

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]



DEPARTMENT OF CHEMISTRY SCHOOL OF BASIC & APPLIED SCIENCES SHRI GURU RAM RAI UNIVERSITY

Bachelor Of Science
OR
Bachelor of Science (Hons.) with Research

Based on NEP 2020

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

Effective from Academic Session 2023-
2024

Patel Nagar, Dehradun, Uttarakhand

KR *Amul*
3/7/23 *Shahin* *Shahin*

Basic Structure of UG Multidisciplinary Program (with Three Core Disciplines) –

Type of Course

Discipline Specific Core (DSC)

Discipline Specific Elective (DSE)

General Elective (GE)

Ability Enhancement Courses (AEC)

Skill Enhancement Course (SEC)

Internship/Apprenticeship / Project/ Community Outreach (IAPC)

Value Addition course (VAC)

Se m	Core - Discipline Specific Core (DSC)	Elective- Discipline Specific Elective (DSE)	Elective- Generic Elective (GE)	Ability Enhance ment Course (AEC)	Skill Enhancement Course (SEC)	(Internship /Apprentic eship / Project/ Communit y Outreach) (IAPC)	Value Addition Course (VAC)	Total credits
	Course/credit distribution (Credits 4) Theory or Theory + Practicum (3T+1L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	Course/ credit distribution (Credits 4) Theory or Theory + Practicum/ Lab (Credits 4T or 3T+1L or 2T+2L)	Course/ credit distribution (Credits 2)	Course/credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	Course/ credit distribution (Credits 2)	22
I	DSC A (Botany/Physics) 1- (4) DSC B (Zoology/Maths) 1- (4) DSC C (Chemistry) 1- (4) (3T+1L) *Either CBZ or PCM combination is allowed		Choose one from a pool of courses GE – 1 (4)	AEC – 1 (2)	Choose one from a pool of courses SEC – 1 (2)		Choose one from a pool of courses VAC – 1 (2)	22

II	DSC A(Botany/Physics) 2- (4) DSC B (Zoology/Maths) 2- (4) DSC C (Chemistry)2- (4) (3T+1L) *Either CBZ or PCM combination is allowed		Choose one from a pool of courses GE - 2 (4)	AEC - 2 (2)	Choose one from a pool of courses SEC - 2 (2)		Choose one from a pool of courses VAC - 2 (2)	22
Students on exit shall be awarded Undergraduate Certificate (in the field of Multidisciplinary study) after securing requisite 44 credits in semester I & II								Total = 44
III	DSC A(Botany/Physics) 3- (4) DSC B (Zoology/Maths) 3- (4) DSC C (Chemistry)3- (4) (3T+1L) *Either CBZ or PCM combination is allowed	Choose one from a pool of courses, DSE A/B/C (4) OR GE - 3 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC - 3 (2)	Choose one from SEC 3 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)		Choose one from a pool of courses VAC - 3 (2)	22	
IV	DSC A(Botany/Physics) 4- (4) DSC B (Zoology/Maths) 4- (4) DSC C (Chemistry)4- (4) (3T+1L) *Either CBZ or PCM combination is	Choose one from a pool of courses, DSE A/B/C (4) credits) OR GE - 4 (4) (4 T/or 3T+1L/or 2T+2L) OR MOOC	AEC - 4 (2)	Choose one from SEC 4 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)		Choose one from a pool of courses VAC - 4 (2)	22	

	allowed					
Students on exit shall be awarded Undergraduate Diploma (in the field of Multidisciplinary study/Discipline) after securing requisite 88 credits in semester III & IV						Total = 88
V	DSC A (Botany/Physics) 5- (4) DSC B (Zoology/Maths) 5- (4) DSC C (Chemistry) 5- (4) (3T+1L) *Either CBZ or PCM combination is allowed	Choose one from a pool of courses, DSE A/B/C (4) credits (3T+1L/or 2T+2L) OR MOOC	Choose one from a pool of courses GE - 5 (4) OR MOOC		Choose one from SEC 5 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)	22
VI	DSC A (Botany/Physics) 6- (4) DSC B (Zoology/Maths) 6- (4) DSC C (Chemistry) 6- (4) (3T+1L) *Either CBZ or PCM combination is allowed	Choose one from a pool of courses, DSE A/B/C (4) credits (3T+1L/or 2T+2L) OR MOOC	Choose one from a pool of courses GE - 6 (4) OR MOOC		Choose one from SEC 5 - (2) OR Internship/Apprenticeship / Project/ Community Outreach (IAPC) - (2)	22
Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) after securing the requisite 132 credits on completion of semester VI						Total= 132
VII	DSC A/B/C 7 - (4) (3T+1L)	Choose 3 DSE (3x4) courses OR Choose 2 DSE - (2x4) and one GE (4) course OR Choose 1 DSE (4) and 2 GE (2x4) courses (Total= 12)			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2)	22

VIII	DSC A/B/C 8 - (4) (3T+1L)	Choose 3 DSE (3x4) courses OR Choose 2 DSE – (2x4) and one GE (4) course OR Choose 1 DSE (4) and 2 GE (2x4) courses (Total= 12)	Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2)	22
Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) (Honours with Research or Honours with Academic project/Entrepreneurship) after securing requisite 176 credits on completion of semester VIII				Total = 176

Course Introduction:

The modified curriculum of Bachelor of Science OR Bachelor of Science (Hons) with Research offers one year certificate, two year diploma, three year degree and four year Degree in (Hons) with Research after securing required credits as per the Curriculum and credit framework for Undergraduate program guidelines by NEP2020 and UGC.

Eligibility Criteria for Admission: The candidate must have passed 10+2 with relevant field as a compulsory subject from a recognized board or its equivalent with minimum 45% marks.

Program Outcomes

PO 1	Bachelor of Science offers theoretical as well as practical knowledge about different subject areas.
PO2	Graduates will develop scientific temperament to solve scientific problems in emerging areas of science at National and International level.
PO3	Graduates will acquire coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future.
PO4	Graduate will have clarity of thought and expression. Qualities like logical thinking and decision making will be enhanced

PO5	Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
PO6	Graduates will be able to compete in various national and international competitive examinations.
PO7	Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological context with a systematic approach towards sustainable development.
PO8	Graduates will have critical thinking, follow innovations and developments in Science and technology
PO9	Graduates will acquire effective communication skills
PO10	Graduates will understand ethical principles and responsibilities for effective citizenship.
PO11	Graduates will develop new and enhancing conversational skills that lead to not only to good communication but also to the excellent drafting abilities linked with technical reports and presentations.
PO12	Graduates will competent enough for doing jobs in Govt. and private sectors of academia, research and industry.

Program Specific Outcome (PSOs)

PSO 1	Chemistry graduates will become familiar with the fundamental concepts in organic, inorganic, physical and analytical chemistry.
PSO2	Chemistry graduates will develop analytical skills and acquire the ability to synthesize, separate and characterize compounds using laboratory techniques.
PSO3	Chemistry graduates will be able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory.
PSO4	Skill enhancement courses like chemistry of cosmetics & perfumes, pesticide and polymer chemistry will equip students with the knowledge and skills which will help them to make a successful career in the respective industries.

Semester Wise Discipline Specific Core

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-C	CHEDC101	Fundamentals of Chemistry I	3	0	0	3
		CHEDL102	Lab course based on CHEDC101	0	0	2	1
II		CHEDC201	Fundamentals of Chemistry-II	3	0	0	3
		CHEDL202	Lab course based on CHEDC201	0	0	2	1
III		CHEDC301	General Chemistry-I	3	0	0	3
		CHEDL302	Lab course based on CHEDC301	0	0	2	1
IV		CHEDC401	General Chemistry-II	3	0	0	3
		CHEDL402	Lab course based on CHEDC401	0	0	2	1

V	(Chemistry)	CHEDC501	Organic Chemistry	3	0	0	3
		CHEDL502	Lab course based on CHEDC501	0	0	2	1
VI		CHEDC601	Analytical Chemistry	3	0	0	3
		CHEDL602	Lab course based on CHEDC601	0	0	2	1
VII		CHEDC701	Inorganic Chemistry	3	0	0	3
		CHEDL702	Lab course based on CHEDC701	0	0	2	1
VIII		CHEDC801	Physical Chemistry	3	0	0	3
		CHEDL802	Lab course based on CHEDC801	0	0	2	1

Semester Wise Generic Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE-C (Chemistry)	CHEGE103	s and p block elements and metallurgy	4	0	0	4
II		CHEGE203	Atomic Structure, Chemical Bonding and Volumetric Analysis	4	0	0	4
III		CHEGE303	General Organic Chemistry and Hydrocarbons	4	0	0	4
IV		CHEGE403	Chemical Energetics and Ionic Equilibria	4	0	0	4
V		CHEGE503	Molecules of Life	4	0	0	4
VI		CHEGE603	Carboxylic Acids, Amines and Derivatives	4	0	0	4

Semester Wise Ability Enhancement Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	AEC	AEC-104	Environment Science-I	2	0	0	2
II		AEC-204	Environment Science-II	2	0	0	2
III		AEC-304	English Communication-I	2	0	0	2
IV		AEC-404	English Communication-II	2	0	0	2

Semester Wise Skill Enhancement Course/IAPC

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	SEC-A/IAPCA (Chemistry)	CHESC105	Basic Analytical chemistry-I	2	0	0	2
II		CHESC205	Basics of Analytical Chemistry-II	2	0	0	2
III		CHESC305	Chemistry of Soil and Water OR Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2

IV		CHESC405	Pesticide Chemistry OR Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
V		CHESC505	Fuel Chemistry OR Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
VI		CHESC605	Business skills for chemist/ OR Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2

Semester Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
V	DSE-C (Chemistry)	CHEDE506	Industrial Chemicals and Environment	3	0	0	3
		CHEDL507	Lab course based on CHEDE506	0	0	2	1
VI		CHEDE606	Quantitative analytical methods	3	0	0	3
		CHEDL607	Lab course based on CHEDE606	0	0	2	1
VII (The student has to choose any three elective theory papers and lab based on it)		CHEDE703	Biomolecules	3	0	0	3
		CHEDL704	Lab course based on CHEDE703	0	0	2	1
		CHEDE705	Coordination Chemistry	3	0	0	3
		CHEDL706	Lab course based on CHEDE705	0	0	2	1
		CHEDE707	Electrochemistry	3	0	0	3
		CHEDL708	Lab course based on CHEDE707	0	0	2	1
		CHEDE709	Pericyclic Reactions and Organic Photochemistry	3	0	0	3
		CHEDL710	Lab course based on CHEDE709	0	0	2	1
		CHEDE711	Research Methodology	3	1	0	4
VIII (The student has to choose any three elective theory papers and lab based on it)		CHEDE803	Structure and Properties of Metal Complexes	3	0	0	3
		CHEDL804	Lab course based on CHEDE803	0	0	2	1
		CHEDE805	Radiation and Photochemistry	3	0	0	3
		CHEDL806	Lab course based on CHEDE805	0	0	2	1
		CHEDE807	Advanced Methods of Chemical Analysis	3	0	0	3
		CHEDL808	Lab course based on CHEDE807	0	0	2	1
		CHEDE809	Chemistry of Natural Products	3	0	0	3
	CHEDL810	Lab course based on CHEDE809	0	0	2	1	

Kd

Mul

Shalin
8/4/11

		CHEDE811	Intellectual Property Right	3	1	0	4
--	--	----------	-----------------------------	---	---	---	---

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	CHEDT712	Dissertation on Major Core/Minor Elective (from VII Semester papers) OR Academic Project/ Entrepreneurship	0	0	0	6
VIII	IAPC	CHEDT812	Dissertation on Major Core/Minor Elective (from VIII Semester papers) OR Academic Project/ Entrepreneurship	0	0	0	6

Semester Wise Value Added Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	VAC		Choose from the pool of courses offered by the University	0	0	0	2
II	VAC		Choose from the pool of courses offered by the University	0	0	0	2
III	VAC		Choose from the pool of courses offered by the University	0	0	0	2
IV	VAC		Choose from the pool of courses offered by the University	0	0	4	2

ka

Mul

Shalin
Sagar

Discipline Specific Core

Semester I

Course code : CHEDC101				
Course Title : Fundamentals of Chemistry I				
Semester /Year : I				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of the basics of atomic structure, periodic properties, chemical bonding, fundamentals of organic chemistry and states of matter.
CO2	Understand fundamentals of atomic structure, periodic properties, chemical bonding, mechanism of organic reactions, stereochemistry and states of matter.
CO3	Develop concept of atomic structure, periodic properties, chemical bonding and, reaction mechanism and stereochemistry.
CO4	Explain structure of different inorganic, organic molecules/ions, mechanism of organic reactions and solid-state chemistry.
CO5	Predict structure of organic/inorganic molecules on the basis of VSEPR and hybridization & determine configurations of organic compounds.
CO6	Solve problems related to chemical bonding, atomic structure and states of matter.

Unit	Content
1	Atomic Structure: Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation; the significance of ψ and ψ^2 . Quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity.
2	Chemical Bonding-I: Ionic bond, covalent bond-Valence Bond Theory, and its limitations; various types of hybridization and shapes of different inorganic and organic molecules. Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of NH_3 , H_2O , H_3O^+ , SF_4 , ClF_3 , ICl_2^- , NH_4^+ and other simple molecules/ions (CO_2 , SO_2 , Cl_2O_7 , SO_4^{2-} , NO_3^- , PO_3^-) including compounds of

	xenon.
3	General Organic Chemistry and Mechanism of Organic Reactions: Resonance, hyperconjugation, field effects- inductive, mesomeric, electromeric effect. Types of reagents- electrophiles and nucleophiles, Energy considerations. Reactive intermediates- carbocations, carbanions, free radicals.
4	Stereochemistry of Organic Compounds: Types of isomerism- optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules diastereomers, threo and erythro diastereomers, meso compounds, inversion, retention, and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometrical isomerism: Determination of the configuration of geometrical isomers, E & Z system of nomenclature.
5	States of Matter-I: Gaseous State- Postulates of the kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases. Molecular velocities: Root mean square, average, and most probable velocities. Numerical problems. Liquid State- Intermolecular forces, Structural differences between solids, liquids, and gases. Physical properties of liquids: surface tension and viscosity. Numerical problems.
6	States of Matter-II: Solid State: Introduction to crystalline materials, Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals. Bragg's equation, Numerical problems. Colloidal State: Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical, and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic

Chemistry”, S. Chand Publishing, New Delhi, India, 2010.

Course code : CHEDL102				
Course Title : Lab course based on CHEDC101				
Semester /Year : I				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, the student will be able to:

CO1	Gain knowledge about the concepts of qualitative analysis of cations and anions in inorganic mixtures.
CO2	Understand lab hazards and safety precautions.
CO3	Determine of absolute configuration of organic molecules using ball and stick models.
CO4	Illustrate the structure of simple organic compounds showing their stereochemistry using Fischer Projection.
CO5	Evaluate surface tension of liquids using stalagmometer.
CO6	Solve problems related to configuration and surface tension.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Salt mixture analysis: Identification of acid radicals (three to four) including anions in combination and basic radicals upto II Group in the given salt mixture.
3	Organic exercise: Determination of absolute configuration of organic molecules using ball and stick models. Students are supposed sketch the structure of simple organic compounds showing their stereochemistry using Fischer Projection.
4	Physical exercise: Determination of relative surface tension of the given liquid using Stalagmometer.

