theories of Coordination Compounds

Valence Bond Theory, Inner and Outer Orbital complexes, Square Planar complexes, Crystal field theory, Crystal field splitting in Octahedral and tetrahedral complexes, factors affecting the magnitude of Δ_O. Crystal Field Stabilization Energy. Merits and limitations of CFT. Jahn-Teller distortion and its consequences on complex formation. Evidence of covalent character in Metal-Ligand bonding. Molecular orbital theory as applied to octahedral, tetrahedral and square planar complexes.

Unit III

Metal-Ligand Equilibria in Solution

Stability of Metal complex. Stepwise and overall formation constants and their interaction. Trends in K value. Irving-Willams series. Chelate effect and its thermodynamic origin. Factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand.

Unit IV

Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction and reactivity of metal complexes. Inert and labile complexes on the basis of VBT and CFT. Ligand substitution reactions in octahedral complexes i.e.SN1, SN2 and SN1CB mechanism. Anation reactions without metal ligand bond cleavage. Substitution reactions in square-planer complexes, Trans effect, theories of Trans effect. Electron transfer reactions (Redox reactions). Outer and inner sphere mechanism (OSM and ISM).

Textbooks:

TB1. Advanced Inorganic Chemistry V Ed., F.A. Cotton and G. Wilkinson, John Wiley,(1988).
TB2. Advanced Inorganic Chemistry VI Ed., F. A. Cotton ,G. Wilkinson, C. A. Murillo and M Bochmann, John Wiley, (1999).
TB3. Inorganic Chemistry, J. E. House, Academic Press, (2008)

Reference Books:

RB1. Inorganic chemistry, A Unified Approach, II Ed.,W W. Porterfield, Academic Press, (1993).
RB2. Coordination Chemistry, IIIrd Ed. ,D Banerjea, Asian Book Pt. ltd., (2009)
RB3. Inorganic Chemistry,3rd Ed.,G L Miessler and D. A. Tarr, Pearson Education, nc.(2004)

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall the concepts of stereochemistry, bonding in main group compounds, and basic coordination chemistry.
CO2	Discuss the bonding and geometry of coordination compounds using Valence Bond Theory and Crystal Field Theory.
CO3	Explain reaction mechanisms of transition metal complexes.
CO4	Illustrate molecular structures using VSEPR theory, hybridization, CFT, MOT, and the chelate effect in coordination complexes.
CO5	Evaluate various types of ligand substitution and electron transfer mechanisms in metal complexes.
CO6	Propose plausible structures of inorganic molecules based on VSEPR and hybridization models.

CO- PSO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	2	0	1	2	1	2	1	3	3	2	2	3	2	2	2
CO2	3	2	0	1	2	1	2	1	3	3	2	2	3	2	2	2
CO3	3	3	0	1	2	2	2	2	3	3	3	3	3	2	3	2
CO4	3	3	0	2	2	2	2	2	3	3	2	3	3	3	3	3
CO5	3	3	1	2	3	2	3	3	3	3	3	3	3	3	3	2
CO6	3	3	0	2	3	2	3	3	3	3	3	3	3	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MCHC102**
Course Name	**: Organic Chemistry I**
Semester/Year	**: Ist**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to make students familiarize with structure,bonding,orientation and reaction mechanism involved in organic chemistry.

Unit I

Nature of Bonding in Organic Molecules

Hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non benzenoid compounds, alternant and non alternant hydrocarbons. Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, PMO approach.

Unit II

Stereochemistry

Conformational analysis of cycloalkane, decalins, effect of conformation on reactivity, conformation of sugars, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Unit III

Reaction Mechanism : Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Effect of structure on reactivity – resonance and field effects, steric effect, quantitative treatments. Hammett equation and linear free energy relationship, Substituent and reaction constants, Taft equation.

Unit IV

Aliphatic Nucleophilic Substitution

SN1, SN2 and mixed SN1 and SN2 mechanism. The neighbouring group mechanism, neighbouring group participation (by π- and σ bonds). Anchimeric assistance. SN1 mechanism- Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon. Reactivity effects of substrate structure, attacking nucleophilic group, leaving group and reaction medium, ambident nucleophile.

Unit V

Aliphatic Electrophilic Substitution

Bimolecular mechanism- SE2 . The SE1 mechanism, electrophilic substitution accompanied by double bond shift. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Text Books:

TB1. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.

TB2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
TB3. Reaction Mechanism in Organic Chemistry, Mukherji and Singh, Macmillan.

Reference Books:

RB1. Advanced Organic Chemistry, Reaction, Mechanism and Structure, Jerry March, 6th Ed., John Wiley.
RB2. Advanced Organic Chemistry, Carey and Sundberg, Springer Verlag, Germany.
RB3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define different type reaction mechanism, aromatic compounds, and substitution reactions.
CO2	Compare the concept of different type reaction mechanism, aromatic compounds, and substitution reactions.
CO3	Solve potential energy of cycloalkane.
CO4	Categorize different type reaction mechanism, aromaticity, and substitution reactions.
CO5	Assess stereochemistry of different type reaction mechanism and substitution reactions.
CO6	Assemble the concept of reaction mechanism, aromatic compounds, and substitution reactions.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	1	2	2	1	2	3	3	3	2	3	2	3	3	1	1
CO2	3	3	1	2	1	1	3	1	3	2	3	2	3	2	1	3
CO3	3	1	1	2	1	1	3	1	3	2	3	2	3	3	1	1
CO4	3	1	1	2	1	1	3	1	3	2	3	2	3	3	1	3
CO5	3	1	3	2	3	3	3	2	3	2	3	2	3	1	1	1
CO6	3	1	1	2	3	1	3	1	3	2	3	2	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC103**
Course Name	**: Physical Chemistry I**
Semester /Year	**: Ist**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about quantum mechanics,quantum mechanical results,approximate methods and chemical bonding in diatomics and classical thermodynamics.

Unit 1

Quantum Chemistry: Fundamentals of Quantum Mechanics

Operators , Eigen values and Eigen functions, Normalisation ,Heisenberg Uncertainty Principle, de Broglie equation, Momentum, Ladder operators ,Hermitian adjoint.

Unit II

Quantum Chemistry: Introduction to Quantum Mechanics

Postulates of quantum mechanics, The Schrodinger wave equation, Solutions of the Schrodinger wave equation to some simple systems as particle in a 1-D box, particle in a 3-D box, 1-D simple harmonic oscillator, rigid rotor, Schrodinger wave equation for hydrogen atom.

Unit III

Quantum Chemistry: Approximation Method of Quantam mechanics

Variation Method, Application of variation method to helium atom, Linear Solutions of the Schrodinger equation for multi-electron atoms: Time-dependent perturbation theory (first and non-degenerate)

Unit IV

Quantum Chemistry: Chemical Bonding in Diatomics

Elementary Concepts of Molecular Orbital and Valence Bond Theory, Huckel Molecular Orbital Theory for conjugated π-electron systems.

Unit V

Thermodynamics: Classical Thermodynamics

Brief resume of concepts of laws thermodynamics, free energy, chemical potential and entropies. Partial molar properties: partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient. Debye-Huckel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

Unit V

Surface Chemistry: Adsorption

Chemisorption, application of adsorption, factors influencing adsorption, Langmuir theory of adsorption, BET theory of multilayer adsorption, Derivation of the BET equation, Gibbs adsorption isotherm.