Books Recommended:

- i. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- ii. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- iii. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- iv. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age

International Publisher, 2009.

Semester II

Course code : CHEDC201				
Course Title : Fundamentals of Chemistry-II				
Semester /Year : II				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of the basics of chemical bonding, properties of s and p block element, aliphatic & aromatic hydrocarbons, chemical kinetics, catalysis and thermodynamics.
CO2	Understand fundamentals of chemical bonding, properties of s and p block element, aliphatic & aromatic hydrocarbons, chemical kinetics, catalysis and thermodynamics.
CO3	Develop concept of chemical bonding, aliphatic & aromatic hydrocarbons, chemical kinetics and thermodynamics.
CO4	Explain MOT, s and p block element properties, preparation and aliphatic and aromatic hydrocarbons properties.
CO5	Derive integrated rate equations and half-lives for first, second and zero order reactions and also evaluate heat capacities at constant volume, pressure and Kirchhoff's equation.
CO6	Solve problems related to chemical kinetics and thermodynamics.

Units	Content
1	Chemical Bonding-II: Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H ₂ , He ₂ , Li ₂ , Be ₂ , B ₂ , C ₂ , N ₂ , O ₂ , F ₂ , Ne ₂ , CO, NO, HF difference between VB and MO theories. Polarization of covalent molecules, Polarizing power, and polarizability; Fajan's rule. Weak interactions-hydrogen bonding in inorganic and organic molecules and van der Waals interactions.
2	Salient Features of s- and p-Block Elements: General discussion with respect to all periodic (Occurrence, electronic configuration, atomic & ionic radii, density, ionization potential, metallic behaviour, electropositive nature, electronegativity, electron affinity, hydration energy, flame colouration, photoelectric effect, polarization power, boiling and melting point) and chemical properties (reactivity towards water, oxygen, air and moisture, hydrogen, halogens, ammonia). Diagonal relationship, catenation, inert pair effect and interhalogen compounds.

3	<p>Aliphatic Compounds: Chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes. Cycloalkanes- Baeyer's strain theory and its limitations.</p> <p>Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration- reduction. Substitution at the allylic and vinylic positions of alkenes. Chemical reactions of alkynes, Mechanism of electrophilic and nucleophilic addition reactions, hydroboration- oxidation.</p>
4	<p>Aromatic Compounds: Aromaticity- the Hückel rule, aromatic ions. Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuriation and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio.</p>
5	<p>Chemical Kinetics and Catalysis: Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light, catalyst; hetero and homocatalysis, significance. Molecularity, Order of reaction- zero order, first order, second order, pseudo-order, Radioactive decay a first order phenomenon, half-life period, Methods of determination of the order of reaction- differential method, method of integration, method of half-life period and isolation methods, Numerical problems.</p>
6	<p>Thermodynamics I: Definition of thermodynamic terms, system, surroundings, etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, the first law of thermodynamics, and the definition of internal energy and enthalpy. Heat capacity - heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Thermochemistry, Standard enthalpy of formation - Hess's law of heat summation and its application. Temperature dependence of enthalpy, Kirchoff's equation, Numerical problems.</p>

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S.Chand Publishing, New Delhi, India, 2010.

Course code	: CHEDL202			
Course Title	: Lab course based on CHEDC201			
Semester /Year	: II			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge about the concepts of qualitative analysis of cation and anions in inorganic mixtures.
CO2	Understand lab hazards and safety precautions.
CO3	Determine the strength of given solution by acid-base titration method.
CO4	Differentiate between alkanes, alkenes and alkynes.
CO5	Distinguish between aliphatic and aromatic compounds using chemical and physical tests.
CO6	Calculate relative viscosity of the given liquid using Ostwald viscometer.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Inorganic exercise: Acid-base titrations; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. For example: preparation of NaOH solution (secondary standard say N/10), preparation of (COOH) ₂ solution (primary standard say N/10), standardization of NaOH solution titrating it against (COOH) ₂ solution using phenolphthalein (indicator) and then the determination of the strength of given HCl solution.
3	Organic exercise: Differentiation between alkanes, alkenes, and alkynes. Differentiation between aliphatic and aromatic compounds using chemical and physical tests.
4	Physical exercise: Determining the given liquid's relative viscosity using Ostwald viscometer.

Books Recommended:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

ke

me

shavin

Shan
Shan

Semester III

Course code : CHEDC301				
Course Title : General Chemistry-I				
Semester /Year : III				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of transition elements, coordination chemistry, halides, alcohols, phenols, thermodynamics, chemical equilibria.
CO2	Understand concepts of transition elements, coordination chemistry, halides, alcohols, phenols, thermodynamics, chemical equilibria.
CO3	Explain transition elements, coordination chemistry, halides, alcohols, phenols, thermodynamics, chemical equilibria.
CO4	Illustrate theories of coordination chemistry, properties of transition elements, mechanism of nucleophilic substitution and name reactions.
CO5	Predict the geometry and magnetic nature of coordination compounds, mechanism of organic reactions and feasibility of reactions.
CO6	Solve numerical problems related to thermodynamics, chemical equilibria.

Unit	Contents
1	Chemistry of Transition Elements (First, second and third Transition Series): Characteristic properties of the elements; electronic configuration, atomic & ionic radii, oxidation states ionization energy, boiling & melting points, complex compound formation, colour, catalytic properties and magnetic properties. coordination number and geometry.
2	Coordination Chemistry-I: Definition, terminology (ligand, coordination number, coordination sphere, complex ion etc.), Nomenclature of coordination compounds (IUPAC system), Werner's theory for coordination compounds, effective atomic number (EAN) concept, 18-electron rule, Valence Bond Theory (VBT) for coordination compounds, geometry of complexes (tetrahedral, octahedral, square planar), Crystal Field Theory, Magnetic properties of complex compounds.
3	Halides: Chemical reactions. Alkyl, aryl and vinyl halides. Mechanism of nucleophilic substitution reactions, SN2 and SN1 reactions with energy profile diagrams.

K

M

Shalin
16

4	<p>Alcohols and Phenols: Alcohols: Preparation, Properties and Chemical reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)₄ and HIO₄] Trihydric alcohols-methods of formation, chemical reactions of glycerol.</p> <p>Phenols: Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, and Reimer-Tiemann reaction.</p>
5	<p>Thermodynamics II: Second law of thermodynamics, need of the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases. Gibbs free energy and Helmholtz work functions. Criteria for thermodynamic equilibrium and spontaneity, Variation of G and A with P, V and T, Gibbs- Helmholtz equation, Numerical problems.</p>
6	<p>Chemical Equilibrium: The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between K_p and K_c. Le-Chatelier's principle, Numerical problems.</p>

Books Recommended:

- Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S.Chand Publishing, New Delhi, India, 2011, 3rd edition.

Course code	: CHEDL302			
Course Title	: Lab course based on CHEDC301			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand physical, inorganic and organic exercises.
CO3	Determine the critical solution temperature of partially miscible liquids.
CO4	Differentiate between alcohols and phenols.
CO5	Test the inorganic mixtures of acidic and basic radicals in given samples.
CO6	Solve practical problems related to physical chemistry.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Inorganic exercise: Complete analysis of inorganic mixture including both acid and basic radicals with a special emphasis on the role of common ion effect and solubility product.
3	Organic exercise: Functional group tests for alcohols and phenols. Differentiation between alcohols and phenols using chemical and physical tests.
4	Physical exercise: Determination of critical solution temperature (CST)

Books Recommended:

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wordsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004

Semester-IV

Course code	: CHEDC401
Course Title	: General Chemistry-II
Semester /Year	: IV

18

	L	T	P	C
	3	0	0	3

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

CO1	Gain knowledge of basic concepts of acid and bases, inner transition elements, aldehydes, ketones, carboxylic acids and electrochemistry.
CO2	Understand the chemistry of acid and bases, inner transition elements, and electrochemistry.
CO3	Establish the mechanism of nucleophilic addition reactions of aldehydes, ketones, carboxylic acids.
CO4	Explain concepts of acid and bases, inner transition elements and carbonyl compounds.
CO5	Summarize the concepts of electrochemistry and its applications.
CO6	Solve numerical problems related to electrochemistry.

Unit	Contents
1	Acids and Bases: Arrhenius concept, Bronsted-Lowry concept, and Lewis concept of acids and bases; Hard and Soft Acid-Base Theory: Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness.
2	Chemistry of Inner Transition Elements: Chemistry of Lanthanides: Electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction and its consequences, complex formation, colour; Methods of separation of lanthanides Chemistry of Actinides: General features of actinides-electronic configuration, atomic & ionic radii, ionization potential, oxidation states and complex formation.
3	Aldehydes and Ketones: Comparative account of properties of aliphatic and aromatic aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin condensation. Condensation with ammonia and its derivatives; Wittig reaction, Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, Clemmensen, Wolff-Kishner, LiAlH_4 and NaBH_4 reductions.
4	Carboxylic Acids: Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, mechanism of decarboxylation. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids.
5	Electrochemistry I: Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations, Numerical Problems.
6	Electrochemistry II: Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Calculation of thermodynamic quantities of cell reactions (ΔG , ΔH and K), Numerical Problems.

Books Recommended:

- iv. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wordsworth Publishing Company, Belmont, California, USA, 1988.
- v. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

vi. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

Course code : CHEDL402				
Course Title : Lab Course based on CHEDC401				
Semester /Year : IV				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand physical, inorganic and organic exercises.
CO3	Determine the concentrations of oxidising and reducing agents through double titration
CO4	Differentiate between aldehydes, ketones and carboxylic acids
CO5	Test the solubility of salts
CO6	Solve practical problems related to physical chemistry.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Inorganic exercise: Volumetric exercises (double titration) based on redox reactions involving internal as well as external indicators.
3	Organic exercise: Preliminary and Functional group tests for aldehydes, ketones and carboxylic acids (both aliphatic and aromatic).
4	Physical exercise: Determination of solubility of salts.

Books Recommended:

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wordsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2002

Handwritten signatures and initials:
 A year
 H
 K
 M
 Ahalin
 S

Semester-V

Course code	: CHEDC501			
Course Title	: Organic Chemistry			
Semester /Year	: V			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course student will be able to:

CO1	Gain knowledge of the basics of Reagents used in organic synthesis, nitrogen containing organic compound, carbohydrates and proteins.
CO2	Understand fundamentals of types of reagents, Chemical reactions of nitroalkanes nitroarenes.
CO3	Develop concept of types of dyes, carbohydrates, proteins etc
CO4	Explain mechanism of different organic reactions.
CO5	Illustrate and understand mechanism of different organic reactions
CO6	Summarize basics of organic synthesis, nitrogen containing, organic compounds, biomolecules and dyes.

Unit	Contents
1	Reagents in Organic Synthesis: Types of reagents, acetylene, ammonia, Bayer's reagent, NBS, n-butyl lithium, chromic acid, chromium trioxide, diborane, DMSO, Fehling reagent, Grignard reagent, hydrazide, hydrogen peroxide, potassium dichromate, potassium permanganate, Raney Ni, silver nitrate, sodium borohydride, NaH, THF, TMS, Tollen's reagent.
2	Nitrogen Containing Organic Compounds: Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel- phthalimide reaction, Hofmann bromamide reaction.
3	Dyes: Color and constitution, types of dyes, Alizarin, Indigo, Congo red, Malachite green, Methylene blue, Phenolphthalein, Methyl orange.
4	Carbohydrates and Proteins: Classification, mechanism of osazone formation, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Epimers and anomers Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Proteins: Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis.

Ka

Mud

Shalin

Shuk
Sh

Books Recommended:

- i. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- ii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994, 1st edition.
- iii. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.
- iv. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.

Course code : CHEDL502				
Course Title : Lab course based on CHEDC501				
Semester /Year : V				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand mechanism of organic synthesis.
CO3	Determine the yield of synthesized organic compounds.
CO4	Analyze carbohydrate and protien
CO5	Separate the binary organic mixture.
CO6	Prepare organic and inorganic compounds.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Organic qualitative analysis: Analysis of Nitrogen containing organic compounds (detection of elements, amines, nitro, amides and anilides) Binary mixture of organic compounds separable by water Organic synthesis: through nitration, halogenation, acetylation, sulphonation and simple oxidation
3	Qualitative analysis of carbohydrate and protien

Handwritten signatures: K, Anil, Shalin, and a signature with 'SHAR' written above it.

Semester-VI

Course code : CHEDC601				
Course Title : Analytical Chemistry				
Semester /Year : VI				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of basic concepts of spectroscopy, green chemistry, data analysis and analytical techniques.
CO2	Understand theory of spectroscopy, green chemistry, data analysis and analytical techniques..
CO3	Explain green chemistry, data analysis and analytical techniques.
CO4	Explain principle, applications and instrumentation of spectroscopic techniques.
CO5	Summarize concepts of green chemistry and spectroscopy.
CO6	Solve problems related with data analysis

Unit	Contents
1	Data Analysis: Errors; Definition, types of errors, precision, accuracy, absolute, Significant Figures; significant figures in Arithmetics-addition, subtraction, multiplication and division, Mean and Standard deviation.
2	Basics of Green Chemistry: Introduction, role of green chemistry in sustainable development, principles of green chemistry.
3	Analytical Techniques: Basic concepts of electro-gravimetric and coulometric analysis. Thermogravimetric analysis. Chromatography: Introduction, Types, paper and column chromatography
4	Spectroscopy: Ultraviolet (UV) absorption spectroscopy- absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.
5	Infra-Red (IR) absorption spectroscopy- molecular vibrations, Hooke's Law, intensity and position of IR bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Books Recommended:

- i. Clark, J. H., and Macquarrie, D.J., Handbook of Green chemistry and Technology, Wiley-Blackwell, 2002.
- ii. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
- iii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2008, 2

Course code	: CHEDL602			
Course Title	: Lab course based on CHED601			
Semester /Year	: VI			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the practical aspects of spectroscopic and chromatographic techniques.
CO3	Determine the functional group of organic compounds by IR and UV.
CO4	Analyze organic compounds by spectrophotometer.
CO5	Demonstrate paper chromatography of amino acids/dyes.
CO6	Interpret the spectral data and chromatograms of organic compounds.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Spectroscopic exercise: Functional Group determination by UV and IR Spectroscopy; analysis of organic compounds including alcohols, phenols, carboxylic acids, carbonyl compounds, nitrogen containing compounds.
3	Chromatographic technique: Demonstrative Chromatography-paper chromatography (Analytical separation of organic compounds- Amino acids/ dyes)

Ka

Mu

Shalin

Mar

25

Semester-VII

Course code	: CHEDC701			
Course Title	: Inorganic Chemistry			
Semester /Year	: VII			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Learn and gain knowledge of main group compounds and coordination chemistry
CO2	Describe theories of coordination compounds and explain metal ligand equilibria and solutions.
CO3	Explain reaction mechanisms of transition metal complexes.
CO4	Illustrate CFT, MOT, VSEPR theory and chelate effect.
CO5	Assess different types of reaction mechanism.
CO6	Propose the structure of various inorganic compounds based on VSEPR model and hybridization.

Units	Content
1	Stereochemistry and Bonding in Main Group Compounds VSEPR model and its shortcomings. Hybridization and three-center bonds. Bent's rule and energetic of hybridization. Walsh's diagrams for tri and tetra atomic molecules. $p\pi-p\pi$ and $p\pi-d\pi$ bonding.
2	Theories of Coordination Compounds Crystal field theory, factors affecting the magnitude of Δ_o . Consequences of crystal field splitting. 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.
3	Metal-Ligand Equilibria in Solution Thermodynamic and kinetic stability of complexes. Stepwise and overall formation constants and their interaction. Trends in K value. Irving-Williams 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. .

Ka

Mud

Shalini

Suresh

Sh

4	Reaction Mechanism of Transition Metal Complexes Energy profile of a reaction and reactivity of metal complexes. Inert and labile complexes. Ligand substitution reactions in octahedral complexes i.e. SN1, SN2 and SN1CB mechanism. Anation reactions without metal ligand bond cleavage. Electron transfer reactions (Redox reactions). Outer and inner sphere mechanism (OSM and ISM). Reactions of coordinated ligands. Substitution reactions in square-planer complexes
---	--

Books recommended

- i) Inorganic chemistry, A Unified Approach, IIrdEd., WW.Porterfield, Academic Press,(1993).
- ii) Coordination Chemistry, IIIrdEd., DBanerjea, Asian Book Pt. ltd.,(2009)
- iii) Inorganic Chemistry, 3th Ed., GLMiessler and D.A.Tarr, Pearson Education, nc.(2004)

Course code : CHEDL702				
Course Title : Lab course based on CHED701				
Semester /Year : VII				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the concept of complexometric and precipitation titrations
CO3	Determine the yield of synthesized inorganic compounds.
CO4	Analyze the concentrations of the compound by titration
CO5	Separate the pure compound by crystallization method.
CO6	Prepare inorganic compounds.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetra ammine copper(II) sulphate and hexa ammine nickel(II) chloride. Crystallization of compounds.
3	Complexometric and precipitation titrations

Ka

Mu

Shackin

Shackin
Sh

Semester-VIII

Course code	: CHEDC801			
Course Title	: Physical Chemistry			
Semester /Year	: VIII			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of basic concepts of surface chemistry, photochemistry, quantum mechanics, solutions, radioactivity, and thermodynamics
CO2	Understand the basics of surface chemistry, quantum mechanics and photochemistry.
CO3	Explain chemistry of solutions, radioactivity, and thermodynamics.
CO4	Explain adsorption models, laws of photochemistry, Jablonski diagram, colligative properties, applications of radioactivity and third law of thermodynamics.
CO5	Summarize the applications of adsorption models, radioactivity, and elementary quantum mechanics.
CO6	Solve numerical problems related to surface chemistry, photochemistry, quantum mechanics, solutions, radioactivity and thermodynamics

Unit	Contents
1	Surface Chemistry: Definition of surface phenomenon- Adsorption. Chemical and physical adsorption, Factors affecting adsorption. Isotherm and Isobar. Free energy of adsorption. Quantitative treatment of adsorption, Freundlich's and Langmuir's adsorption model and their applications. Limitation of Langmuir adsorption model. Adsorption in catalysis, characteristics of catalyzed reactions.
2	Elementary Quantum Mechanics: Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, , Schrödinger wave equation and its importance, physical interpretation of the wave function, Numerical Problems.
3	Photochemistry: Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert- Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, Numerical Problems.

4	Solutions and Colligative Properties: Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point, Numerical Problems.
5	Thermodynamics III: Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data, Numerical Problems
6	Radioactivity: Definition, nature of radioactivity, emission, types of radioactivity, occurrence, Energetics and kinetics radioactivity, rates of radioactive transitions, Applications of radioactivity, Numerical Problems.

Books Recommended:

- ii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- iv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- v. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition

Ka

Mud

Shalin'

Suor

Course code : CHEDL802				
Course Title : Lab course based on CHEDC801				
Semester /Year : VIII				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the physical and inorganic exercises.
CO3	Determine the solubility of organic compounds by titration method.
CO4	Analyze inorganic metal ions by gravimetric method.
CO5	Estimate different metal ions through gravimetric exercise.
CO6	Interpret the practical results.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Physical exercise: Determination of solubility of organic compound (viz. oxalic acid) in water by titration method.
3	Inorganic Exercise: Gravimetric analysis of any one or two metal ions; Ba ²⁺ , Fe ³⁺ , Ni ²⁺ , Cu ²⁺ , Zn ²⁺ etc..

Books Recommended:

- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

Generic Elective Courses

SEMESTER I

Course code	: CHEGE103			
Course Title	: s and p block elements and Metallurgy			
Semester /Year	: I			
	L	T	P	C
	4	0	0	4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of chemistry of s and p block elements and metallurgy
CO2	Understand concepts of s and p block elements and metallurgy
CO3	Explain general principles of metallurgy and chemistry of s and p block elements
CO4	Explain the structure, bonding, properties and uses of compounds of p block elements.
CO5	Predict shape of noble gas compounds on the basis of VSEPR Theory
CO6	Solve problems related to coordination chemistry

Unit	Contents
1	General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, van Arkel-de Boer process and Mond's process, Zone refining.
2	Chemistry of s and p Block Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. interhalogen compounds, and basic properties of halogens.
3	Noble Gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF ₂ , XeF ₄ and XeF ₆ ; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF ₂). Molecular shapes of noble gas compounds (VSEPR theory).
4	Inorganic Polymers : Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes

Kd

Mud

Shalini

Ahar

[Signature]

Books Recommended:

- i. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- ii. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- iii. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- iv. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- v. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- vi. Shriver & Atkins, Inorganic Chemistry 5th Ed.

SEMESTER II

Course code : CHEGE203
Course Title : Atomic Structure and Chemical Bonding
Semester /Year : II
L T P C
4 0 0 4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of atomic structure and chemical bonding
CO2	Understand concepts of atomic structure and chemical bonding
CO3	Explain quantum mechanics, Schrodinger equation, various related principles and rules, periodic properties of elements, different types of chemical bonds including ionic bond, covalent bond, VSEPR theory, hybridization, molecular orbital theory, metallic bond and weak chemical forces
CO4	Illustrate MO diagrams of homonuclear and heteronuclear molecules, Born-Haber's cycle and atomic structure
CO5	Predict the structure of molecules on the basis of VSEPR theory and hybridization
CO6	Justify the magnetic nature of homonuclear and heteronuclear molecules on the basis of MO diagram

Unit	Contents
1	Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous

	electronic configurations.
2	<p>Chemical Bonding and Molecular Structure: Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.</p> <p>Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.</p> <p>MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and pp combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods and heteronuclear diatomic molecules such as CO, NO and NO⁺.</p> <p>Comparison of VB and MO approaches.</p>

Books Recommended:

J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.

- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
 - Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley.
 - James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
 - Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.

SEMESTER III

Course code	: CHEGE303			
Course Title	: General Organic Chemistry and Hydrocarbons			
Semester /Year	: III			
	L	T	P	C
	4	0	0	4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Get Knowledge about the fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO2	Understand about the fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO3	Explain various fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO4	Illustrate different type concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO5	Compare the different type concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO6	Write about different type concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.

Handwritten signatures and initials in blue ink, including 'K', 'W', 'M. Shalini', and 'Suar'.

Unit	Contents
1	Fundamentals of Organic Chemistry: Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.
2	Stereochemistry : Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems)
3	Aliphatic and Aromatic Hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. <i>Alkanes:</i> (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. <i>Alkenes:</i> (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO ₄) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. <i>Alkynes:</i> (Upto 5 Carbons) Preparation: Acetylene from CaC ₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO ₄ , ozonolysis and oxidation with hot alk. KMnO ₄ .

Books Recommended:

- Douglas, McDaniel and Alexander: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- T. W. Graham Solomon: *Organic Chemistry*, John Wiley and Sons.

SEMESTER IV

Course code	: CHEGE403			
Course Title	: Chemical Energetics and Ionic Equilibria			
Semester /Year	: IV			
	L	T	P	C
	4	0	0	4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Learn the fundamentals of thermochemistry
CO2	To understand thermodynamics and its laws, important principles and definitions of thermochemistry.
CO3	Explain the concepts of chemical equilibrium and ionic equilibrium
CO4	Illustrate the concepts of Le Chatelier's principle.
CO5	Explain the buffer solution and solubility products.
CO6	Solve the numerical related to thermochemistry

Unit	Content
1.	Chemical Energetics : Laws of Thermodynamics. Principles of thermochemistry. Concept of standard state and standard enthalpies of formations. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.
2.	Chemical Equilibrium : Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle.
3.	Ionic Equilibria : Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect.
4.	Salt hydrolysis : Calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Books Recommended:

- i. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007)
- ii. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- iii. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985)

SEMESTER V

Course code	: CHEGE503			
Course Title	: Molecules of Life			
Semester /Year	: V			
	L	T	P	C
	4	0	0	4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of chemistry of s and p block elements and metallurgy
CO2	Understand concepts of s and p block elements and metallurgy

ke

Shalin

Shor

CO3	Explain general principles of metallurgy and chemistry of s and p block elements
CO4	Explain the structure, bonding, properties and uses of compounds of p block elements.
CO5	Predict shape of noble gas compounds on the basis of VSEPR Theory
CO6	Solve problems related to coordination chemistry

Unit	Contents
1	General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, van Arkel-de Boer process and Mond's process, Zone refining.
2	Chemistry of s and p Block Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. interhalogen compounds, and basic properties of halogens.
3	Noble Gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF ₂ , XeF ₄ and XeF ₆ ; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF ₂). Molecular shapes of noble gas compounds (VSEPR theory).
4	Inorganic Polymers : Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes

Books Recommended:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.

Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann.

SEMESTER VI

Course code	: CHEGE603			
Course Title	: Carboxylic Acids, Amines and Derivatives			
Semester /Year	: VI			
	L	T	P	C
	4	0	0	4

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

Ka

Shalin

Shalin

CO1	Get Knowledge about the preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins.
CO2	Understand about the preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO3	Explain various preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO4	Illustrate different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO5	Compare the different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO6	Write about different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins

Unit	Contents
1	Carboxylic acids and their derivatives <i>Carboxylic acids (aliphatic and aromatic):</i> <i>Preparation:</i> Acidic and Alkaline hydrolysis of esters. <i>Reactions:</i> Hell – Vohlard - Zelinsky Reaction.
2	Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) <i>Preparation:</i> Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. <i>Reactions:</i> Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.
3	Amines and Diazonium Salts <i>Amines (Aliphatic and Aromatic): (Upto 5 carbons)</i> <i>Preparation:</i> from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. <i>Reactions:</i> Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO ₂ , Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: <i>Preparation:</i> from aromatic amines. <i>Reactions:</i> conversion to benzene, phenol, dyes.



4	Amino Acids, Peptides and Proteins <i>Preparation of Amino Acids:</i> Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. <i>Reactions of Amino acids:</i> ester of $-\text{COOH}$ group, acetylation of $-\text{NH}_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins
---	--

Books Recommended:

- i. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- ii. B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).

ke
A
M
Shukla
Shukla

Skill Enhancement Courses

SEMESTER I

Course code	: CHESC105			
Course Title	: Basic Analytical chemistry-I			
Semester /Year	: I			
	L	T	P	C
	2	0	0	2

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge about the basic concepts of analytical chemistry.
CO2	Understand analytical approaches, lab equipment and concentrations of solutions.
CO3	Explain lab equipment, concentrations of solutions and various types of titrations.
CO4	Explain errors, precision, accuracy, sampling, measuring equipment and strength of solutions.
CO5	Summarize the concepts of analytical chemistry.
CO6	Solve numerical problems based on analytical chemistry

Unit	Contents
1	Analytical approaches : Types of errors, precision & accuracy, absolute and relative uncertainty. Significant figures; significant figures in Arithmetics- addition, subtraction, multiplication and division. Mean and standard deviation.
2	Laboratory Apparatus: Laboratory burner; Bunsen burner, air flow regulation, obtaining warm gentle flame with the burner, Hottest flame of the burner. Cutting and bending of glass tubing/glass rod, fine polishing of glass tubing or rod.
3	Steps in Chemical Analysis: Sampling, sample preparation, analysis, interpretation and preparation of report.
4	Use of Measuring Equipments: Pipette, burette, chemical balance, least count.
5	Chemical Concentration: Normality, molarity, preparation of solution of defined normality/molarity of a given compound and From a given solution of different strength, percent composition, part per million (ppm), part per billion (ppb), calculations.
6	Titration: Types of titrations, end point, equivalence point, Indicators-types and theory.

Books recommended

- Nivaldo, J. and Tro, H. O. Y. Au- Yeung, Introductory Chemistry, Pearson India Education, 2017, 5th edition.

- ii. Timberlake, K.C., and Timberlake, W., Basic Chemistry, Pearson India Education, 2017, 4th edition.
- iii. Pavia, D.L., Lampman, G.M., Kriz, G.S., and Engel, R.G., Micro scale and Macro scale Techniques in the Organic Laboratory, Harcourt College Publishers, 2001, 1st edition.
- iv. Harris, D.C., Exploring Chemical Analysis, W.H. Freeman and Company, New York, 1993, 4th edition.

SEMESTER II

Course code	: CHESC205			
Course Title	: Basic Analytical chemistry-II			
Semester /Year	: II			
	L	T	P	C
	2	0	0	2

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge about the basic concepts of analytical chemistry.
CO2	Understand concepts of physical constants, polarimeter, and electromagnetic radiation.
CO3	Explain distillation, crystallization, filtration, solubility and extraction.
CO4	Illustrate instrumentation of polarimeter, spectrophotometer and distillation assemblies.
CO5	Summarize the concepts of analytical chemistry.
CO6	Solve numerical problems related to polarimeter, electromagnetic radiation and solubility.

Unit	Contents
1	Physical Constants: Melting points, melting point theory, mixture melting point, packing of melting point tube, Determination of melting point; decomposition, discoloration, softening, shrinking and sublimation. Boiling point, determination of boiling point, use of boiling chips, calibration of thermometer.
2	Polarimeter: Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity.
3	Electromagnetic Radiation: Properties, absorption of light, transmittance, absorbance and Beer's Law. Spectrophotometer- Single beam and double beam instruments.

ke

Amul

[Signature]

Shalin

4	Distillation: Simple distillation, distillation theory, fractional distillation, difference between simple and fractional distillation, vapour- liquid composition diagram, Raoult's Law.
5	Crystallization filtration: Filtration- Selection of suitable solvent/s, purification of compounds. Filtration- Gravity filtration, Filter papers, vacuum filtration, aspirator.
6	Solubility and Extraction: Solubility-Definition, predicting solubility behaviour, water as a solvent, organics solvents. Extraction Theory, distribution coefficient, separation and drying agents.