Text Books:

TB1. Physical Chemistry, P.W. Atkins, ELBS.
TB2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

Reference Books:

RB1. Quantum Chemistry, Ira N. Levine, Prentice Hall.
RB2. Coulson's Valence, R. McWeeny, ELBS

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Describe basic principles of Quantum Mechanics, Classical Thermodynamics and Surface Chemistry.
CO2	Discuss different concept based on surface adsorption and curved surface.
CO3	Explain laws of Thermodynamics for the determination of different quantities, apply appropriate approximation techniques for the analysis of multi electron molecules.
CO4	Analyze the classical thermodynamics and to explore the ideas of non-ideal systems and phase diagrams,
CO5	Estimate the Quantum mechanics result, approximate methods, chemical bonding in di atomics
CO6	Solve the problems based on Quantum chemistry, Surface phenomena and thermodynamics

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	1	3	2	1	3	3	1	2	2	3	3	3	2	1	1
CO2	3	1	1	2	2	1	3	2	2	2	3	3	3	1	1	1
CO3	3	2	1	2	1	1	3	1	2	2	3	3	3	1	3	1
CO4	3	1	1	2	1	1	3	1	2	2	3	3	3	1	1	1
CO5	3	1	1	2	1	1	3	1	2	2	3	3	3	1	1	1
CO6	3	3	3	2	2	3	3	3	2	2	3	3	3	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC104**
Course Name	**:Spectroscopy and Group Theory**
Semester /Year	**: Ist**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about EMR, different spectroscopic techniques (i.e UV-VIS, IR),symmetry elements and group theory.

Unit I

Unifying Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter. Absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, result of the time dependent perturbation theory, transition moment, selection rules, intensity of special lines, Born-oppenheimer approximation, rotational, and electronic energy levels.

Unit II

Atomic Electronic Spectroscopy Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Unit III

Ultra Violet and Visible Spectroscopy: Electronic transitions (185-800 nm), Beer- Lambert Law, Effect of solvent on electronic transitions, Ultra Violet bands of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Steric effect in biphenyls, Fieser- Woodward rules for conjugated dienes and carbonyl compounds, ultra violet spectra of aromatic and heterocyclic compounds.. Applications of UV- visible spectroscopy in organic chemistry.

Unit IV

Infrared Spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, Zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, virbration-rotation spectroscopy; P,Q,R branches. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region., metal-ligand vibrations.

.**Unit V**

Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroups, conjugacy relation and classes. Point symmetry group, Schonflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. group to be worked out explicitly).

Text Books:

TB1. Modern Spectroscopy, J.M. Hollas, John Wiley.
TB2. Physical Methods for Chemistry, R.S. Drago, Saunders Company.

Reference Books:

RB1. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
RB2. Symmetry and Spectroscopy of Molecules, K. Veera Reddy, New Age International.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall the basics of spectroscopy and group theory.
CO2	Describe the interaction of matter with EMR, and different spectroscopic techniques.
CO3	Acquire knowledge of UV,IR spectroscopy and group theory.
CO4	Explain different phenomenon related with EMR and use of spectroscopic techniques.
CO5	Asses and summarize the structures of organic compounds by using spectroscopic techniques.
CO6	Generalize the concept related to spectroscopy and group theory.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	1	3	1	2	1	3	3	3	2	2	3	3	3	3	2	3
CO2	1	3	1	2	1	3	3	3	2	2	3	3	3	1	1	3
CO3	3	3	3	3	1	3	1	1	2	2	3	3	3	1	1	3
CO4	3	1	1	2	1	1	3	1	2	2	3	3	3	2	2	1
CO5	3	1	1	2	3	1	3	1	2	2	3	3	3	1	1	1
CO6	3	1	1	2	1	1	3	1	2	2	3	3	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL105**
Course Name	**: Laboratory Course I**
Semester /Year	**: Ist**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about semi-micro analysis of mixtures, separation, identification of mixtures by Chromatography and interpretation of results.

Part1: Inorganic Chemistry
Qualitative analysis of mixtures by semi micro methods containing not more than six cation and anions including:

(i). Rare-earth elements

(ii).Anions, which have not been done in under graduate practicals.

(iii).Insolubles.

Part2: Organic Chemistry

Qualitative Analysis

Separation, purification and identification of compounds of binary mixture (solid-solid or liquid and solid) using TLC and Paper Chromatography, Chemical tests and spectroscopic analysis.

Part3: Physical Chemistry

Chemical Kinetics

1. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactants and catalyst and (c) ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.

2. Determination of the velocity constant of hydrolysis of an ester.

3. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics of the reaction.

4. Flowing clock reactions (Ref: Experiments in Physical Chemistry by Showmaker).

5. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the bronsted relationship (iodide ion is oxidized by persulphate ion).

Text Books:

TB1. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi
TB2. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House

Reference Books:

RB1. Vogel's textbook of Practical Organic Chemistry Vth Edition,Brian S. Furniss, Antony J. Hannaford, Peter W.G Smith. Pearson
RB2. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall the principles and procedures involved in qualitative analysis of inorganic and organic compounds.
CO2	Explain the theory behind semi-micro qualitative analysis of cations, rare earth elements, uncommon anions, and insoluble compounds.
CO3	Apply chromatographic and spectroscopic techniques to identify and separate binary mixtures of organic compounds.
CO4	Analyze the effect of variables such as temperature, concentration, catalysts, and ionic strength on the rate of chemical reactions.
CO5	Evaluate the experimental data and errors.
CO6	Determine the different parameters related to chemical kinetics.

CO- PSO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	2	1	1	2	1	2	1	3	3	2	2	3	3	2	2
CO2	3	2	1	1	2	1	2	2	3	3	2	2	3	3	2	2
CO3	2	3	1	2	2	2	2	2	3	3	2	3	3	3	3	2
CO4	3	3	0	2	2	2	2	2	3	3	2	3	3	3	3	2
CO5	3	3	1	2	2	2	3	3	3	3	3	3	3	3	3	2
CO6	3	3	0	2	2	2	2	2	3	3	2	3	3	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL106**
Course Name	**:Laboratory Course II**
Semester /Year	**: Ist**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about chromatography, synthesis of organic compounds and experiments related to physical chemistry.

Part 1: Inorganic Chemistry

Chromatography

Separation of cations and anions by: Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography

Part 2: Organic Chemistry

Organic Synthesis

Acetylation: Acetylation

Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.

Grignard reaction: Synthesis of triphenylmethanol from benzoic acid.

Sandmeyer reaction: p-Chlorotoluene from p-toluene

Part 3: Physical Chemistry

Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.

Determination of solubility and solubility product of sparingly soluble salts (e.g., PbSO4, BaSO4) conductometrically.

Determination of the strength of strong and weak acids in a given mixture conductometrically.

To study the effect of solvent on the conductance of $AgNO_3/CH_3COOH$ and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Huckel-Onsager theory.

Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye Huckel's limiting law.

Text Books:

TB1. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi
TB2. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House

Reference Books:

RB1. Vogel's textbook of Practical Organic Chemistry Vth Edition,Brian S. Furniss, Antony J. Hannaford, Peter W.G Smith. Pearson
RB2. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Remember the basics of chemistry practicals and lab rules.
CO2	Understand the basics of organic synthesis and physical chemistry.
CO3	Set experiment for organic synthesis and chromatography.
CO4	Analyze the RF values of cationic and anionic mixtures by chromatography.
CO5	Evaluate the experimental data and errors.
CO6	Determine the different parameters related to physical chemistry.