Books recommended

- Nivaldo, J. and Tro, Ho Yu Au- Yeung, Introductory Chemistry, Pearson India Education, 2017, 5th edition.
- Timberlake, K.C., and Timberlake, W., Basic Chemistry, Pearson India Education, 2017, 4th edition.
- Pavia, D.L., Lampman, G.M., Kriz, G.S., and Engel, R.G., Micro scale and Macro scale Techniques in the Organic Laboratory, Harcourt College Publishers, 2001, 1st edition.
- Harris, D.C., Exploring Chemical Analysis, W.H. Freeman and Company, New York, 1993, 4th edition.

SEMESTER III

Course code	: CHESC305			
Course Title	: Chemistry of Soil and Water			
Semester /Year	: III			
	L	T	P	C
	2	0	0	2

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about basic composition of soil and water.
CO2	Describe about the chemistry of soil and water
CO3	Explain physical, chemical and biological parameters of soil.
CO4	Analyze physical, chemical and biological parameters of water
CO5	Evaluate pH of soil and water samples
CO6	Test the quality of soil and water samples

Unit	Contents
1	Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
2	Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Books recommended

- Srilakshmi, B., Food Science, 7th Ed., New Age International, New Delhi (2018)
- Biswas, T. D.; Mukherjee, S. K., Text Book of Soil Science, 2nd Ed., McGraw Hill Publishing Company, New Delhi (2017).

SEMESTER IV

Course code	: CHESC405			
Course Title	: Pesticide Chemistry			
Semester /Year	: IV			
	L	T	P	C
	2	0	0	2

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about pesticides
CO2	Develop understanding of various types of pesticides.
CO3	Learn about the applications of various synthetic classes of pesticides.
CO4	Explain benefits, adverse effects and types of pesticides.
CO5	Distinguish various types of pesticides.
CO6	Write the synthesis and properties of pesticides.

Unit	Contents
1	General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides

2	Structure activity relationship, 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).
---	---

Books recommended

- i) Handa S.K., Principles of Pesticide Chemistry, Agrobios India (1 January 2004).
- ii) Saha C., Chakraborty B., Chakraborty S., Basu k., Lectures on Pharmaceutical Chemistry and Pesticide Chemistry, Techno world.

SEMESTER V

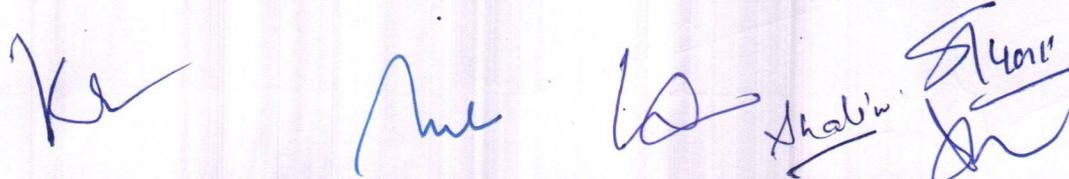
Course code : CHESC505				
Course Title : Fuel Chemistry				
Semester /Year : V				
	L	T	P	C
	2	0	0	2

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Understand and know the renewable and non-renewable sources of energy, different types of fuels and their calorific values
CO2	Learn the uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.
CO3	Explain composition and uses of coal gas, producer gas and water gas.
CO4	Apply knowledge in petroleum and petrochemical industry, different types of petroleum products and their applications.
CO5	Classify lubricants and their classification, properties of lubricants (viscosity index, cloud point, pore point) and their determination.
CO6	Summarize concept of fuel chemistry.

Unit	Contents
1	Uses of coal (fuel and nonfuel) in various industries, its composition, proximate analysis, ultimate analysis, determination of % of carbon, hydrogen, nitrogen, sulphur, ash and oxygen. Carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.



2	Composition of crude petroleum, Refining and different types of petroleum products, Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), knocking, octane number, unleaded petrol, Reforming, Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.
3	Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point, flash point, fire point) and their determination.

Books recommended

- i. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd.
- ii. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
- iii. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

SEMESTER VI

Course code	: CHESC605			
Course Title	: Business skills for Chemists			
Semester /Year	: VI			
	L	T	P	C
	2	0	0	2

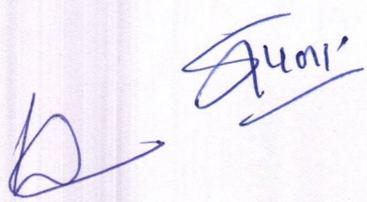
Course outcomes (COs):

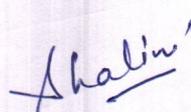
Upon successful completion of the course, students will be able to

CO1	Understand and know the basic key business concepts including businessplans, market need, project management and routes to market.
CO2	Learn and know the current challenges and opportunities in chemical industries
CO3	Explain composition and uses of coal gas, producer gas and water gas.
CO4	Identify the role of chemistry in India and global economies.
CO5	Analyse financial aspects of business with case studies.
CO6	Summarize the concept of intellectual property including patent

Unit	Contents
1	Business Basics: Key business concepts: Business plans, market need, project management and routes to market

2	Chemistry in Industry: Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies
3	Making money: Financial aspects of business with case studies
4	Intellectual property: Concept of intellectual property, patents






Discipline Specific Electives

Semester-V

Course code : CHEDE506				
Course Title : Industrial Chemicals and Environment				
Semester /Year : V				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn the fundamentals of chemical technology
CO2	Explain the different types of equipment used in chemical technology
CO3	Explain the manufacture, application, analysis, and hazards in handling the following chemicals.
CO4	Discuss the pollutants and their sources of air pollution.
CO5	Discuss the pollutants and their sources of water pollution.
CO6	Discuss about the Water treatment and purification

Unit	Content
1.	<p>Chemical Technology</p> <p>Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction to the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, and emulators Scaling up operations in the chemical industry. Introduction to clean technology.</p>
2.	<p>Industrial Gases</p> <p>Industrial Gases: Large-scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulfur dioxide and phosgene.</p>
3.	<p>Inorganic Chemicals</p> <p>Inorganic Chemicals: Manufacture, application, analysis, and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum,</p>



	chrome alum, potassium dichromate and potassium permanganate.
4.	Environment- Air Pollution: Pollutants and their sources, pollution by SO ₂ , CO ₂ , CO, NO _x , H ₂ S and other foul-smelling gases. Methods of estimation of CO, NO _x , SO _x and control procedures. Green House effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.
5.	Water pollution and Water Quality Standards: Pollutants and their sources, Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluent from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

Books Recommended:

- i. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- ii. K. De, Environmental Chemistry: New Age International Pvt, Ltd, New Delhi.
- iii. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

Course code	: CHEDL507			
Course Title	: Lab course based on CHEDE506			
Semester /Year	: V			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the basics of chemistry practicals and lab rules
CO2	Understand the basics of Industrial chemicals and environment.
CO3	Apply Chemical Oxygen Demand (COD)
CO4	Analyze and interpret the results of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD)
CO5	Evaluate the experimental data of total alkalinity of water samples.
CO6	Determine the different parameters related to Industrial chemicals.



Unit	Content
1	i. Determination of dissolved oxygen in water. ii. Determination of Chemical Oxygen Demand (COD) iii. Determination of Biological Oxygen Demand (BOD) iv. Percentage of available chlorine in bleaching powder. v. Measurement of chloride, sulphate and salinity of water samples by simple titration method. (AgNO ₃ and potassium chromate) vi. Estimation of total alkalinity of water samples (CO ₃ , HCO ₃) using double titration method. vii. Measurement of dissolved CO ₂ .

Books Recommended:

- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi).
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

Semester-VI

Course code : CHEDE606				
Course Title : Quantitative analytical methods				
Semester /Year : VI				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the basics of different titrations
CO2	Understand concept of use of indicators.
CO3	Illustrate different titrimetric methods.
CO4	Explain fundamentals of titrations and use of indicators etc.
CO5	Summarize different types of titrations .

he

me

to

Shalin'

Shalin'

CO6	Solve the numerical based on theory.
-----	--------------------------------------

Unit	Content
1	Fundamental of volumetric analysis: Methods of expressing concentrations, primary and secondary standards . Neutralization reactions: Theory of indicators and neutralizations indicators
2	Oxidation-reduction titration: Principle of oxidation reduction filtrations, redox indicators & their use in pharmaceutical analysis. Complexometric titrations: Complexometric methods using EDTA, principle of complexometric titrations, chelating agents, indicators, titrations with disodium edetate.
3	Precipitation titration : Theory of precipitation titrations and use of adsorption indicators
4	Complexometric titrations: Complexometric methods using EDTA, principle of complexometric titrations, chelating agents, indicators, titrations with disodium edetate.

Books Recommended:

- i. A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4th ed., CBS Publishers & Distributors, New Delhi, 1997.
- ii. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989 .
- iii. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3rd ed., Wiley Interscience Singapore, 1982.

Course code	: CHEDL607			
Course Title	: Lab course based on CHEDE606			
Semester /Year	: VI			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the basics different titrimetric methods
CO2	Understand calibration of weights and chemical balance
CO3	Apply theoretical knowledge in practicals.

ke *me* *Shalin* *Stuar* *Sh* 49

CO4	Do quantitative analysis by titration methods.
CO5	Measure concentration of different solutions
CO6	Solve the experimental data.

Unit	Content
1	Standardization of analytical weights and calibration of volumetric apparatus.
2	Titrametric analysis including acid base titration, redox titration, precipitation titrations, gravimetric analysis..

Books Recommended:

- i. A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4th ed., CBS Publishers & Distributors, New Delhi, 1997.
- ii. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989 .
- iii. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3rd ed., Wiley Interscience Singapore, 1982

Semester-VII

Course code : CHEDE703				
Course Title : Biomolecules				
Semester /Year : VII				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn and gain knowledge of molecules of life.
CO2	Understand the classifications and other details of carbohydrates, enzymes, lipids etc.
CO3	Illustrate the concept of lipids, proteins, enzymes etc.
CO4	Explain carbohydrates, enzymes, proteins, lipids,enzymes etc

CO5	Summarize the concept of different biomolecules.
CO6	Express the details of biomolecules.

Unit	Content
1	Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, open chain structure of glucose. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.
2	Amino Acids, Peptides and Proteins Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (DNFB method) and C-terminal amino acid (carboxypeptidase enzyme).
3	Enzymes Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibition).
4	Lipids Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Books

Recommended:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.

Course code	: CHEDL704
Course Title	: Lab course based on CHEDE703
Semester /Year	: VII

	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge of separation amino acids.
CO2	Understand saponification and iodine value of oil/fats.
CO3	Examine the action of salivary amylase on starch.
CO4	Differentiate between reducing and non-reducing sugar.
CO5	Evaluate and interpret the obtained results
CO6	Interpret the results of different experiments.

Unit	Content
1	Separation of amino acids by paper chromatography To determine the concentration of glycine solution by formylation method. Study of titration curve of glycine Differentiate between a reducing/ nonreducing sugar.
2	Action of salivary amylase on starch Effect of temperature on the action of salivary amylase on starch. To determine the saponification value of an oil/fat. To determine the iodine value of an oil/fat

Books**Recommended:**

1. Trniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
2. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand

Course code	: CHEDE705
Course Title	: Coordination Chemistry
Semester /Year	: VII
	L T P C
	3 0 0 3

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of transition elements, coordination chemistry, lanthanoids, actinides and bioinorganic chemistry
------------	--

Handwritten signatures and initials in blue ink.

CO2	Understand concepts of transition elements, coordination chemistry, lanthanoids, actinides and bioinorganic chemistry
CO3	Explain theories and properties of transition and inner transition elements.
CO4	Illustrate splitting in Oh and Td complexes, Na/K Pump and Latimer diagram. Also explain the role of metal ions in biological process.
CO5	Predict geometry, magnetic nature of coordination compounds and lanthanides and actinides. Also predict the lability and inertness of complexes.
CO6	Solve problems related to coordination chemistry

Unit	Contents
1	Coordination Chemistry Werner's theory, valence bond theory (inner and outer orbital complexes), Crystal field theory, measurement of $10 Dq$ (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of $10 Dq$ (Δ_o , Δ_t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes
2	Transition Elements General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams). Difference between the first, second and third transition series.
3	Lanthanoids and Actinoids Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).
4	Bioinorganic Chemistry Metal ions present in biological systems, classification of elements according to their action in biological system. Sodium / K-pump. Excess and deficiency of some trace metals. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Books Recommended:

- i. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
- ii. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- iii. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- iv. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
- v. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- vi. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997.

Course code	: CHEDL706
Course Title	: Lab course based on CHEDE705
Semester /Year	: VII
	L T P C
	0 0 2 1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of chemistry of coordination complexes
CO2	Understand concepts of formation of coordination complexes
CO3	Explain the preparation of various coordination compounds
CO4	Illustrate principle of formation of coordination complexes
CO5	Predict structure of coordination complexes
CO6	Synthesize coordination complexes

Unit	Contents
1	i. To synthesize cuprous Chloride, [i.e., Cu_2Cl_2] ii. To prepare manganese (III) phosphate, [i.e., $\text{MnPO}_4 \cdot \text{H}_2\text{O}$] iii. To prepare aluminium potassium sulphate $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (Potash alum) or Chrome alum. iv. To synthesize tetraamminecopper (II) sulphate, $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$ v. To synthesize cis and trans $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2 \cdot (\text{H}_2\text{O})_2]$ Potassium dioxalatodiaquachromate (III) vi. To synthesize tetraamminecarbonatocobalt (III) ion vii. To synthesize potassium tris(oxalate)ferrate(III) viii. To synthesize ammonium iron(II) sulfate $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ (Mohr's salt)

Recommended Books:

- Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House
- Advanced Practical Physical Chemistry, J B Yadav. Educational Publishers

Course code	: CHEDE707
Course Title	: Electrochemistry

Semester /Year : VII				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn the fundamentals of electrochemistry
CO2	Explain the electrochemical cell with reference and counter electrode in electrochemistry
CO3	Explain the laws in electrochemistry
CO4	Illustrate the concepts of electrode-electrolyte interfaces and structure of double layer
CO5	Explain the various electrochemical techniques used in electrochemistry
CO6	Solve numerical related to the electrochemistry

Unit	Content
1.	Conductance Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation
2.	Electrochemistry Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.
3.	Introduction to Electroanalytical Methods: Electrochemical Cells, electrode potential, Calculation of Cell Potentials from Electrode Potentials, reference electrode, three electrodes cell, supporting electrolyte, Currents in Electrochemical Cells, Types of Electroanalytical Methods, Reference Electrodes, Current-Voltage Relationships during an Electrolysis.
4.	Fundamentals of Electrochemistry: Electrode-electrolytes interfaces, Structure of electrical double layer, Helmholtz model, the Gouy-Chapman model, and the Stern model, Kinetics of electrode reactions and derivation of Butler-Volmer Equation, Tafel equations and Polarography theory.