CO-PO Mapping
CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	2	3	1	2	2	3	1	1	2	2	3	3	1	3	1	2
CO2	1	3	3	2	2	3	2	1	2	2	3	3	1	3	1	2
CO3	1	3	1	3	2	3	1	2	2	2	3	3	2	3	1	2
CO4	1	3	1	2	2	3	1	1	2	2	3	3	1	3	1	2
CO5	1	3	1	2	2	3	1	1	2	2	3	3	1	3	1	2
CO6	3	3	1	3	2	3	3	2	2	2	3	3	1	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

MSc Chemistry (IInd Semester)

Course code	**:MCHC201**
Course Name	**: Inorganic Chemistry II**
Semester /Year	**: II**

	L	T	P	C
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about electronic spectra &magnetism of coordination compounds, bonding in organometallic compounds, basics of metal clusters and silicates.

Unit I: Electronic Spectra & Magnetic Properties of Transition Metal Complexes.

Types of electronic transitions, Selection rules for electronic transitions in complexes, Spectral terms, Russell-Saunder's Coupling, Spectroscopic Terms, Ground State Term. Band Width, Terms generated in ligand fields. Orgel diagrams for d^1 to d^9 states, Tanabe-Sugano diagrams. Racah parameters. Charge Transfer Spectra, Types of Charge Transfer Spectra. Magnetic properties of complexes, Magnetic moment , magnetic exchange coupling and spin crossover.

Unit II: Metal-π-Complexes and organometallic Compounds.

Metal carbonyl complexes. Preparation, properties and uses. Nature of bonding in metal carbonyls and carbon monoxide analogues i.e., nitrosyls and dinitrogen complexes. Evidence for back bonding in complexes. Nature of M-C bond Synthesis, bonding and uses of organometallic compounds, two electron ligands (olefinic and acetylenic complexes), three electron ligands (allylic complexes), four electron ligand (butadiene and cyclobutadiene complexes),five electron ligand (ferrocene complexes).

Unit III: Metal Clusters

Boranes, Preparation of boranes, properties of boranes, Polyhedral boranes and borane anions. Synthesis, reactivity, bonding and topology of boranes. Wade's rules. Carboranes and its types, metalloboranes and metallocarboranes. Metal carbonyls clusters: LNCC and HNCC. Metalcarbonylhydrides.

Unit IV: Silicates

Occurrence and principles of silicates. Structure and classification of silicates. Asbestos, Zeolites and Ultramarines as silicate materials. Silicates in technology.

Text Books:

TB1. Advanced Inorganic Chemistry Vth Ed., F.A. Cotton and G. Wilkinson, JohnWiley,(1988).

TB2. Advanced Inorganic Chemistry VIth Ed., F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, JohnWiley,(1999).

Reference Books:

RB1. Inorganic Chemistry, A Unified Approach, IInd Ed., W W. Porterfield, Academic Press, (1993).
RB2. Inorganic Chemistry ,J. E. House, Academic Press, (2008)

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Recall the basic concepts of electronic spectra, magnetic properties of transition metal complexes, metal π-complexes, clusters, and silicates.
CO2	Explain the principles behind electronic spectra, magnetic properties, metal π-complexes, metal clusters, and silicates.
CO3	Classify different types of silicates and explain the features of charge transfer spectra.
CO4	Compare the preparation, properties, and uses of metal π-complexes, organometallic compounds, and metal clusters
CO5	Evaluate the structural and chemical features of various types of boranes and carboranes.
CO6	Solve numerical or conceptual problems related to Russell-Saunders (R–S) coupling.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO 4
CO1	3	2	0	2	2	1	3	1	2	2	3	3	3	1	1	1
CO2	3	1	0	2	1	1	3	2	2	2	3	3	3	1	2	1
CO3	3	1	0	2	1	1	3	1	2	2	3	3	3	1	1	1
CO4	3	1	0	2	1	1	3	1	2	2	3	3	3	3	1	1
CO5	3	1	1	2	1	1	3	1	2	2	3	3	3	1	1	1
CO6	3	2	1	2	1	3	3	1	2	2	3	3	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MCHC202**
Course Name	**: Organic Chemistry II**
Semester /Year	**: IInd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about mechanism of various substitution, addition and elimination reactions.

Unit I Aromatic Electrophilic Substitution

Orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrate and electrophiles. Diazonium coupling, VilsmeirHaak reaction, Gattermann-Koch reaction.

Unit II Aromatic Nuecleophilic Substitution

The SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity- effect of substrate structure, leaving group and attacking nucleopile. The von Rictor, Sommelet-Hauser, and Smiles rearrangements.

Unit III Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism of an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Unit IV Addition Reactions

Mechanism and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation. Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Wittig reaction.

Unit V Elimination Reactions

The E2, E1 and E1cB mechanisms and their stereochemistry. Orientation of the double bond.Reactivity- effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit VI Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann. Correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and suprafacial additions, 4n, and 4n+2 systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements- suprafacial and antarafacialshiffs of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and aza- Cope rearrangements. Fluxional tautomerism. Ene reaction.

Text Books:

TB1. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
TB2. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
TB3. Reaction Mechanism in Organic Chemistry, Mukherji and Singh, Macmillan.

Reference Books:

RB1. Advanced Organic Chemistry, Reaction, Mechanism and Structure, Jerry March, 6th Ed., John Wiley.
RB2. Advanced Organic Chemistry, Carey and Sundberg, Springer Verlag, Germany.
RB3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define different types of pericyclic, substitution, addition, elimination and free radicals reactions.
CO2	Compare the pericyclic, substitution, addition, elimination and free radicals reactions.
CO3	Illustrate various pericyclic, substitution, addition, elimination and free radicals reactions.
CO4	Categorize different pericyclic, substitution, addition, elimination and free radicals reactions.
CO5	Assess the mechanism of pericyclic, substitution, addition, elimination and free radicals reactions.
CO6	Integrate different type pericyclic, substitution, addition, elimination and free radicals reactions.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	1	2	2	3	1	3	3	2	2	1	3	3	3	1	3
CO2	3	3	1	2	2	1	3	1	2	2	1	3	3	1	2	1
CO3	3	1	1	2	2	1	3	1	2	2	1	3	3	1	1	1
CO4	3	1	1	2	2	1	3	1	2	2	1	3	3	1	1	1
CO5	3	1	1	2	2	3	3	1	2	2	1	3	3	1	1	1
CO6	3	2	1	2	2	1	3	1	2	2	3	3	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC203**
Course Name	**: Physical Chemistry II**
Semester /Year	**: IInd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about theories of chemical dynamics & its application in deriving kinetics of various reactions,laws of statistical thermodynamics and use of EMR to measure different aspects of molecular structure.

Unit I Chemical Dynamics

Methods of determining rate laws, collision theory of reaction rates, activated complex theory, Arrhenius equation and the activated complex theory. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen- chlorine reactions) and oscillatory reactions (Belousov-Zhabotinsky reaction), Study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrierless chemical reactions in solution, dynamics of unimolecular reactions (Lindemann theory – Hinshelwood theory and Rice-Ramsperger-Kassel-Marcus [RRKM] theories of unimolecular reactions).

Unit II Statistical Thermodynamics

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws- (using Lagrange's method of undetermined multipliers). Partition functions-translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.Heat capacity behaviour of solids- chemical equilibria and chemical equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law and applications to metal. Bose-Einstein statistics – distribution law and application to helium.

Unit III Non-Equilibrium Thermodynamics

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.

Unit IV Electrochemistry

Electrochemistry of solutions, Debye-Huckel, Onsager treatment and its extension, ion solvent interactions. Thermodynamics of electrified interface equations. Structure of electrified interfaces. Guoy Chapman, Stern. Over potentials, exchange current density, derivation ofButler-Volmer equation, Tafel plot. Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Electrocatalysis – influence of various parameters. Hydrogen electrode. Polarography theory, Ilkovic equation. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

Text Books:

TB1. Physical Chemistry, P.W. Atkins, ELBS.
TB2. Coulson's Valence, R. McWeeny, ELBS.
TB3. Modern Electrochemistry, Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum.

Reference Books:

RB1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
RB2. Quantum Chemistry, Ira N. Levine, Prentice Hall.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Observes basic principles of Chemical Dynamics, Statistical Thermodynamics, Non-Equilibrium Thermodynamics, and Electrochemistry.
CO2	Interpret the basic elements and laws of statistical thermodynamics, estimate thermodynamics criteria for non-equilibrium states.
CO3	Illustrate the knowledge of chemical dynamics in deriving kinetics of various reactions ,determine the electrochemistry of various solution and explain its theory.
CO4	Analyze various regions of the electromagnetic spectrum which can be used to measured different aspects of molecular structure.
CO5	Consider the theory and principles of solution in electrochemistry and its various applications.
CO6	Solve the problems based on Chemical Dynamics, Statistical, Non-Equilibrium Thermodynamics, and Electrochemistry**.**

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	2	1	2	2	1	3	1	2	2	1	3	3	1	3	1
CO2	3	1	1	2	1	1	3	1	2	2	3	3	3	1	1	1
CO3	3	1	1	2	1	1	3	1	2	2	1	3	3	1	1	1
CO4	3	1	1	2	1	1	3	1	2	2	1	3	3	1	1	1
CO5	3	1	1	3	1	3	3	1	2	2	1	3	3	1	1	1
CO6	3	1	3	3	1	1	3	1	2	2	1	3	3	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC204**
Course Name	**: Spectroscopy and separation methods**
Semester /Year	**: IInd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about chromatography, radioactivity and different spectroscopic techniques& its application in structural elucidation of organic compounds.

Unit I
Molecular Electronic Spectroscopy: Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of excited states, Franck-Condon principle, Dissociation and pre-dissociation, electronic spectra of polyatomic molecules. Emission spectra, radiative and non-radiative decay, internal conversion,

Unit II

Magnetic Resonance Spectroscopy:

Nuclear Magnetic Resonance Spectroscopy: Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurement, factor influencing chemical

shift, deshielding, spin-spin interaction, factors influencing coupling constant 'J'. Classification (ABX, AMX, ABC, A2B2 etc.), spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton-^{13}C, ^{19}F. FT NMR, advantages of FT NMR, use of NMR in medical diagnostics.

Unit III

Mass Spectrometry: Introduction, ion production—EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, and ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, Molecular ion peak, Meta-stable peak, McLafferty rearrangement. Nitrogen Rule. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination. Introduction to negative ion Mass spectrometry, TOF-MALDI.

Unit IV

Chromatographic Methods: Principle, instrumentation and applications of gas liquid chromatography and HPLC. Ion exchange chromatography: cationic and anionic exchanges and their applications. Van-Deemter equation (no derivation), concept about HEPT-plate theory and rate theory. Applications.

Unit V

Radio Analytical Methods: Basic principles and types of measuring instruments, isotope dilution techniques: principle of operations and uses. Applications.

Text Books:

TB1. Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern).
TB2. Modern Spectroscopy, J.M. Hollas, John Wiley.
TB3. High Performance Liquid Chromatography, Heinz Engelhardt.

Reference Books:

RB1. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
RB2. Introduction of Molecular Spectroscopy, G.M. Barrow, McGraw Hill.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Memorize the basics of spectroscopy, chromatography and radioanalytical techniques.

CO2	Explain the molecular electronic spectroscopy and theory & instrumentation of NMR, Mass spectrometry.
CO3	Acquire knowledge about chromatographic and radioanalytical techniques and molecular electronic spectroscopy.
CO4	Analyze the spectra of organic molecules and chromatograms.
CO5	Explain principle and uses of spectroscopy and chromatography.
CO6	Solve numerical based on spectroscopy, chromatography and radioanalytical techniques.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	2	1	2	1	1	3	3	2	2	1	3	3	1	1	3
CO2	3	1	1	2	3	1	3	1	2	2	1	3	3	3	1	3
CO3	3	1	1	2	1	1	3	1	2	2	1	3	3	1	1	3
CO4	3	1	1	2	1	1	3	1	2	2	1	3	3	1	1	3
CO5	3	1	1	2	1	3	3	1	2	2	1	3	3	1	1	3
CO6	3	1	3	2	1	1	3	1	2	2	2	3	3	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL205**
Course Name	**: Laboratory Course I**
Semester /Year	**: IInd**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about volumetric and gravimetric analysis, synthesis of organic compounds and spectral techniques.

Part 1: Inorganic Chemistry

Quantitative Analysis of mixtures of two metal ions involving Volumetric (by complexometric titration using masking and demasking agents) and gravimetric analysis.

Part 2: Organic Chemistry

1. Synthesis of Acetoacetic ester Condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.
2. Cannizzaro reaction: 4-Chlorobenzaldehyde as substrateAromatic electrophilic Substitutions: Synthesis of p-nitroaniline and p-bromoaniline.The products may be characterized by Spectral Techniques where possible.

Part 3: Physical Chemistry

Solutions

1. Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
2. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Text Books:

TB1. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi
TB2. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House

Reference Books:

RB1. Vogel's textbook of Practical Organic Chemistry Vth Edition,Brian S. Furniss, Antony J. Hannaford, Peter W.G Smith. Pearson
RB2. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall the principles of quantitative analysis using complexometric and gravimetric methods for estimation of metal ions.
CO2	Discuss the reaction mechanisms involved in organic syntheses.
CO3	Apply experimental procedures for the synthesis and purification of organic compounds using techniques like TLC, recrystallization, and chromatography.
CO4	Analyze solution behaviour by determining molecular weights and activity coefficients of electrolytes using colligative properties.
CO5	Evaluate the experimental data.
CO6	Design and conduct titrations using masking and demasking agents to selectively determine metal ions in mixtures.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	3	1	2	1	3	1	2	2	2	1	3	1	3	1	2
CO2	1	3	1	2	1	3	1	1	2	2	1	3	1	3	1	2
CO3	1	3	1	2	1	3	1	1	2	2	1	3	1	3	1	2
CO4	1	3	2	2	1	3	3	1	2	2	1	3	2	3	1	2
CO5	1	3	1	2	1	3	1	1	2	2	1	3	1	3	1	2
CO6	1	3	1	2	3	3	1	1	2	2	3	3	1	3	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL206**
Course Name	**: Laboratory Course II**
Semester /Year	**: IInd**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about water and oil analysis, inorganic preparations and quantitative analysis by using potentiometer and pH meter.

Part 1: Inorganic Chemistry

Preparations of selected inorganic compounds:

VO (acac)2

TiO (C9H8NO)2. 2H2O

cis-K[Cr(C2O4)2 (H2O)2]

Na[Cr(NH3)2(SCN)4]

Mn (acac)3

K3 [Fe (C2O4)3] 3H2O

Prussian Blue, Turnbull's Blue

Co [(NH3)6] Cl3

[Cu (en)2 (H2O)2] I2

Cu2HgI4

[Co (Py)2Cl2]

[Ni (NH3)6] Cl2

Tris-(thiourea) copper (I) sulphate [Cu (tu)3] SO4.2H2O

K3[Cr (C2O4)3]

Part 2: Organic Chemistry

Quantitative Analysis

Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.

Estimation of amines/phenols using bromate bromide solution/or acetylation method.

Determination of Iodine and Saponification values of an oil sample

Determination of DO, COD and BOD of water sample.

Part 3: Physical Chemistry

Potentiometry/pH-metery

Determination of strengths of halides in a mixtures potentiometrically.