Ke

Mud

Shalin
Sh

5.	Electrochemical Techniques: Potentiostatic Coulometry, Amperostatic Coulometry, Cyclic Voltammetry, Linear sweep voltammetry, Electrochemical Impedance Spectroscopy (EIS), Mott-Schottky analysis.
----	---

Books Recommended

- i. Modern Electrochemistry, Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
- ii. Physical Chemistry, P.W. Atkins, ELBS.
- iii. Principles of Physical Chemistry, Puri, Sharma, and Pathania

Course code	: CHEDL708			
Course Title	: Lab course based on CHEDE707			
Semester /Year	: VII			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn the fundamentals of electrochemistry
CO2	Explain the conductometric titration
CO3	Explain the potentiometric titration
CO4	Illustrate the concepts of strong acid and strong base
CO5	Explain the various curves in the conductometric and potentiometric titrations
CO6	Solve numerical related to the electrochemistry

Unit	Content
1.	Conductometry i. To determine cell constant ii. To perform the following conductometric titrations: iii. Strong acid vs. strong base iv. Weak acid vs. strong base
2.	Potentiometry i. To perform and study the following potentiometric titrations: ii. Strong acid vs. strong base iii. Weak acid vs. strong base iv. Dibasic acid vs. strong base

ke *Mud* *Shah* *Shah*

Books Recommended:

- i. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
- ii. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- iii. Principles of Physical Chemistry, Puri, Sharma, and Pathania

Course code :	CHEDE709			
Course Title :	Pericyclic Reactions and Organic Photochemistry			
Semester /Year :	VII			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get knowledge about the pericyclic and photochemical reactions.
CO2	Understand about the pericyclic and photochemical reactions.
CO3	Explain various pericyclic and photochemical reactions.
CO4	Illustrate different of pericyclic and photochemical reactions.
CO5	Compare the mechanism of pericyclic and photochemical reactions.
CO6	Write about different type pericyclic and photochemical reactions.

Unit	Contents
1	<p>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. Conservation of orbital symmetry, State correlation diagrams, aromatic transition state (ATS) theory, generalized orbital symmetry (GOS) rule. Frontier Molecular Orbital (FMO) and Perturbation Molecular Orbital (PMO) approach.</p> <p>Electrocyclic reaction; conrotatory and disrotatory motions, orbital correlation diagrams for $4n$, $4n+2$ and allyl systems, torquoselectivity.</p> <p>Cycloaddition: antarafacial and suprafacial addition, $4n$ and $4n+2$ systems, 2+2 addition of ketenes, 1,3 dipolar cycloaddition, Diels-Alder Reaction and its variants, Cheletropic and ene reactions.</p>

57

2	Organic Photochemistry Quantum yields, intersystem crossing, photosensitization and energy transfer reactions. Photochemistry of olefins and carbonyl compounds, photo oxygenation and photo fragmentation, Photochemistry of aromatic compounds: isomerisation, additions and substitutions. Singlet molecular oxygen reactions. Paterno-Buchi reaction, Di-pimethane rearrangement, Bartons reaction and Photo-Fries rearrangement. Norrish I and II reactions.
---	---

Books Recommended:

- i. I. Fleming & John Wiley "*Frontier Orbital and Organic Chemical Reactions*" 1976.
- ii. W. Carruthers "*Some modern Methods of Organic Synthesis*" Cambridge University Press, (1990).
- iii. T.W. Greene, "*Protective Groups in Organic Synthesis*" Wiley-VCH, (1999)
- iv. I. L. Finar, "*Organic Chemistry*", Vol 11, ELBS (1968).

Course code	: CHEDL710			
Course Title	: Lab course based on CHEDE709			
Semester /Year	: VII			
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Describe the practical concepts underlying the purification, separation and analysis of organic mixture of a compound
CO2	Distinguish 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	Develop the ability of performing accurate quantitative measurements with an understanding of the theory and use of contemporary instrumentation.
CO4	Analyse the practical concept qualitatively and quantitatively.

58

CO5	Test the purity of separated compounds.
CO6	Develop Preparation of derivatives.

Unit	Contents
1	<p>Qualitative Analysis</p> <p>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.</p>

Books Recommended:

- i. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
- ii. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
- iii. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
- iv. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

Course code	: CHEDL711
Course Title	: Research Methodology
Semester /Year	: VII
	L T P C
	3 1 0 4

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Define various kind of research, objectives of doing research, research process and research design
CO2	Discuss the ability to choose methods appropriate to research aims and objectives.
CO3	Explain analyze data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.

CO4	Explain Statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO5	Summarize the properties of mechanism of research methodology
CO6	Create a research methodology

Unit	Contents
1	Meaning & Functions of Research Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.
2	Research Problem and Research Design Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.
3	Interpretation and Report Writing Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report
4	Statistical Techniques and Tools Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Books Recommended:

- v. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
- vi. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
- vii. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
- viii. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

Semester-VIII

Course code	: CHEDE803
Course Title	: Structure and Properties of Metal Complexes
Semester /Year	: VIII
	L T P C
	3 0 0 3

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Learn and gain knowledge of main group compounds and coordination chemistry
CO2	Describe theories of coordination compounds and explain metal ligand equilibria in solutions.
CO3	Explain electronic spectra and magnetic properties of coordination compounds
CO4	Illustrate CFT, MOT, JTD and chelate effect.
CO5	Summarize the concepts of metal ligand equilibria in solution
CO6	Propose the structure of various inorganic compounds based on VSEPR model and hybridization.

Unit	Contents
1	Stereochemistry and bonding in main group compounds VSEPR theory, Walsh diagrams (tri- and penta-atomic molecules) $d\pi - p\pi$ bonds, bent rule and energetics of hybridization, stereoisomerism in inorganic complexes, isomerism arising out of ligand and ligand conformation, chirality and nomenclature of chiral complexes.
2	Metal-ligand bonding and molecular orbital theory (MOT) Limitations of crystal field theory, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral and square pyramidal complexes, Jahn-Teller distortion, nephelauxetic series, composition of ligand group orbitals, molecular orbital diagrams of octahedral, tetrahedral, including both σ and π bonding.
3	Metal-ligand equilibria in solution Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with references to the nature of metal ion and ligand, chelate effect and its thermodynamic origin

[Handwritten signatures and initials in blue ink]

4	Electronic spectra of coordination compounds Spectroscopic ground states, correlation and spin-orbit coupling in free ions for 1 st series of transition metals, Orgel and Tanabe Sugano diagrams for transition metal complexes (d ¹ - d ⁹ states), calculation of Dq, B and B parameters,
5	Magnetic properties of transition metal complexes Fundamental equations in molecular magnetism, magnetic susceptibility and magnetic moment, diamagnetic and paramagnetic behaviour of transition metal complexes, spin-orbit coupling effects (LS coupling and j-j coupling), temperature independent paramagnetism (TIP) of complexes, spin cross over, ferromagnetic, anti-ferromagnetic, ferrimagnetic behaviour of transition metal compounds, effect of temperature on their magnetic properties.

Books recommended:

- Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, 1999.
- Douglas, B. E., McDaniel, D. H. and Alexander, J. J., "Concepts and Models in Inorganic Chemistry", 3rd Ed., John Wiley & Sons, 2001.
- Figgis, B. N., and Hitchman, M. A., "Ligand Field Theory and Its Applications", Wiley Eastern Ltd., 1999.
- Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry Principle of Structure and Reactivity", 4th Ed, Pearson Education, Inc., 2003.
- Atkins, P., Overton, T., Rourke, J., Mark, W. and Armstrong, F., "Shriver and Atkins' Inorganic Chemistry", 4th Ed, Oxford university press, 2009.

Course code	: CHEDL804				
Course Title	: Lab course based on CHEDE803				
Semester /Year	: VIII				
		L	T	P	C
		0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of chemistry of coordination complexes
CO2	Understand concepts of formation of coordination complexes
CO3	Explain the preparation of various coordination compounds
CO4	Illustrate principle of formation of coordination complexes

[Handwritten signatures in blue ink]

CO5	Predict structure of coordination complexes
CO6	Synthesize coordination complexes

Unit	Contents
1	i. To synthesize ammonium ferric sulphate ii. To prepare chrome red. iii. To prepare chrome alum iv. To prepare Mohr's salt v. To prepare Nickel ammonium sulphate vi. To prepare potash alum

Recommended Books:

- iii. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House
- iv. Advanced Practical Physical Chemistry, J B Yadav. Educational Publishers

Course code	:	CHEDE805				
Course Title	:	Radiation and Photochemistry				
Semester /Year	:	VIII				
			L	T	P	C
			3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

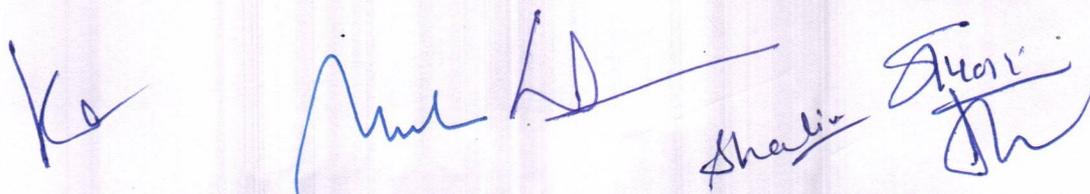
CO1	Learn the fundamentals of Photochemistry
CO2	To understand the interaction of high energy radiation with material and induced chemical changes
CO3	Explain the radiolysis briefly
CO4	Illustrate the concepts of excited states, complex excited states and the kinetics of radiation
CO5	Explain the Radiolysis of Gases and Liquids.
CO6	Discuss about the principle of photochemistry

Unit	Content
1.	Introduction The scope of radiation chemistry, its relation to other scientific disciplines, the interactions of directly ionising (charged particles) and indirectly ionising (neutrons, photons) radiation with a matter as starting point of radiation-chemical reaction (radiolysis).
2.	Primary Intermediate Products (PIP) of Radiolysis, their Formation and Properties: Excited states, cations, electrons, radicals and anions, Complex excited states: Excimers, exciplexes, plasmons. Superexcited states, Electrons generated by irradiation as the most important agents responsible for the deposition of the radiation energy in a matter, electron degradation spectrum, thermalization and solvation of electrons, Relaxation processes in excited atoms and molecules, Reactions of PIP giving the stable products of radiolysis, Track of an ionising charged particle and its structure.
3.	Stages of Radiolysis: Physical stage, physicochemical stage chemical stage and their products. The stage of post-effects (either chemical or biological). The kinetics of radiation-chemical processes
4.	Radiolysis of Gases and Liquids: Ionisation in noble gases, the radiolysis of selected gaseous elements, the radiolysis of N_2O and its use in dosimetry, the radiolysis of water vapour, radiolysis of liquid water (including the mechanism, the properties and reactivity of radiolytic products), the influence of conditions during the irradiation on the result of radiolysis.
5.	Photochemistry Quantum efficiencies of photochemical and photophysical processes, experimental techniques for continuous photolysis, Primary and secondary photochemical processes, Franck-Condon principle and its applications, rates of absorption and emission, lifetimes of electronically excited states and their fate, quenching of excited states species-dynamic and static quenching, radiation less transition and pre-dissociation, energy transfer processes.

Books Recommended:

- i. Modern Electrochemistry, Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
- ii. Physical Chemistry, P.W. Atkins, ELBS.
- iii. Principles of Physical Chemistry, Puri, Sharma, and Pathania

Course code	:	CHEDL806				
Course Title	:	Lab course based on CHEDE805				
Semester /Year	:	VIII				
			L	T	P	C
			0	0	2	1



Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn the fundamentals of spectroscopy
CO2	Explain the electron spin resonance spectroscopy
CO3	Explain the NMR spectroscopy
CO4	Illustrate the concepts of principle of XRD
CO5	Explain the hyperfine splitting and kramer's degeneracy
CO6	Solve the curves related to NMR and ESR spectroscopy.

Unit	Content
1.	Vibrational Spectroscopy Symmetry and shapes of AB ₂ , AB ₃ , AB ₄ , AB ₅ and AB ₆ , modes of bonding of ambidentate ligands, Raman Spectroscopy particularly for the study of active sites of metalloproteins as myoglobin and haemoglobin.
2	Electron Spin Resonance Spectroscopy Principle, presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, factors affecting magnitude of g, zero field splitting and Kramer's degeneracy, applications to transition metal complexes having one and more than one unpaired electron.
3	NMR spectroscopy: Principle and Instrumentation.
4	Principles and Applications of XRD

Books Recommended:

- i. Drago, R.S., "Physical Methods in Inorganic Chemistry", Reinhold Publishing Corp., East West Press.
- ii. Banweil, C.N. and McCash, E.L.M., "Fundamentals of Molecular Spectroscopy", 4th Ed. McGraw-Hill. 1999.
- iii. Slichter. C. P., "Principles of Magnetic Resonance", Springer Verlag, 1981.

Course code	: CHEDE807				
Course Title	: Advanced Methods of Chemical Analysis				
Semester /Year	: VIII				
		L	T	P	C
		3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn and gain knowledge about quantitative and qualitative analysis.
CO2	Understand basics of spectroscopic and chromatographic techniques.
CO3	Illustrate different chromatographic techniques.
CO4	Explain errors, sampling, chromatography, and spectroscopy.
CO5	Summarize different terms used in spectroscopic and chromatography .
CO6	Express the applications of different spectroscopic and separation techniques.

Unit	Content
1	Qualitative and quantitative aspects of analysis Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.
2	Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Applications of UV-Vis
3	Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Applications of IR spectroscopy
4	Chromatography: Classification, principal instrumentation of HPLC, GC and ion exchange chromatography and their uses. Development of chromatograms: Frontal, elution and displacement methods.

Books recommended:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.

Course code	:	CHEDL808				
Course Title	:	Lab course based on CHEDE807				
Semester /Year	:	VIII				
			L	T	P	C
			0	0	2	1

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the basics of chemistry practicals and lab rules.
CO2	Understand separation of ions, sugars and pigments by chromatography.
CO3	Apply theoretical knowledge in practicals.
CO4	Analyse pH of different shampoo solutions.
CO5	Measure BOD, COD, DO and other parameters the obtained results
CO6	Solve the experimental data.

Unit	Content
1	Chromatography: Paper chromatographic separation of Fe ³⁺ , Al ³⁺ , and Cr ³⁺ Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R _f values. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
2	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. Determination of pH of soil, total soluble salt, Estimation of calcium, magnesium, phosphate, nitrate.
3	Structural characterization of compounds by infrared spectroscopy.

Books recommended:

1. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
2. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

Course code	:	CHEDE809
Course Title	:	Chemistry of Natural Products.

ke *me* *AD* *Shalin* *Shrin*

Semester /Year : VIII				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get Knowledge about the terpenoids, alkaloids, pigments and prostaglandins.
CO2	Understand about the terpenoids, alkaloids, pigments and prostaglandins.
CO3	Apply various types of terpenoids, alkaloids, pigments and prostaglandins.
CO4	Analyze synthetic route of terpenoids, alkaloids, pigments and prostaglandins.
CO5	Distinguish different type reaction mechanism of terpenoids, alkaloids, pigments and prostaglandins synthesis.
CO6	Design various synthetic routes of terpenoids, alkaloids, pigments and prostaglandins.