Determination of the valency of mercurous ions potentiometrically.

Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.

Determination of temperature dependence of EMF of a cell.

Determination of the formation constant of silver-ammonia complex and stiochiometry of the complex potentiometrically.

Acid-base titration in a non-aqueous media using a pH meter.

Determination of activity and activity coefficient of electrolytes.

Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.

Determination of the dissociation constant of monobasic/dibasic by Albert-Serjeant method.

Determination of thermodynamic constants ΔG, ΔS and ΔH for the reaction by e.m.f.method. $Zn + H_2SO_4 \longrightarrow ZnSO_4 + 2H$

Text Books:

TB1. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi
TB2. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House

Reference Books:

RB1. Vogel's textbook of Practical Organic Chemistry Vth Edition,Brian S. Furniss, Antony J. Hannaford, Peter W.G Smith. Pearson
RB2. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Remember the basics of chemistry practicals and lab rules.
CO2	Understand basics of inorganic, organic and physical chemistry.
CO3	Prepare inorganic compounds.
CO4	Estimate hydroxyl groups, BOD, COD, iodine and saponification value etc.
CO5	Evaluate the experimental data.
CO6	Determine different parameters of physical chemistry by PH meter.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4

CO1	1	3	1	2	1	3	1	3	2	2	1	3	1	3	1	2
CO2	1	2	1	2	2	3	1	1	2	2	1	3	1	3	1	2
CO3	1	3	1	2	1	3	1	1	2	2	1	3	1	3	1	2
CO4	1	3	1	2	1	3	1	1	2	2	1	3	2	2	3	3
CO5	1	3	1	2	1	3	3	1	2	2	1	3	2	2	1	3
CO6	3	3	1	2	1	3	1	1	2	2	2	3	2	2	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

MSc Chemistry IIIrd Semester

Course code	**:MCHC301**
Course Name	**:ORGANIC SYNTHESIS AND PHOTOCHEMISTRY**
Semester /Year	**: IIIrd**

	L	T	P	C
	3	0	0	3

Course Objective:

The objective of this course is to gain knowledge about disconnection approach, reaction mechanisms and photochemical reactions.

Unit I

Disconnection Approach

An introduction to synthons and synthetic equivalents disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions and amine synthesis.

Unit II

Protecting Groups

Principle of protection of alcohols, amine, carbonyl and carboxyl groups

Unit III

One Group and Two Group C-C Disconnections

Alcohols and carbonyl compounds regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. Diels-Alder reaction, 1,3-difunctional compounds, α,β-unsaturated carbonyl compounds, control in carbonyl condensations. Micheal addition and Robinson annelation.

Unit IV

Determination of Reaction Mechanism

Classification, rate constants and life times of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photo-dissociation, gas-phase photolysis.

Unit V

Photochemical Reactions

Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4-and 1,5-dienes. Intramolecular reactions of carbonyl compounds-saturated

cyclic and acyclic, β,γ-unsaturated and α,β-unsaturated compounds. Cyclohexadienones. Intramolecular cycloaddition reactions-dimerisation and oxetane formation. Isomerisation, additions and substitutions.. Photo-Fries rearrangement, Barton reaction.

Text Books:

TB1. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, New Age International
TB2. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication

Reference Books:

RB1. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
RB2. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
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Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define the various photochemical reactions and organic synthesis.
CO2	Compare the various photochemical reactions and organic synthesis.
CO3	Illustrate the various photochemical reactions and organic synthesis.
CO4	Categorize the various photochemical reactions and organic synthesis.
CO5	Assess the mechanism of various photochemical reactions and organic synthesis.
CO6	Integrate various synthetic routes of photochemical reactions and organic synthesis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	1	1	2	3	3	3	3	3	1	2	3	3	3	1	3
CO2	3	3	2	2	3	1	3	1	3	3	2	1	3	1	1	3
CO3	3	1	1	2	3	1	3	1	3	1	2	1	3	1	3	3
CO4	3	1	1	2	3	1	3	1	3	1	2	1	3	1	1	3
CO5	3	1	1	2	3	3	3	2	3	1	2	1	3	1	1	3
CO6	3	1	2	2	3	1	3	1	3	2	2	2	3	3	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC302**
Course Name	**: Heterocyclic Chemistry**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about nomenclature, classification, chemical and physical properties of various heterocyclic compounds.

Unit I

Nomenclature of Heterocycles: Replacement and Systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles

Unit II

Aromatic and Non-aromatic Heterocycles: General chemical behaviour of aromatic heterocycles, classification (structural type), Heteroaromatic reactivity and tautomerism in aromatic heterocycles Strain –bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions. Stereo-electronic effects, aromatic and related effects. Attractive interactions - hydrogen bonding and intermolecular nucleophilic, electrophilic interactions.

Unit III

Small Ring Heterocycles: Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes.

Unit IV

Benzo-Fused Five-Membered Heterocycles: Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes

Unit V

Six-Membered Heterocycles with One, Two or More Heteroatoms

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts. Synthesis and reactions of benzopyrylium salts and coumarins. Synthesis and reacitons of diazines, triazines, tetrezines and thiazines.

Unit VI

Seven-and Large-Membered Heterocycles

Synthesis and reactions of azepines,oxepine,diazepines,azocines and oxocines.

Text Books:

TB1. Heterocyclic Chemistry Vol. 1 & 2, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag
TB2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.

Reference Books:

RB1. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
RB2. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scietific Technical

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Identify the basics of heterocyclic compounds.
CO2	Explain the nomenclature, general behaviour, synthesis and properties of heterocyclic compounds.
CO3	Predict the reactivity, isomerism, conformers etc of heterocyclic compounds.
CO4	Illustrate the properties and uses of different aromatic, non-aromatic heterocyclic compounds.
CO5	Explain synthesis, properties and uses of heterocyclic compounds.
CO6	Summarize the concept of heterocyclic compounds.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	1	1	2	2	3	3	1	2	3	3	2	3	1	2	3
CO2	3	1	1	2	2	1	3	2	2	3	3	2	3	3	1	3
CO3	2	1	3	2	3	1	3	1	2	3	3	2	3	1	1	3
CO4	3	1	1	2	2	1	3	1	2	3	3	2	3	1	1	3
CO5	3	1	1	2	2	2	3	1	2	3	3	2	3	1	1	3
CO6	3	3	1	2	2	1	3	2	2	3	3	2	3	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL303**
Course Name	**: Laboratory Course I**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about separation, purification and identification of the components of a mixture.

Qualitative Analysis

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid), using TLC for checking the purity of the separated compounds. Preparation of derivatives and spectral analysis.

Text Books:

TB1. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
TB2. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

Reference Books:

RB1. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
RB2. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

Course outcomes (Cos):
Upon successful completion of the course student will be able to

CO1	Define the purification, separation and analysis of organic mixture of a compound
CO2	Compare a range of practical techniques used in science such as the analysis of substances, the separation of substances and the use of instruments/ glassware's.
CO3	Illustrate the ability of performing accurate quantitative measurements with an understanding of the theory and use of contemporary instrumentation.
CO4	Categorize the practical concept of qualitatively and quantitatively analysis.
CO5	Assess the purity of separated compounds.
CO6	Develop Preparation of derivatives and spectral analysis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	1	3	3	2	2	3	1	1	3	3	1	2	1	3	2	2
CO2	1	3	1	2	1	3	1	1	3	3	3	2	3	3	1	2
CO3	2	3	1	2	1	3	3	1	3	3	1	2	1	3	1	2
CO4	1	3	1	2	1	3	1	1	3	3	1	2	1	3	1	2
CO5	1	3	1	2	1	3	1	3	3	3	2	2	1	3	2	2
CO6	2	3	3	2	1	3	1	1	3	3	1	2	1	3	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL304**
Course Name	**: Laboratory Course II**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about multistep organic synthesis, photochemical reactions, synthesis of heterocyclic compounds.

Multi-step Synthesis of Organic Compounds

The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

Photochemical reaction

Benzophenone ⟶ Benzpinacol ⟶ Benzpinacolone

Beckmann rearrangement: Benzanilide from benzene

Benzene ⟶ Benzophenone ⟶ Benzophenone oxime ⟶ Benzanilide Benzilic acid rearrangement: Benzilic acid from benzoin

Benzoin ⟶ Benzil ⟶ Benzilic acid

Synthesis of heterocyclic compounds

Skraup synthesis: Preparation of quinoline from aniline. Fisher-Indole synthesis: Preparation of 2-phenyl indole from phenylhydrazine.

Text Books:
TB1. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
TB2. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

Reference Books:

RB1. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
RB2. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Identify the organic compounds in the ternary mixture using separation techniques and confirmatory tests.
CO2	Distinguish organic compounds and to identify various functional group transformations.
CO3	Illustrate various synthetic methodologies involved in organic synthesis.
CO4	Analyze different synthetic methodologies involved in organic chemistry.
CO5	Measure their experimental skills for synthesis of various organic compounds.
CO6	Create various synthetic methodologies involved in organic synthesis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	1	3	2	1	3	3	1	3	1	3	1	2
CO2	3	3	3	2	1	3	1	3	3	3	2	2	3	3	2	2
CO3	1	3	1	2	1	3	1	1	3	3	1	2	1	3	1	2
CO4	1	3	1	2	1	3	1	1	3	3	1	2	1	3	1	2
CO5	1	3	1	2	1	3	3	1	3	3	1	2	1	3	1	2
CO6	1	3	3	2	3	3	1	2	3	3	2	2	3	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

Course code	**: MCHE313**
Course Name	**: Bioinorganic, Bioorganic and Biophysical Chemistry**
Semester /Year	**: III**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about bioinorganic, bioorganic and biophysical chemistry.

Unit I: Bioinorganic Chemistry

Metal Ions in Biological Systems, Na+/K+Pump: Essential and trace metals. Role of metal ions in biological processes. Na^+/K^+ Pump.

Bioenergetics and ATP Cycles: DNA polymerization, glucose storage, metal complexes in transmission of energy; chlorophylls, photosystem I and photosystem II in cleavage of water.

Transport and Storage of Dioxygen: Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin.

Unit II: Bioorganic Chemistry

Enzymes & Mechanism of Enzyme Action: Introduction and historical perspective, chemical and biological catalysis, properties of enzymes- catalytic power, specificity and regulation. Fischer's lock and Koshland's induced fit hypothesis, Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, acid base catalysis, covalent catalysis, strain of distortion.

Kinds of Reactions Catalysed by Enzymes : Nucleophillic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerization reactions,-cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Unit III: Biophysical Chemistry

Biological Cell and its Constituents, Cell Membrane and Transport of Ions: Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition. Structure and functions of cell membrane, ion transport through cell membrane.

Bioenergetics: Standard free energy change in biological reactions, exergonic, endergonic. Hydrolysis of ATP, Synthesis of ATP from ADP.

Textbooks:

TB1. Bioinorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
TB2. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.

Reference Books:

RB1. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
RB2. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.

Course outcomes (Cos):
Upon successful completion of the course student will be able to

CO1	Recall the fundamental concepts of bioinorganic, bioorganic, and biophysical chemistry.
CO2	Describe the basics of bioinorganic, bioorganic and biophysical chemistry.
CO3	Explain the role of metal ions in biological systems, including the transport and storage of oxygen.
CO4	Illustrate the mechanism of enzyme action, types of enzyme-catalyzed reactions, Na^+/K^+ pump, and biological cell structure.
CO5	Summarize the structure and functions of proteins, enzymes, nucleic acids, and the cell membrane.
CO6	Express standard free energy change in biological reactions, hydrolysis of ATP and its synthesis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	2	1	3	1	3	3	1	2	3	1	2	3
CO2	2	3	3	2	2	3	3	2	3	3	2	2	3	3	3	3
CO3	3	1	1	2	2	1	3	1	3	3	1	2	3	1	1	3
CO4	3	1	1	2	2	1	3	1	3	3	1	2	3	1	1	3
CO5	1	2	2	2	2	2	3	2	3	3	1	2	3	1	1	3
CO6	3	1	1	2	2	1	3	1	3	3	1	2	3	3	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHE315**			
Course Name	**: Polymers**			
Semester /Year	**: IIIrd**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about classification,properties, thermodynamics, synthesis and applications of polymer.

Unit I

Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain, ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions. Polymerization n homogenous and heterogeneous systems.

Unit II

Polydispersion-average molecular w eight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing tensile strength. Fatigue, impact. Tear resistance. Hardness and abrasion resistance.

Unit III

Structure and Properties Morphology and order in crystalline polymers, configurations of polymer chains. Crystal structure of polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties, crystalline melting point Tm, melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg. Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

Unit IV

Plastic, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

Textbooks:

TB1. Textbook of Polymer Science, F.W. Billmeyer Jr, Wiley.
TB2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.

Reference Books:

RB1. Functional Monomers and Polymers, K. Takemoto, Y. inaki and R.M. Ottanbrite.

RB2.. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define synthesis, properties and applications of different polymers
CO2	Compare different types of mechanisms in polymerization processes.
CO3	Illustrate the importance of functionality of polymers in polymerization.
CO4	Categorize the properties of polymers with their structure.
CO5	Assess the molecular weight of polymers by using different methods.
CO6	Integrate different type of polymeric products.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	3	1	3	3	1	2	3	1	1	3
CO2	2	1	1	3	2	3	2	3	3	3	1	2	3	3	1	1
CO3	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	1
CO4	3	2	1	2	3	1	3	1	3	3	1	2	3	1	1	2
CO5	1	1	3	1	3	2	3	2	3	3	1	2	3	2	1	1
CO6	3	1	1	2	1	1	1	1	3	3	1	2	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHE317**
Course Name	**: Medicinal Chemistry**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about fundamentals of medicinal chemistry, classification and mechanism of action of drugs and structure of enzymes and their interaction with biomolecules.

Unit I

Basics of Medicinal Chemistry- History and scope, drug action on biomolecules (lipids, proteins, nucleic acids), drug metabolism, receptors, basics of drug discovery, design, delivery, and resistance.

Unit II

Drug Classification and Design Tools

Drug classification (structure and function), synthesis of selected drugs (e.g., α-methyldopa, chloramphenicol), basics of molecular modeling, conformational analysis, and SAR/QSAR.

Unit III

Antibiotics and Antivirals

Mechanism and types of antibiotics (β-lactam and others), penicillin chemistry and synthesis, semisynthetic penicillins, and introduction to antiviral agents.

Unit IV

Enzyme structure Enzymes and Drug Interaction
Enzyme structure, mechanism, inhibition, and mimics; drug-enzyme and DNA interactions; basics of rational drug design and factors affecting drug activity.

Text Books:

TB1.I. Wilson, Giswald and F. Doerge, Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.B. Lippincott Company, Philadelphia, 1971.
TB2.A. Burger, Medicinal Chemistry, Wiley Interscience, New York, Vol. I and II, 1970.