Unit	Content
1	Terpenoids and Carotenoids Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule Structures of abietic acid and β -carotene.
2	Alkaloids Classification, Nomenclature, Isolation and structure of ephedrine, quinine.
3	Steroids Structural features of cholesterol and bile acids (without synthesis). Chemistry of testosterone, estrone and progesterone.
4	Pigments Plant Pigments: Occurrence, nomenclature and general methods of structure determination. Isolation of cyanidin, and quercetin. Porphyryns General Introduction of haemoglobin and chlorophyll. Chemistry of chlorophyll (without synthesis). Structure of haem.
5	Prostaglandins Occurrence, nomenclature, classification, biogenesis and physiological effects of Key intermediate, PGE ₂ and PGF ₂

Books Recommended:

- Finar, I. L. (1956). Organic Chemistry, Volume 2: Stereochemistry and The Chemistry Natural Products, 5th Ed. Pearson Education India.
- Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan 2010.
- Agarwal, O. P. *Chemistry of Organic Natural Products, Vol 1 and 2*, Goel Pub. House, 2002.
- Chatwal, Gurdeep. *Chemistry of Organic Natural Products, Vol 1 and 2*, Goel Pub. House, 2002.

Course code	: CHEDL810
Course Title	: Lab course based on CHEDE809
Semester /Year	: VIII
	L T P C
	0 0 2 1

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get Knowledge about the terpenoids, alkaloids, pigments and prostaglandins.
CO2	Understand about the terpenoids, alkaloids, pigments and prostaglandins.
CO3	Apply various types terpenoids, alkaloids, pigments and prostaglandins.
CO4	Analyze synthetic route of terpenoids, alkaloids, pigments and prostaglandins.
CO5	Distinguish different type reaction mechanism of terpenoids, alkaloids, pigments and prostaglandins synthesis.
CO6	Design various synthetic routes of terpenoids, alkaloids, pigments and prostaglandins.

Unit	Content
1	Extraction and isolation of Organic Compounds from Natural Sources <ol style="list-style-type: none"> Isolation of caffeine from tea leaves. Isolation of nicotine dipicrate from tobacco. Isolation of cinchonine from cinchona bark. Isolation of piperine from black pepper. Isolation of lycopene from tomatoes. Isolation of β-carotene from carrots. Isolation of eugenol from cloves.

Books Recommended:

- Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
- Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and S Kriz, Saunders College Publishing, Philadelphia, New York.
- Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn & Bacon, Inc.

Boston.

- iv. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.

Course code :	CHEDE811			
Course Title :	Intellectual Property Right			
Semester /Year :	VIII			
	L	T	P	C
	3	1	0	4

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Acquire knowledge about Intellectual property rights, copyrights, trademarks and patents.
CO2	Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO3	Analyse layout designs of integrated circuits, risks involved in trade secret protection, international design registration, rules for registration of geographical indications etc.
CO4	Analyze to Research-IPR. Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO5	Summarize the properties of mechanism of Research-IPR.
CO6	Create the Research-IPR.

Unit	Content
1	Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights: Introduction, how to obtain, Differences from Patents.
2	Trade Marks: Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs. Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.
3	Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India. Industrial Designs: Definition, how to obtain, features, international design registration. Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance

	for electronic industry.
4	Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. World Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Books Recommend

1. Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
2. Guru, M,&Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
3. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller, A, R, Micheal H. Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
5. Watal, J., Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford

ke

Mul

Lh

Shalin

Suar

A

ABILITY ENHANCEMENT COURSE

Semester-I

Course code : AEC-104				
Course Title : Environment Science- I				
Semester /Year : I				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Discover knowledge in ecological perspective and value of environment.
CO2	Understand the significance of various natural resources and its management
CO3	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO4	Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Create environmental laws and sustainable development

Unit	Content
1	Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure, and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles Hydrological cycle, Phosphorous cycle, Nitrogen cycle
2	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.
3	Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation.

4	Endangered and Endemic species, Hot spots of biodiversity. Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act..
---	---

Books Recommended:

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1 st Edition, 2006.
2. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
3. Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

Semester-II

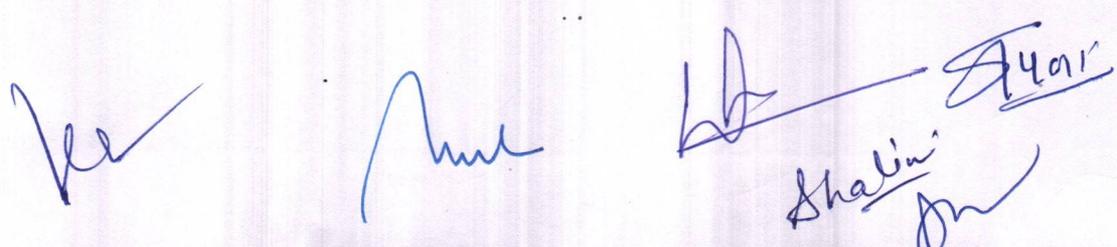
Course code : AEC-204				
Course Title : Environment Science- II				
Semester /Year : II				
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Discover knowledge in ecological perspective and value of environment.
CO2	Understand the significance of various natural resources and its management
CO3	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO4	Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Create environmental laws and sustainable development

Unit	Content
-------------	----------------



1	Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary.
2	Concepts of bioremediation; Global environmental problems and global efforts: Global Warming, Climate change, Sea level rise, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions/protocols: Earth summit, Kyoto protocol and Montreal protocol
3	Environmental legislations: Environmental protection act, air act 1981, water act, forest act. Municipal solid waste management and handling rules, biomedical waste management and handling rules 2016, hazardous waste management and handling rule.
4	Environmental impact assessment (EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building..

Book Recommended:

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1 st Edition, 2006.
2. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
3. Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

Semester-III

Course code	: AEC-304			
Course Title	: English Communication- I			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
------------	--

CO2	Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
CO4	Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of plant physiology.
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Content
1	Theory of Communication, Types and Modes of Communication: Introduction, Definitions and Function of Communication, Needs for Effective Communication, Process of Communication, Barrier to Communication, Kinds of Communication; Intrapersonal, Personal, Group and Mass, Verbal and Non-verbal Communication
2	Listening and Speaking Skills: Types of Listening, Developing Effective Listening Skills, Academic Listening (Lectures), Listening to Talks and Presentation, Monologue, Dialogue, Group Discussion, Miscommunication, Interview, Public Speech, Pronunciation, Accent and Intonation and Rhythm.
3	Reading Skills: Skimming, Scanning, Summary, Paraphrasing, Comprehension.

Book Recommended:

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjhana Kaul, Dr. Brati Biswas.

Handwritten signatures in blue ink, including a large signature on the left, a signature in the middle, and two signatures on the right, one of which appears to be 'Shalin'.

Semester-IV

Course code	: AEC-404			
Course Title	: English Communication- II			
Semester /Year	: IV			
	L	T	P	C
	3	0	0	3

Course outcomes (COs):

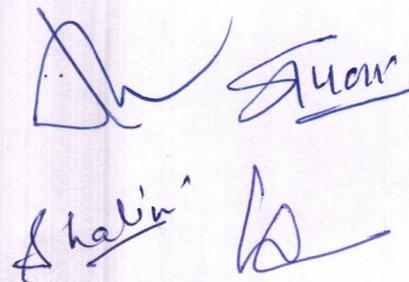
Upon successful completion of the course, students will be able to

CO1	Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
CO2	Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
CO4	Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of plant physiology.
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Content
1	Introductory English Grammar: Parts of Speech, Tenses, Punctuation, Common Errors in English.
2	Writing Skills; Social and Official Correspondence: Enquiries, Complaints and Replies, Letters to the Editor.
3	Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.
4	Career Skills: Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling, Mock Interviews, Group Discussions

Book Recommended:

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
1. Language, Literature and Creativity, Orient Blackswan, 2013.
2. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.



Shalin'

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)

Ka

Shubh
3/1/23

Shalin

Shalin
Shalin

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 pharmaceuticals.

2

Eligibility for admission

Undergraduate degree in any branch of science or engineering with chemistry and physics as two of the subject 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

3

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 III	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 IVth Semester

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

Examination Scheme:

Components	I st internal	II nd 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. Bent's rule. Walsh's diagrams for tri and tetra atomic molecules. $p\pi-p\pi$ and $p\pi-d\pi$ 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_0 . 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-Williams 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).

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 MBochmann, JohnWiley, (1999).

TB3.Inorganic Chemistry, J.E.House, Academic Press,(2008)

Reference Books:

RB1. Inorganic chemistry, A Unified Approach, IIndEd.,WW.Porterfield, Academic Press,(1993).

RB2. Coordination Chemistry,IIIrdEd.,DBanerjea, Asian Book Pt. Ltd.,(2009)

RB3. Inorganic Chemistry,3th Ed.,GLMiessler and D.A.Tarr, Pearson Education, nc.(2004)

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Learn and gain knowledge of main group compounds and coordination chemistry
CO2	Describe theories of coordination compounds and explain metal ligand equilibria and solutions.
CO3	Explain reaction mechanisms of transition metal complexes.
CO4	Illustrate CFT, MOT, VSEPR theory and chelate effect.
CO5	Assess different types of reaction mechanism.
CO6	Propose the structure of various inorganic compounds based on VSEPR model and hybridization.

CO- PSO-PO Mapping:

Cour se	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	1	3	1	1	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	1	2	1	3	1	1	2	2	1	3	2	2	1	3
CO5	1	3	1	2	1	3	1	1	2	2	1	3	2	2	1	3
CO6	1	3	1	2	1	3	1	1	2	2	1	3	2	2	1	3

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. Bonds weaker than covalent, crown ether complexes and cryptands, inclusion compounds, cyclodextrin, catenanes and rotaxanes.

Unit II

Stereochemistry

Conformational analysis of cycloalkane, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis, chirality due to helical shape. 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. Methods of determining Reaction mechanism

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	Gain Knowledge about different type reaction mechanism, aromatic compounds, and substitution reactions.
CO2	Understand the concept of different type reaction mechanism, aromatic compounds, and substitution reactions.
CO3	Explain the concept of reaction mechanism, aromatic compounds, and substitution reactions.
CO4	Illustrate reaction mechanism, aromaticity, and substitution reactions.

CO5	Compare different type stereochemical and substitution reactions.
CO6	Solve potential energy of cycloalkane.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO4
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	3	1	3
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 Quantum 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	Understand molecular orbital theory to explain bonding and molecular structure on the basis of quantum mechanics, 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO	PO	PO	PO	PSO	PSO	PSO	PSO4
CO1	3	1	3	2	1	3	3	1	9	10	11	12	1	2	3	
CO2	3	1	1	2	2	1	3	2	2	2	3	3	3	2	1	1
CO3	3	2	1	2	1	1	3	1	2	2	3	3	3	1	1	1
CO4	3	1	1	2	1	1	3	1	2	2	3	3	3	1	3	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	1
									3	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.

[Handwritten signatures and initials]

12

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 spectral 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, vibration-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 C_n , C_{nv} , C_{nh} , D_{nh} 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	Remember the basics of spectroscopy and group theory.
CO2	Understand the interaction of matter with EMR, and different spectroscopic techniques.
CO3	Explain about theory, instrument, applications of spectroscopy.
CO4	Explain EMR and spectroscopic techniques and group theory.
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	3	2	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	1	1	3
CO5	3	1	1	2	3	1	3	1	2	2	3	3	3	2	2	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

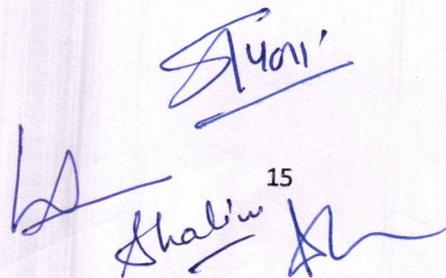
Separation, purification and identification of compounds of binary mixture (solid-solid or liquid and solid) using TLC and Paper Chromatography, Chemical tests and spectroscopic analysis.

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:



15

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 Chemistry, 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 chromatography, qualitative semimicro analysis and chemical kinetics.
CO3	Apply Paper and Thin Layer Chromatography to separate and identify given mixtures
CO4	Analyze and interpret the results of different experiments
CO5	Evaluate the experimental data and errors.
CO6	Determine the different parameters related to chemical kinetics.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	1	3	3	1	3	3	2	2	2	3	3	2
CO2	3	3	1	2	1	3	1	1	3	3	2	2	1	2	3	2
CO3	1	3	3	2	2	3	1	1	3	3	2	2	1	2	3	2
CO4	1	3	1	2	1	3	1	1	3	3	2	2	1	3	2	2
CO5	1	3	1	2	1	3	1	3	3	3	2	2	1	3	3	2
CO6	3	3	1	2	2	3	1	1	3	3	2	2	2	1	2	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., PbSO_4 , BaSO_4) conductometrically.

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

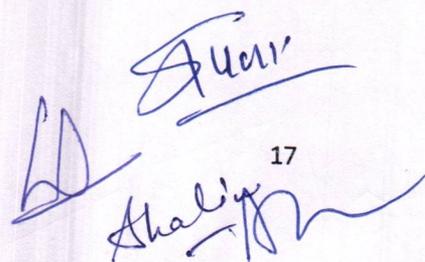
To study the effect of solvent on the conductance of $\text{AgNO}_3/\text{CH}_3\text{COOH}$ and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye-Huckel-Onsager theory.

Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using DebyeHuckel'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:



Shalini

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 Chemistry, 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	1	3	1	2
CO4	1	3	1	2	2	3	1	1	2	2	3	3	2	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

pe

Mu

20 *Shalini* *18* *Shalini*

MSc Chemistry (IInd Semester)

Course code	:MCHC201			
Course Name	: Inorganic 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 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-Saunders'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 carbonyl clusters: LNCC and HNCC. Metalcarbonylhydrides.

19

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, John Wiley, (1988).

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

Reference Books:

RB1. Inorganic chemistry, A Unified Approach, II Ind 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	Learn and gain knowledge of electronic spectra, magnetic properties of transition metal complexes, metal π complexes, metal clusters and silicates.
CO2	Understand electronic spectra, magnetic properties metal π complexes, metal clusters and silicates.
CO3	Understand the classification of silicates and charge transfer spectra.
CO4	Illustrate preparation, properties and uses of metal π complexes, organometallic compounds and metal clusters.
CO5	Compare various types of boranes and carboranes.
CO6	Express the applications of silicates in technology and solve problems related to R-S coupling.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	1	3	1	2	2	3	3	3	1	1	1
CO2	3	1	1	2	1	1	3	2	2	2	3	3	3	1	1	1
CO3	3	1	3	2	1	1	3	1	2	2	3	3	3	1	2	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	3	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, Vilsmeier-Haack reaction, Gattermann-Koch reaction.