Reference Books:

RB1. A. Gringauz, Introduction to Medicinal Chemistry, How Drugs Act and Why?, John Wiley and Sons, 1997.
RB2.G. L. Patrick, Introduction to Medicinal Chemistry, Oxford Univeristy Press, 2001.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Memorize the fundamentals of medicinal chemistry.
CO2	Explain the drugs, antibiotics, enzymes etc .
CO3	Apply an idea of antibiotics and their mechanism of action.
CO4	Analyze the structure of enzymes and their interaction with biomolecules.
CO5	Summarize the concept of medicinal chemistry.
CO6	Generalize the concept of enzymes, antibiotics and their mechanism of action.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	2	1	1	2	1	1	3	1	3	3	1	2	3	3	1	3
CO2	3	2	3	2	2	2	3	2	3	3	2	2	3	1	2	3
CO3	3	1	3	3	1	1	3	1	3	3	3	2	3	1	1	3
CO4	3	1	3	2	1	1	3	1	3	3	1	2	3	1	1	3
CO5	2	3	1	2	1	1	3	1	3	3	1	2	3	1	1	3
CO6	3	1	3	2	3	3	3	3	3	3	3	2	3	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHE322**
Course Name	**:Instrumental methods of analysis**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about different electroanalytical,microscopic, chromatographic and thermal techniques.

Unit I

Thermal methods : Theory, instrumentation and applications of thermogravimetric analysis (TGA),Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), thermometric titrations

Unit II

Electrophoresis: Separation by adsorption-affinity techniques, polyacrylamide gel electrophoresis, isoelectric focussing isotachophoresis, two-dimensional gel electrophoresis, applications in clinical and capillary zone electrophoresis of carbohydrates

Unit III

High performance liquid chromatography methods: HPLC theory and instrumentation, adsorption chromatography, liquid-liquid partition techniques, affinity techniques, size exclusion, capillary chromatography, ion pair separations, chiral and isotope separations, applications in food and pesticide analysis

Unit IV

Gas chromatography: Gas chromatography theory and Instrumentation, column types, solid/liquid stationary phases, basic and specialized detectors, elemental detection, chiral separations, pyrolysis gas chromatography, high temperature techniques, application (clinical, petrochemical etc.) and problems

Unit V

Optical and diffraction methods: Atomic fluorescence spectrometry-theory, instrumentation and applications, basic principles of electron and neutron diffraction, X-ray methods: x-ray absorption spectroscopy (XAS), x-ray diffraction (XRD), x-ray photoelectron spectroscopy (XPS), energy dispersive x-ray spectroscopy (EDX), scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic-force microscopy (AFM)

Unit VI

Electroanalytical methods: Basic theory, instrumentation and applications of electrogravimetry, coulometry, polarography, cyclic voltammetry, amperometry

Text Books:

TB1. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Cengage Learning.
TB2.. Vogel's Quantitative Chemical Analysis by J. Mendham, R.C.Denney, M.J.Kthomas, David J. Barnes, Pearson

Reference Books:

RB1. Instrumental Methods of Analysis By H.H.Willard, L.L.Merritt, J.A. Dean, CBS Publishers & Distributors Pvt. Ltd.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall theory, instrumentation and applications of different electroanalytical methods.
CO2	Describe various electroanalytical techniques including cyclic voltametry, coulometry, polarography etc.
CO3	Apply basics of scanning electron microscopy and transmission electron microscopy to determine morphology of materials.
CO4	Illustrate the theories, instrumentation and applications of high-performance liquid chromatography and gas chromatography.
CO5	Summarize various types of thermal methods for characterization of different types of compounds.
CO6	Generalize the concept of various analytical techniques.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	3	3	1	2	1	2	3	3	3	3	3
CO2	2	1	1	2	2	1	3	1	3	3	1	2	2	1	1	2
CO3	3	1	1	3	2	1	3	3	3	3	1	2	3	1	1	3
CO4	3	3	1	2	2	1	2	1	3	1	2	2	3	1	3	3
CO5	3	1	2	2	3	1	3	1	2	3	1	2	3	2	1	2
CO6	3	1	1	2	2	1	3	1	3	3	1	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHS320**
Course Name	**: Pesticide Chemistry**
Semester /Year	**: IIIrd**

	L	**T**	**P**	**C**
	0	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about classification, synthesis and properties of various pesticides.

Unit I: General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship,

Unit II: synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Text Books:

TB1: Chemistry of Pesticides, N.K Roy. CBS Publishers and Distributors
TB2: Principles of Pesticide Chemistry, S.K.Handa. AgrobiosIndia

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall of fundamentals of pesticide chemistry.
CO2	Describe the classification of pesticides.
CO3	Apply and use self study for teaching practice.
CO4	Analyze synthetic route of pesticides.
CO5	Distinguish different type of pesticides.
CO6	Design various synthesis of pesticides.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	1	3	2	2	1	3	1	2	3	1	1	3
CO2	3	3	3	3	3	1	3	1	3	3	3	2	3	1	1	3
CO3	3	1	3	1	3	1	3	1	3	3	1	2	3	2	1	3
CO4	3	1	3	3	3	1	3	1	3	3	1	2	3	1	1	3
CO5	2	3	2	3	1	1	2	2	1	3	1	2	3	1	1	3
CO6	3	1	3	3	3	3	3	1	3	3	1	2	3	1	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

MSc Chemistry (IVth Semester)

Course code	**:MCHC401**
Course Name	**:Chemistry of natural products**
Semester /Year	**: IVth**

	L	T	P	C
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about isolation, structural features, biosynthetic pathways for various classes of natural products**.**

Unit I

Terpenoids and Carotenoids

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule Structures of abietic acid and β-carotene.

Unit II

Alkaloids

Classification, Nomenclature, Isolation and structure of ephedrine, quinine.

Unit III

Steroids

Structural features of cholesterol and bile acids (without synthesis). Chemistry of testosterone, estrone and progesterone.

Unit IV

Pigments

(a) Plant Pigments: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of cyanidin, and quercetin.

(b) Porphyrins

General Introduction of haemoglobin and chlorophyll. Chemistry of chlorophyll (without synthesis). Structure and synthesis of haem.

Unit V

Prostaglandins

Occurrence, nomenclature, classification, biogenesis and physiological effectsSynthesis of Key intermediate, PGE2 and PGF2

Text Books:

TB1. Natural Products: Chemistry and Biological Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
TB2. Organic Chemistry, Vol 2, I.L. Finar, ELBS.
TB3. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.

Reference Books:

RB1. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
RB2. New Trends in Natural product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define terpenoids, alkaloids, pigments and prostaglandins.
CO2	Compare terpenoids, alkaloids, pigments and prostaglandins.
CO3	Illustrate various types terpenoids, alkaloids, pigments and prostaglandins.
CO4	Categorize synthetic route of terpenoids, alkaloids, pigments and prostaglandins.
CO5	Assess different type reaction mechanism of terpenoids, alkaloids, pigments and prostaglandins synthesis.
CO6	Integrate various synthetic routes of terpenoids, alkaloids, pigments and prostaglandins.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	3
CO2	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	3
CO3	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	3
CO4	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	3
CO5	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	1
C06	3	1	1	2	3	1	3	1	3	3	1	2	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHL402**
Course Name	**: Laboratory Course I**
Semester /Year	**: IVth**

	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

Course Objective:

The objective of this course is to gain practical knowledge about isolations and purification of natural products by chromatography and their structural elucidation.

I. Extraction of Organic Compounds from Natural Sources

1. Isolation of caffeine from tea leaves.
2. Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
3. Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and Rf value reported).
4. Isolation of nicotine dipicrate from tobacco.
5. Isolation of cinchonine from cinchona bark.
6. Isolation of piperine from black pepper.
7. Isolation of lycopene from tomatoes.
8. Isolation of -carotene from carrots.
9. Isolation of oleic acid from olive oil (involving the preparation of complex with urea and separation of linoleic acid).
10. Isolation of eugenol from cloves.
11. Isolation of limonene from citrus fruits.