Unit II**Aromatic Nucleophilic Substitution**

The S_NAr, S_N1, benzyne and S_{RN}1 mechanisms. Reactivity- effect of substrate structure, leaving group and attacking nucleophile. The von Richter, 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 to Carbon-Carbon Multiple Bonds

Mechanism and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Unit V**Addition to Carbon-Hetero Multiple Bonds**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Wittig reaction. Mechanism of condensation reactions involving enolates- Knoevenagel, Claisen, Mannich Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

Unit VI**Elimination Reactions**

The E₂, E₁ and E_{1cB} 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 VII**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 cheletropic reactions. Sigmatropic rearrangements- suprafacial and antarafacial shifts 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.

22

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	Get knowledge about the pericyclic, substitution, addition, elimination and free radicals reactions.
CO2	Understand about the pericyclic, substitution, addition, elimination and free radicals reactions.
CO3	Explain various pericyclic, substitution, addition, elimination and free radicals reactions.
CO4	Illustrate different of pericyclic, substitution, addition, elimination and free radicals reactions.
CO5	Compare the mechanism of pericyclic, substitution, addition, elimination and free radicals reactions.
CO6	Write about different type pericyclic, substitution, addition, elimination and free radicals reactions.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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

ke

me

Shalin
23

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 1**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 of Butler-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.

ke

me

Shahin

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	1	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-¹³C, ¹⁹F. FT NMR, advantages of FT NMR, use of NMR in medical diagnostics.

26

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	Remember the basics of spectroscopy, chromatography and radioanalytical techniques.
CO2	Understand the theory, principle and instrumentation of NMR, Mass and molecular electronic spectroscopy.
CO3	Explain principle, instrument and applications of chromatographic and radioanalytical techniques.
CO4	Explain different terms used in spectroscopy and chromatography and radioanalytical techniques.
CO5	Illustrate the theory and uses of spectroscopy and chromatography.

CO6	Solve exercises related to spectroscopy, chromatography and radioanalytical techniques.
-----	---

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	3	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

Synthesis of Acetoacetic ester Condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.

Cannizzaro reaction: 4-Chlorobenzaldehyde as substrate Aromatic electrophilic Substitutions: Synthesis of p-nitroaniline and p-bromoaniline. The products may be characterized by Spectral Techniques where possible.

Part 3: Physical Chemistry

Solutions

Handwritten signature

Handwritten signatures and text: "28" and "Shalini"

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 Chemistry, 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	Apply their knowledge in synthesis of various organic compounds.
CO4	Analyze mixture of two metal ions using volumetric and gravimetric analysis.
CO5	Evaluate the experimental data.
CO6	Infer the spectroscopic results.

CO- PSO-PO Mapping:

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

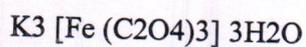
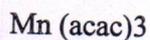
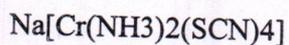
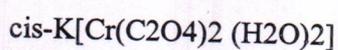
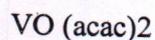
3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

29

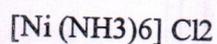
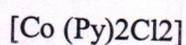
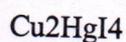
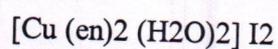
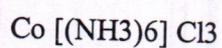
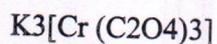
Course code	:MCHL206			
Course Name	: Laboratory Course II			
Semester /Year	: IInd			
	L	T	P	C
	0	0	4	4

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:**

Prussian Blue, Turnbull's Blue

Tris-(thiourea) copper (I) sulphate [Cu (tu)₃] SO₄ · 2H₂O**Part 2: Organic Chemistry****Quantitative Analysis**

30

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-metry

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.

$$\text{Zn} + \text{H}_2\text{SO}_4 \longrightarrow \text{ZnSO}_4 + 2\text{H}$$

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 Chemistry, 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	1	3	1	2
CO5	1	3	1	2	1	3	3	1	2	2	1	3	2	2	3	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

Shalini³²

MSc Chemistry IIIrd Semester)

Course code	:MCHC301			
Course Name	:ORGANIC SYNTHESIS AND PHOTOCHEMISTRY			
Semester /Year	: III rd			
	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

33

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.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get Knowledge about the various photochemical reactions and organic synthesis.
CO2	Understand about the various photochemical reactions and organic synthesis.
CO3	Explain various photochemical reactions and organic synthesis.
CO4	Illustrate various photochemical reactions and organic synthesis.
CO5	Distinguish the mechanism of various photochemical reactions and organic synthesis.
CO6	Design various synthetic routes of photochemical reactions and organic synthesis.

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	3	3	3	3	3	1	2	3	3	2	3	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	3	2	1	3	1	1	3
CO4	3	1	1	2	3	1	3	1	3	1	2	1	3	1	3	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

34
 Shalini

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, thiranes, 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

35

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 reactions of diazines, triazines, tetrazines 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 Scientific Technical

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get knowledge about basics of heterocyclic compounds.
CO2	Understand nomenclature, general behaviour, synthesis and properties of heterocyclic compounds.
CO3	Explain synthesis, properties and uses of heterocyclic compounds.
CO4	Explain aromatic, nonaromatic features, synthesis and properties of different heterocyclic compounds.
CO5	Predict the reactivity, isomerism, conformers etc of heterocyclic compounds.
CO6	Write the synthesis and applications of six and seven membered heterocyclic compounds

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	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	1	2	3
CO3	2	1	3	2	3	1	3	1	2	3	3	2	3	3	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	1	1	3

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

ko

me to

Ayan
36
Shobha

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 Williamson, 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	Describe the practical concepts underlying the purification, separation and analysis of organic mixture of a compound
CO2	Distinguish 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.

37
 Shalin

CO3	Develop the ability of performing accurate quantitative measurements with an understanding of the theory and use of contemporary instrumentation.
CO4	Analyse the practical concept qualitatively and quantitatively.
CO5	Test the purity of separated compounds.
CO6	Develop Preparation of derivatives and spectral analysis.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO	PSO	PSO4
CO1	1	3	3	2	2	3	1	1	3	0	1	2	1	2	3	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	1	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

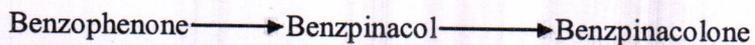
Course Objective:

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

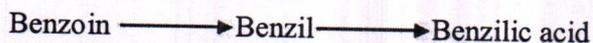
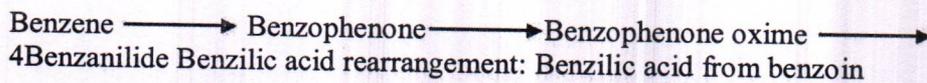
Multi-step Synthesis of Organic Compounds

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

38

Photochemical reaction

Beckmann rearrangement: Benzanilide from benzene

**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	Examine organic compounds and to identify various functional group transformations.
CO2	Identify the organic compounds in the ternary mixture using separation techniques and confirmatory tests.
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	2	1	3	2	1	3	3	1	2	1	2	3	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	: IIIrd			
	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

Nucleophilic 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.

Text Books:

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. Colliins 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	Gain Knowledge about bioinorganic, bioorganic and biophysical chemistry.
-----	--

CO2	Understand the basics of bioinorganic, bioorganic and biophysical chemistry.
CO3	Explain the role of metal ions in biological systems, transport and storage of oxygen.
CO4	Illustrate about mechanism of enzyme action and types of reaction catalyzed by enzymes, Na/K pump, biological cell and its constituent.
CO5	Summarize structure and functions of proteins, enzymes, nucleic acids and cell membrane.
CO6	Express standard free energy change in biological reactions, hydrolysis of ATP and its synthesis.

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	1	3	0	1	2	1	2	3	
CO2	2	3	3	2	2	3	3	2	3	3	1	2	3	1	2	3
CO3	3	1	1	2	2	1	3	1	3	3	2	2	3	3	3	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	1	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 in homogenous and heterogeneous systems.

Unit II

42

Polydispersion-average molecular weight 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 T_m , melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, T_g . Relationship between T_m and T_g , 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. Otanbrite.
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	Get Knowledge about synthesis, properties and applications of different polymers
CO2	Understand about different types of mechanisms in polymerization processes.
CO3	Apply the importance of functionality of polymers in polymerization.

CO4	Analyze the properties of polymers with their structure.
CO5	Evaluate molecular weight of polymers by using different methods.
CO6	.Design the different type of polymeric products.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	3	1	1
CO4	3	2	1	2	3	1	3	1	3	3	1	2	3	1	1	1
CO5	1	1	3	1	3	2	3	2	3	3	1	2	3	1	1	2
CO6	3	1	1	2	1	1	1	1	3	3	1	2	3	2	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

Introduction: History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nucleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design and delivery systems, gene therapy and drug resistance.

Unit II

Classification: Drugs based on structure or pharmacological basis with examples, synthesis of important drugs such as α - methyl dopa, chloramphenicol, griseofulvin, cephalosporins and

44

nystatin. Molecular modelling, conformational analysis, qualitative and quantitative structure activity relationships.

Unit III

General introduction to antibiotics: Mechanism of action of lactam antibiotics and non lactam anti biotics, antiviral agents, chemistry, stereochemistry, biosynthesis and degradation of penicillins - An account of semisynthetic penicillins - acid resistant, penicillinase resistant and broad spectrum semisynthetic penicillins.

Unit IV

Elucidation of enzyme structure: Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors.

Unit V

Interactions of enzymes: DNA-protein interaction and DNA-drug interaction. Introduction to rational approach to drug design, physical and chemical factors associated with biological activities, mechanism of drug action.

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	Gain the knowledge of fundamentals of medicinal chemistry.
CO2	Understand 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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	3	1	3
CO3	3	1	3	3	1	1	3	1	3	3	3	2	3	1	2	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 isotachopheresis, 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 voltametry, amperometry

Text Books:

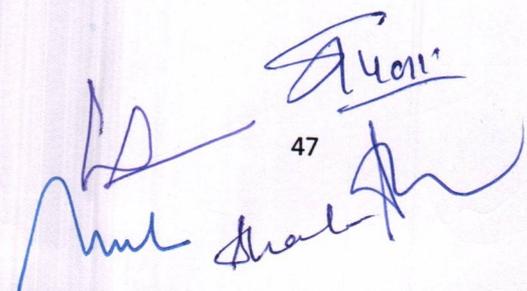
TB1. Principles of instrumental analysis by douglas a. skoog, f. james holler, stanley r. crouch, cengage learning.

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):



47

Upon successful completion of the course student will be able to

CO1	Gain Knowledge about theory, instrumentation and applications of different electroanalytical methods.
CO2	Differentiate between various electroanalytical techniques including cyclic voltametry, coulometry, polarography etc.
CO3	Determine morphology of materials using scanning electron microscopy and transmission electron microscopy
CO4	Illustrate the theories, instrumentation and applications of high performance liquid chromatography and gas chromatography.
CO5	Distinguish various types of thermal methods for characterization of different types of compounds.
CO6	Design various types of chromatography techniques.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	3	3	1	2	0	1	2	1
CO2	2	1	1	2	2	1	3	1	3	1	2	3	3
CO3	3	1	1	3	2	1	3	3	3	3	1	2	1
CO4	3	3	1	2	2	1	2	1	3	1	2	3	1
CO5	3	1	2	2	3	1	3	1	2	3	2	3	3
CO6	3	1	1	2	2	1	3	1	3	3	1	2	2

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.

ku

Am *Sh* *48* *Sh*

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, 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	Gain the knowledge of fundamentals of pesticide chemistry.
CO2	Understand 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	1	1	3
CO4	3	1	3	3	3	1	3	1	3	3	1	2	3	2	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

ke

W. S. Kar
M. S. Kar
 49

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 effects
Synthesis 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. Banthrophe 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	Get Knowledge about the terpenoids, alkaloids, pigments and prostaglandins.
CO2	Understand about the terpenoids, alkaloids, pigments and prostaglandins.
CO3	Apply various types of terpenoids, alkaloids, pigments and prostaglandins.
CO4	Analyze synthetic route of terpenoids, alkaloids, pigments and prostaglandins.
CO5	Distinguish different type reaction mechanism of terpenoids, alkaloids, pigments and prostaglandins synthesis.
CO6	Design various synthetic routes of terpenoids, alkaloids, pigments and prostaglandins.

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	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	3
CO6	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

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 for given 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO	PSO	PSO4
CO1	3	1	1	2	2	1	3	3	3	0	1	2	1	2	3	
CO2	3	3	1	3	1	1	3	2	1	3	2	3	3	2	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	1	2	3	1	3	1
CO6	3	1	1	3	2	2	2	2	3	3	2	2	2	1	3	2

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	Learn basics to identify 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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

54

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), class 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 ratio, correlation and regression, least 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, Arnold Publishers, 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	Give examples 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	3	1	3	1
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,

57

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	Get knowledge about the environment, its segments, and pollution.
CO2	Understand the composition of the environment and the pollutants present in it.
CO3	Explain the chemistry of water, soil and atmosphere.
CO4	Focus on environmental toxicology and environmental pollution.
CO5	To use practical approach for determination of different pollutants.
CO6	Generalize the concept of pollution.

CO- PSO-PO Mapping:

MSc Chemistry

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	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

Ke

Shabir
Shabir
 59
Shabir

SHRI GURU RAM RAI UNIVERSITY

PATEL NAGAR DEHRADUN, UTTARAKHAND

(Established under Shri Guru Ram Rai University Act No.3 of 2017)



SYLLABUS

Pre-Ph.D. Course Work (CHEMISTRY)

(w.e.f 2023 – 2024)

Ke
Shabir
3/7/23
Shabir

STUDY & EVALUATION SCHEME
Choice Based Credit System
Pre-PhD Chemistry

S. No.	Course Category	Course Code	Course Name	Periods				Subject Total
				L	T	P	C	
1	Core Paper	PRMC-101	Research Methodology	4	0	0	4	80
2	Core Paper	PRMC-102	Research and publication ethics	2	0	0	2	40
3	Core Paper	PCHC-103	Spectroscopy and Chromatographic Techniques	4	0	0	4	80
4	Elective Paper	PCHE 104	Advanced Environmental Science	4	0	0	4	80
5	Elective Paper	PCHE 105	Advances in corrosion chemistry	4	0	0	4	80
6	Elective Paper	PCHE 106	Chemistry of natural products and name reactions	4	0	0	4	80
7	Core Paper	PCHF 106	Field work (Seminar/ conference presentation/ review literature, journal club and other activities.)	0	2	2	4	80
Total							18	360

*Student will study any one elective subject

Kol

to
Shariq

Course code: PRMC 101				
Course Name: Research Methodology				
Semester /Year: I				
	L	T	P	C
	2	1	1	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objective:

The main purpose of the course is to familiarize students for meaningful knowledge for conducting quantitative and qualitative research methods. Students will gain knowledge in understanding design, methodology and technique, data management, presentation, and data analysis.

Unit 1- Concept & Types of Research

Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem –Research Design, Classification of Research, Pure and Applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/Study, Evaluation research/Studies, Action Research, Experimental Research, Analytical Study of Statistical Method, Historical Research. History and basic concepts (validity, reliability, objectivity and subjectivity) characteristics and format. Steps to better writing, flow method, organization of material and style.

Unit 2 - Methods Research

Surveys, Case Study, Field Studies General Survey of various Methods including Survey Method, Interdisciplinary Method, Case Study Method, Sampling Method, Statistical Method, Observation Method, Interview Method, Schedule Method, Questionnaire Method, Documentary Method, Library Method, Historical Method and Scientific Method. Characteristic Features of Scientific Method; Empirical Verifiable, Cumulative, Self - Correcting, Deterministic, Ethical & Ideological neutrality (Value Free), Statistical Generalizability.

Unit 3 - Data Collection and Data Analysis

Collection, Objectives and Classification of Data, Aims, Methods and Objects of Tabulation of Data, Forms and Processes of Interpretation and Presentation of Data. Primary, Secondary and Tertiary Data. Construction and adaptation of instruments, administration of questions and tests. Data organization in SPSS & Excel, Graphical representation of data. Definition and Aims of Content Analysis, Problems of Content Analysis, Computer and Content Analysis Discussion and Interpretation of results, Testing of Hypothesis: Logical and Statistical Techniques.

Unit 4 - Report Writing

Locating Information on a Topic of Interest, Acquiring Copies of Articles of Interest, The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables, Levels of Measurement, Various Paradigms, The Basic Format for a Research Report, Identification of the Parts of a Research Report, Citation and Referencing Styles, Essentials of Report Writing, Aids for Writing Good Research Report.

ke

Shah's

Text book:

1. Ganesan R, Research Methodology for Engineers, MJP Publishers, Chennai. 2011
2. C.R.Kothari, "Research Methodology", 5th edition, New Age Publication,
3. Cooper, "Business Research Methods", 9th edition, Tata McGraw hills publication

Reference books:

1. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
2. Bordens K.S. and Abbott, B.b.: Research Design and Methods, McGraw Hill, 2008.
3. Morris R Cohen: An Introduction to logic and Scientific Method (Allied Publishers) – P 197-222; 391-403

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	To develop understanding of the basic framework of research process.
CO2	To develop an understanding of various research designs and techniques
CO3	To identify various sources of information for literature review and data collection.
CO4	To develop an understanding of the ethical dimensions of conducting applied research
CO5	Appreciate the components of scholarly writing and evaluate its quality.
CO6	To create the research design and experimental approaches to conduct research.

[Handwritten signature]

[Handwritten signature]
[Handwritten signature]
[Handwritten signature]
[Handwritten signature]

Course code: PRMC 102				
Course Name: Research and Publication Ethics				
Semester /Year: I				
	L	T	P	C
	1	1	0	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objective:

The main aim of this course to convey the principles of ethical research. Students will gain the knowledge of hands-on experience to identify research misconduct and predatory publications.

Theory

•RPE 01 Philosophy and Ethics

1. Introduction to philosophy: definition, nature and scope, concept, branches.
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions.

•RPE 02 Scientific Conduct

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, and Plagiarism (FFP)
4. Redundant publication: duplicate and overlapping publication, salami slicing
5. Selective reporting and misrepresentation of data

• RPE 03 Publication Ethics

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals Practice

•RPE 04: Open Access Publishing

1. Open access publications and initiatives
2. SHERPA / ROMEO online resource to check publisher copyright and self-archiving policies
3. Software tools to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier journal Finder, Springer, Journal Suggester, etc.

• RPE 05: Publication Misconduct

Handwritten signatures and initials in blue ink at the bottom of the page.

A. Group Discussion

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad.

B. Software tools

- Use of plagiarism software like Turnitin, Urkund and other open source software tools.

• RPE 06: Databases and Research Metrics

A. Databases

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics

1. Impact factor of journal as per journal Citation report, SNP, SJR, IPP, Cite score
2. Metrics: h-index, g index, i10 index, altmetrics

Recommended Books:

Text book:

1. Todorovich M, Kurtz P, The Ethics of Teaching and Scientific Research, Sidney Hook.
2. Michael P Marder (2004) Research Methods for Science. Oxford Press
3. Murthy SN, Bhojanna U (2008) Business Research Methods Excel Books

Reference books:

1. Kambadur M K, Ghosh A, Singhvi A K, (2019) ETHICS in, Science Education, Research and Governance, Indian National Science Academy New Delhi, India
2. Erlbaum J LL, (2003) Ethics and Values in Industrial-Organizational Psychology.
3. Barbara H. S., Joan E. Sieber; Gary B. Melton Research Ethics: A Psychological Approach

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	To develop an understanding of research ethics, publications misconduct and plagiarism.
CO2	To develop Intellectual honesty and research integrity.
CO3	To identify various sources of information for data bases and research matrices.
CO4	To develop an understanding of Open access publications and initiatives.
CO5	Appreciate the components of scholarly writing and evaluate its quality.
CO6	To create the research matrices based on cite score.

Ka

Dr. Shalini
Sh

Course code: PCHC 103				
Course Name: Spectroscopy and Chromatographic Techniques				
Semester /Year: I				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objective:

This course aims to gain knowledge about chromatography and different spectroscopic techniques & its application in structural elucidation of organic compounds.

Unit I: Ultraviolet and visible spectrophotometry (UV-VIS)

Calculation of absorption maxima of dienes, dienones and polyenes, applications.

Unit II: Infrared Spectroscopy(IR)

Instrumentation, Sampling techniques, Selection rules, Molecular vibrations, absorption of common functional groups, factors affecting frequencies and applications.

Unit III: Nuclear Magnetic Resonance(NMR)

FT-NMR, Sample preparation applications of H-1 NMR, DEPT.C-13 NMR, HMQC, HMBC. COSY, NOESY.

Unit IV: Mass spectroscopy(MS)

Working of mass spectrometer(double beam) ,formation of different types of ions, Mclafferty rearrangement, fragmentation of alkanes, alkylaromatics,alcohols and ketones,simple applications.Simple structural problems.

Unit V: Atomic Absorption Spectroscopy

Introduction, Principle and Instrumentation.Single and double beam AAS,detection limit and sensitivity.Interference and applications.

Unit VI: Chromatographic Separation techniques

Column chromatography, HPTLC, Liquid Chromatography-HPLC,Ion chromatography
Planar Chromatography-TLC, Paper chromatography
Gas Chromatography-GC,GC-MS.

Recommended Books:

Text Books:

TB1. Spectrometric identification of organic compounds by Robert M Silverstein,
francis x webster, wiley.

TB2. Elementary organic spectroscopy principles and chemical applications by Y.R.Sharma, S Chand
Publishing

K

24/01/20
Sharma
Sharma

Reference Books:

RB1. Introduction to spectroscopy 5 th edition by Donald I Pavia, Gary M Lampman, George S Kriz, James A Vyvyan, Cengage Learning.

RB2. Separation chemistry by Budhiraja, R. P., New age international.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Get Knowledge of Nuclear Magnetic resonance spectroscopy of H^1 , C^{13} and Flourine ¹⁹ nuclei, its use in medical sciences and field of chemistry.
CO2	Apply theory of UV-VIS and IR spectroscopy to evaluate the structure of spectroscopy in organic compounds
CO3	Understand principle, theory and use of mass spectroscopy, chromatographic and radioactive technique.
CO4	Apply theory in structural elucidation of organic compounds.
CO5	Interpret results obtained from different analytical techniques
CO6	Solve the problems based on different analytical techniques

Ka

Shan
Shan
Shan

Course code: PCHE 104				
Course Name: Advanced Environmental Science				
Semester /Year: I				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objective:

The objective of this course is to gain knowledge about different segments of environment. It also gives an idea about energy conservation, pollutions, environmental biotechnology and management.

Unit I: Energy Resource and Conservation

Renewable and non-renewable energy resources, growing energy need, sun as a source of energy, solar radiation and its spectral characteristics, fossil fuels classification, composition. Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principles of generation and conservation of conventional and non-conventional energy, energy from biomass and biogas, anaerobic digestion, energy conservation policies, energy production and trade, energy balance, energy security and energy audit.

Unit II: Environmental Pollution and Chemistry

Concept and scope of environmental chemistry, composition and structure of atmosphere. Air pollution, effects of air pollutants of physico-chemical and biological properties of atmosphere. Water pollution, types and major sources of water pollutants, water quality parameters (physical, chemical and biological), significance of DO, BOD, COD. Waste Water Treatment. Composition of lithosphere/soil, organic and inorganic components in soil, acid-base and ion exchange reaction in soil, NPK in soil. Toxic chemicals in the environment, biochemical effects of pesticides. Sources and effects of noise pollution on health. Radioactive and thermal pollution sources and their effects, solid waste disposal and its effects on environment.

Unit III: Environmental Biotechnology

Concept, biotechnological approach of environmental pollution abatement, Air and Water pollution control through biotechnology, microbiology of wastewater treatment (aerobic and anaerobic), solid waste; sources and management (composting, vermicomposting and methane production), biotechnological approach of energy management (biomass, biogas, bioethanol), biofertilizer and biopesticide, bioremediation.

Unit IV: Environmental Management

Introduction and scope of environment management, Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS), scope and types of environmental audit, cost benefit analysis, environmental management plan (EMP), international organization for standardization (ISO), ISO 14000 standards and certification, environmental clearance for establishing industry, environmental safety, risk management and emergency preparedness, important dates dedicated to environmental management.

Kd
Am
gaur
gaur
Am

Pre Ph.D. Course Chemistry

Text Books:

- TB1. Environmental Chemistry :De A.K.;New Age International Publication.
TB2. Environmental Pollution,Sharma B.K.;Goel Publishing House Meerut.

Reference Books:

- RB1. Guideline Manual released by Ministry of Environment, Forest and Climate Change.
RB2. Environmental Biotechnology(Industrial Pollution Management), Jogdand S.N.;Himalaya Publishing House.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Describe different energy resources and the principle of conservation of energy
CO2	Understand the various types of pollution and their harmful effects on the environment.
CO3	Apply the biotechnological approach for the control of pollution and energy management
CO4	Understand the basic concepts of environmental management
CO5	Determine different parameters of water quality parameters.
CO6	Summarize different segments of environment and pollutants present in it.

Kal

Sharma
Anurag Shrivastava

Course code: PCHE 105				
Course Name: ADVANCES IN CORROSION CHEMISTRY				
Semester /Year: I				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objective:

The objective of this course is to gain knowledge about different segments of corrosion. It also gives an idea about corrosion, electrochemical studies, surface analysis and prevention techniques.

Unit I: Introduction of Corrosion

Definition and scope of corrosion, Direct chemical corrosion, Electrochemical corrosion and different mechanisms, Types of electrochemical corrosion-Galvanic and concentration cells, Types of electrochemical corrosion-Differential aeration corrosion, Water-line corrosion and Pitting corrosion, Type of electrochemical corrosion- Intergranular and Soil corrosion and factors affecting corrosion.

Unit II: EIS and polarization techniques

Electrode-electrolytes interfaces, double layer, electrode potential, reference electrode, three electrodes cell, supporting electrolyte, rate constant, EIS basics, electrical elements, differential impedance, differential impedance, time domains result, bode plane plots in EIS and polarization techniques.

Unit III: Corrosion and Material analysis

Data analysis, electrical equivalent circuits, choice of circuits, confidence interval, initial value, distinguishability, zeros and poles representation, charge transfer resistance and polarization resistance. Constant phase elements (CPE). XPS spectroscopy, SEM analysis, SEM-EDX, SEM-EDS, XRD, AFM spectroscopy. Quantum chemical calculation and Monte carlo method for corrosion study.

Unit IV: Corrosion Prevention Techniques

General method for corrosion prevention. Conditioning of environment to reduce corrosion. Basics and classification of corrosion Inhibitors. Mechanisms of corrosion inhibition. Techniques for evaluation of inhibition efficiency. Application of corrosion inhibitors for boiler corrosion, cooling water systems, reinforced concrete, chemical and petrochemical industries. Inhibitors for microbial corrosion. Organic paints and varnishes for corrosion prevention.

Handwritten signatures and initials in blue ink, including "Ka", "Shahin", and other illegible marks.

Pre Ph.D. Course Chemistry

Text Books:

TB1. M.G. Fontana: Corrosion Engineering, McGraw Hill International Book Co. London.

TB2. L.L. Shreir: Corrosion, Vol I and Vol II, Newness Butterworths, Edward Arnold Ltd, London.

Reference Books:

RB1. J.C. Scully: Fundamental of Corrosion, Pargmon Press Inc. New York,

RB2. V.S. Sastry: Corrosion Inhibitors, Principles & Applications, John Wiley & Sons.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Gain Knowledge about the basic concepts of Corrosion and material.
CO2	Understand the various types of corrosion and their harmful effects.
CO3	Explain the concept of the EIS and polarization techniques for measurement of corrosion inhibition efficiency.
CO4	Illustrate different type corrosion prevention techniques and their applications in the different areas.
CO5	Compare different type corrosion prevention techniques and their applications in the different areas.
CO6	Write about the EIS and polarization techniques.

Kd

Shreir
Shreir
Shreir

Course code: PCHE 106				
Course Name: CHEMISTRY OF NATURAL PRODUCTS AND NAME REACTIONS				
Semester /Year: I				
	L	T	P	C
	4	-	-	4

L - Lecture T - Tutorial P - Practical C - Credit

Course Objective:

The objective of this course is to gain knowledge about different segments of natural products. It also gives an idea about secondary metabolized, hetrocyclic compounds and name reactions.

Unit I: Carbohydrate:

Sucrose, lactose, polysaccharides, starch. Glycosides arbutin ,amygdaline.

Unit II: Alkaloids

Isolation & purification. General methods of structure determination. Structural elucidation of atropine, quinine, Nicotine

Unit III: Steroids

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

Unit IV: Terpenoids and plant pigments

General introduction, isolation, purification.

Unit V: Heterocyclic Compounds

Pyridine, pyrimidine, Quinilene.

Unit VI: Name Reactions

Beckmann rearrangement, Hofmann, Curtius reaction, Schmidt Reaction, Claisen's Condensation, Wittig Reaction, Oppenauer oxidation, Meerwein Ponderoff Valery Reduction, Birch Reduction, Clemmensen reduction, Wolf Kishner's Reduction, Michael's Condensation,.

Recommended Books:**Text Books:**

Ka

Dr. Arun
Dr. Shalini

TB1. I.L. Finar, Organic chemistry, Vol. II, 1st Indian ed., Pearson Education Pte Ltd Indian Branch, Delhi, 2002.

TB2. Heterocyclic Chemistry Vol. 1 & 2, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag

Reference Books:

RB1. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon

RB2. Natural Products: Chemistry and Biological Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Bantrophe and J.B. Harborne, Longman, Essex.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Describe different types of isolated natural products form plant extract.
CO2	Understand the various types of phytochemicals and structural features of biomolecules, including terpenoids, alkaloids, steroids and plant pigments.
CO3	Learn synthesis, reactions and medical applications of Pyridine, pyrimidine, and Quinilene.
CO4	Learn about different type of name reactions and rearrangements.
CO5	Compare structural differences of natural produts.
CO6	Summarize chemistry of different natural products.

pd

Sharma
Sharma
me