II. Paper Chromatography

Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

III. Spectroscopy

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS)

IV. Spectrophotometric (UV/VIS) Estimations

1. Amino acids
2. Proteins
3. Carbohydrates
4. Cholesterol
5. Ascorbic acid
6. Aspirin
7. Caffeine

Text Books:

TB1. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
TB2. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.

Reference Books:

RB1. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.
RB2. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define the use of spectroscopic techniques in structural determination of natural product
CO2	Paraphrase about the isolations and purification of natural products and check their purity by Chromatography.
CO3	Apply the use of spectroscopic techniques in structural determination of natural products.
CO4	Analyze and comprehend the practical concepts in the identification of components forgiven organic mixtures.
CO5	Recognize the practical concepts for organic mixture.
CO6	Justify the isolation and purification of natural products by chromatography

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	2	1	3	3	3	2	1	2	3	2	3	1
CO2	3	3	1	3	1	1	3	2	1	3	2	3	3	1	3	1
CO3	2	1	3	2	2	2	1	2	3	3	1	2	3	1	3	1
CO4	3	1	1	2	2	1	3	2	3	3	1	2	3	1	3	1
CO5	3	2	2	2	1	1	3	3	1	3	2	2	2	1	3	2
CO6	3	1	1	3	2	2	2	2	3	3	1	2	3	1	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHC403**
Course Name	**:Dissertation**
Semester /Year	**: IVth**

	L	**T**	**P**	**C**
	0	**0**	**0**	**10**

Course Objective:

The objective of this course is to inculcate the research aptitude in students.

Project from parent institute/industry /Research Organizations. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry / research organization one member of that body can also be included as project guide.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Identify the research problem.
CO2	Explain research gap.
CO3	Develop the methodology for experiments.
CO4	Analyze experimental data.
CO5	Defend thesis in presence of examiners.
CO6	Write thesis and research papers

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	3	3	3	1	2	3	1	2	3	3	1	3
CO2	3	1	3	1	3	3	3	1	2	3	1	2	3	3	1	3
CO3	2	1	1	2	1	1	1	1	3	1	2	3	2	1	2	1
CO4	3	3	3	3	3	3	3	3	3	3	1	2	3	1	1	1
CO5	3	1	3	2	3	3	2	1	3	3	1	2	3	1	3	2
CO6	3	1	3	2	3	3	3	1	3	3	3	1	3	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHE410**
Course Name	**:Computer and Biostatistics**
Semester /Year	**: IVth**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about use of computers and biostatistics in different field of biological and chemical sciences.

Computers

Unit I

History of computer Simple model of computer and its working, input-output devices, computer languages and their hierarchy(low level and high level),Introduction of microcomputers, concept of operating system, computer networking, concept of OSI layers, Introduction of software(MS-Word, MS-Excel & Power point etc.)

Unit II

Introduction of C++ Programming Difference between C and C++, concept of OOP'S, basic data types and operators, sample programs, conditional statements(IF-ELSE ,NESTED IF),concept of looping(for, while and dowhile),Introduction to arrays(single and double), classs and objects, function & function overloading, constructor and destructor, file handling.

Unit III

Internet and its working,Uniform resource locator(URL),World wide web,HTTP,Internet explorer,PDB,NRL-3D,BLAST &FASTA,Special software to align sequences,general DNA sequence data base,protein structure data base,genome project database,human mapping data base.

Biostatistics

Unit IV

Introduction and scope of Biostatistics Presentation of data: classification of data, Methods of collection of data, frequency distribution, graphical representation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve. Central tendency and measures of dispersion, mean, median, mode and their properties, partition value, standard deviation and coefficient of variation, simple correlation coefficient and regression coefficient, regression lines, tests of significance :t-test, z-test, chi-square tests, F-test, heterogeneity and independence of attributes.

Unit V

Testing of hypothesis Types of errors, power of test, test of significance based on normal distribution T-test for mean of population, difference of means of two normal population, chi-square test of goodness of fit, independent test ,test of variance of normal population F-test for variance ration, correlation and regression ,latest square methods and its application, significance of coefficient of correlation, rank correlation curve fitting and sign test.

Text books:

TB1. Information technology-D.P.Curtin,Tata McGraw Hill,New Delhi.

TB2. Guide to Medical Informatics,The Internet & Telemedicine-E Coiera,AmoldPublishers,USA

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define the simple model of computer, introduction to arrays, human mapping database, basics of biostats and test of hypothesis.
CO2	Describe the different tests, internet working, MS Office.
CO3	Apply the different significance test in simple problems, correlation in daily problems, internet working and operating system in various fields.
CO4	Explain the significance test, errors, human mapping data, computer languages.
CO5	Evaluate the curve fitting problems, different tests and sample programs.
CO6	Write the concept of OSI layers, basic data types, mapping data base, graphical representation of data and curve fitting.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	2	1	3	3	3	2	1	2	3	2	3	1
CO2	3	3	1	3	1	1	3	2	1	3	2	3	3	1	3	1
CO3	2	1	3	2	2	2	1	2	3	3	1	2	3	1	3	1

CO4	3	1	1	2	2	1	3	2	3	3	1	2	3	1	3	1
CO5	3	2	2	2	1	1	3	3	1	3	2	2	2	1	3	2
CO6	3	1	1	3	2	2	2	2	3	3	1	2	3	1	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:MCHE411**
Course Name	**:Environmental Chemistry**
Semester /Year	**: IVth**

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objective:

The objective of this course is to gain knowledge about different segments of environment. It also gives an idea about composition, pollution, quality parameters, toxic elements of these segments

Unit I

Environment

Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Bio distribution of elements.

Unit II

Atmosphere

Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals chlorofluorohydrocarbons. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

Unit III

Soils

Composition, micro and macro nutrients, Pollution of fertilizers, pesticides and metals.

Unit IV

Hydrosphere

Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. 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 etc.) residual chloride and chlorine demand. Purification and treatment of water

Unit V

Environmental Toxicology

Introduction; threshold limiting value (TLV); Toxicity and control of toxicants-- Nonmetallic compounds, asbestos, organic compounds, endocrine disrupters, persistent organic pollutants (POP's), polychlorinated biphenyls (PCB's), dioxins, pesticides, phthalates, heavy metals- As, Hg, Cd, Pb..

Text Books:

TB1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
TB2. Environmental Chemistry, Sharma and Kaur, Krishna Publishers.
TB3. Environmental Chemistry, A.K. De, Wiley Eastern.

Reference Books:

RB1. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
RB2. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Recall basics of environment, its segments, and pollution.
CO2	Describe the composition of the environment and the pollutants present in it.
CO3	Acquire knowledge about the chemistry of water, soil and atmosphere.
CO4	Analyse the reasons for environmental toxicology and environmental pollution.
CO5	Summarize the concept of environment and its pollution.
CO6	Generalize the concept of pollution.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	1	3	1	3	3	3	1	2	3	1	2	3	3	1	3
CO2	2	1	1	2	1	1	1	1	3	1	2	3	2	1	2	1
CO3	3	3	3	3	3	3	3	3	3	3	1	2	3	1	1	1
CO4	3	1	3	2	3	3	2	1	3	3	1	2	3	1	3	2
CO5	3	1	3	2	3	3	3	1	3	3	3	1	3	1	1	1
CO6	2	3	2	2	2	1	1	3	2	3	1	2	1	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated