GLA UNIVERSITY
MATHURA
Established vide U.P. Act 21 of 2010.

Course Curriculum

M.Sc. Chemistry

Session: 2020-2022

[DEPARTMENT OF CHEMISTRY]

[Institute of Applied Sciences & Humanities]

COURSE STRUCTURE

First Semester

S. No.	Code	Subject	L-T-P	Credits
1.	MCHC0101	Inorganic Chemistry -I	3-2-0	4
2.	MCHC0102	Organic Chemistry-I	3-2-0	4
3.	MCHC0103	Physical Chemistry-I	3-2-0	4
4.	MCHC0104	Analytical Chemistry	3-2-0	4
5.	MMAS0502 MCHS0101	(a) Mathematics for Chemists (GE1) (b) Biology for Chemists(GE1)	2-0-0	2
6.	BCSO00005	Fundamentals of Computer (GE2)	2-0-0	2
PRACTICALS				
7.	BCSO00074	Fundamentals of Computer Lab (GE2)	0-0-2	1
8.	MCHC0801	Advanced Chemistry Lab	0-0-4	2
			18-0-6	23

Second Semester

S. No.	Code	Subject	L-T-P	Credits
1.	MCHC0201	Inorganic Chemistry-II	3-2-0	4
2.	MCHC0202	Organic Chemistry-II	3-2-0	4
3.	MCHC0203	Physical Chemistry-II	3-2-0	4
4.	MCHC0204	Spectroscopy-I	3-2-0	4
PRACTICALS				
5.	MCHC0802	Physical Chemistry Lab	0-0-4	2
6.	MCHC0803	Inorganic Chemistry Lab-I	0-0-4	2
7.	MCHC0804	Organic Chemistry Lab-I	0-0-4	2
			16-0-12	22

Third Semester

S. No.	Code	Subject	L-T-P	Credits
1.	MCHC0301	Spectroscopy- II	3-2-0	4
2.	MCHC0302	Nano Science and Nanotechnology	3-2-0	4
3.	MCHC0303	Heterocyclic Chemistry	3-2-0	4
4.	MCHE0316	Corrosion Chemistry	3-2-0	4
PRACTICALS				
5.	MCHC0805	Inorganic Chemistry Lab-II	0-0-4	2
6.	MCHC0806	Organic Chemistry Lab-II	0-0-4	2
7.	MCHJ0960	Graduate Seminar (AEC-1)	0-0-2	2
			16-0-8	22

Fourth Semester

S. No.	Code	Subject	-T-P	Credits
1.	MCHC0401	Polymer Chemistry	3-2-0	4
2.	MCHC0402	Environmental and Green Chemistry	3-2-0	4
3.	MCHE0401	Chemistry of Selected Natural Products	3-2-0	4
4.	MCHE0402	Methods in Organic Synthesis	3-2-0	4
PROJECT				
5.	MCHJ0971	Dissertation	0-0-8	8
				24

Course Structure

Semester	Core Courses			Discipline Specific Elective			Open elective courses			Total Credits
	No. of papers	Credits (L+T/P)	Total credits	No. of papers	Credits (L+T/P)	Total credits	No. of papers	Credits (L+T/P)	Total credits	
I	4	16+2(P)	18	0	0	0	2	4+1	5	**23**
II	4	16+6(P)	22	0	0	0	0	0	0	**22**
III	3	12+4(P)	16	1	4	4		2(P)	2	**22**
IV	2	8	8	2	8+8(P)	16	0	0		**24**
Total credits for the course			**64**			**20**			**7**	**91**

Semester	Core Course (C)	Ability Enhancement Compulsory Course (AECC)	Ability Enhancement Elective Course (AEEC) (2) + Lab (1) (Skill Based)	Elective: Discipline Specific DSE	Elective: Generic (GE)
I	Inorganic Chemistry-I Organic Chemistry-I Physical Chemistry-I Analytical Chemistry Advanced Chemistry Lab		**Fundamentals of Computer SEC-1:** Theory (2) + Lab (1)		**Mathematics for Chemists (GE-1)** for PCB students at UG level **Biology for Chemists (GE-2)** for PCM students at UG level
II	Inorganic Chemistry-II Organic Chemistry-II Physical Chemistry-II Spectroscopy-I Inorganic Chemistry Lab-1 Organic Chemistry Lab-1 Physical Chemistry Lab				
III	Spectroscopy –II Nano Science and Nanotechnology Heterocyclic Chemistry Inorganic Chemistry Lab-2 Organic Chemistry Lab-2	**Graduate Seminar (AEC-1)**		**DSE-1**	
IV	Polymer Chemistry Environmental & Green Chemistry	**Dissertation (AEC-2)**		**DSE-2** **DSE-3**	

Core Courses (C)

S. No.	Course Name	Code	L-T-P	Credit	Min. Contact Hrs.
1.	Inorganic Chemistry-I	MCHC0101	3-2-0	4	48
2.	Organic Chemistry-I	MCHC0102	3-2-0	4	48
3.	Physical Chemistry-I	MCHC0103	3-2-0	4	48
4.	Analytical Chemistry	MCHC0104	3-2-0	4	48
5.	Inorganic Chemistry-II	MCHC0201	3-2-0	4	48
6.	Organic Chemistry-II	MCHC0202	3-2-0	4	48
7.	Physical Chemistry-II	MCHC0203	3-2-0	4	48
8.	Spectroscopy-I	MCHC0204	3-2-0	4	48
9.	Spectroscopy –II	MCHC0301	3-2-0	4	48
10.	Nano Science and Nanotechnology	MCHC0302	3-2-0	4	48
11.	Heterocyclic Chemistry	MCHC0303	3-2-0	4	48
12.	Polymer Chemistry	MCHC0401	3-2-0	4	48
13.	Environmental and Green Chemistry	MCHC0402	3-2-0	4	48
14.				52	

Core Courses Lab

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
1.	Advanced Chemistry Lab	MCHC0801	0-0-4	2	30
2.	Physical Chemistry Lab	MCHC0802	0-0-4	2	30
3.	Inorganic Chemistry Lab-1	MCHC0803	0-0-4	2	30
4.	Organic Chemistry Lab-1	MCHC0804	0-0-4	2	30
5.	Inorganic Chemistry Lab-2	MCHC0805	0-0-4	2	30
6.	Organic Chemistry Lab-2	MCHC0806	0-0-4	2	30
7.				12	

Discipline Specific Elective Papers: DSE

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
SEM III					
1	Bioinorganic Chemistry	MCHE0301	3-2-0	4	48
2	Chemistry of Biological Components	MCHE0302	3-2-0	4	48
3	Corrosion Chemistry	MCHE0316	3-2-0	4	48
4	Food Science and biotechnology	MCHE0304	3-2-0	4	48
5	Fertilizers, Cement, Ceramic, Glass and paint	MCHE0305	3-2-0	4	48
SEM IV					
6	Chemistry of Selected Natural Products	MCHE0401	3-2-0	4	48
7	Methods in Organic Synthesis	MCHE0402	3-2-0	4	48
8	Pharmaceutical Chemistry	MCHE0403	3-2-0	4	48
9	Chemical, Electrochemical cells and Biosensor	MCHE0404	3-2-0	4	48
10	Chemical Sugar and Pulp Industry	MCHE0405	3-2-0	4	48
11	Petroleum Chemistry and agrochemicals	MCHE0406	3-2-0	4	48
12	Soil and Water chemistry	MCHE0407	3-2-0	4	48
13	Material Science	MCHE0408	3-2-0	4	48

Discipline Specific Lab

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
1	Dissertation	MCHJ0971		8	

General Elective (Other Discipline) GE

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
1.	Mathematics for Chemists	MMAS0502	2-0-0	2	30
2.	Biology for Chemists	MCHS0101	2-0-0	2	30

Skill Enhancement Courses (SEC)

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
1.	Fundamentals of Computer	BCSO0005	2-0-0	2	24
2.	Fundamentals of Computer Lab	BCSO0074	0-0-2	1	24

Ability Enhancement Compulsory (AEC)

S. No.	Course Name	Code	L-T-P	Credit	Contact Hrs.
1	Graduate seminar	MCHJ0960		2	

PROGRAMME SPECIFIC OBJECTIVES (PSOS)

1. To provide a broad foundation in Chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.

2. To make the Department a growing center of excellence in teaching, cutting-edge research, curriculum development and popularizing Chemistry.

3. To provide students with the skills required to succeed in M.Sc. the Chemical industry or professional school.

4. To make international collaborations for students and faculty exchange and research cooperation.

5. The Department would like to attain worldwide recognition in Chemistry research and teaching.

6. To expose the students to a breadth of experimental techniques using modern instrumentation.

7. The Department also endeavors to contribute to industry and address problems of societal importance.

8. The Department also aims at Chemistry outreach in the form of books, online courses, and other Chemistry education activities that showcase the role of Chemistry as a central science.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

At the completion of the M.Sc. Chemistry program, the students of our Department will be able to:

1. Work in the interdisciplinary and multidisciplinary areas of chemical sciences and its applications.

2. Apply green/sustainable chemistry approach towards planning and execution of research in frontier areas of chemical sciences.

3. Have sound knowledge about the fundamentals and applications of chemical and scientific theories.

4. Helps in understanding the causes of environmental pollution and can open up new methods for environmental pollution control.

5. Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.

6. Learns about the potential uses of analytical industrial chemistry, medicinal chemistry inorganic and green chemistry.

7. Understands the background of organic reaction mechanisms, complex chemical structures, and instrumental method of chemical analysis, molecular rearrangements and separation techniques.

8. Discipline specific competitive exams conducted by CSIR, IITs, Govt. Sectors, PSUs and service commission

DETAILED SYLLABUS

MCHC0101 INORGANIC CHEMISTRY-I

Course Objectives: To provide better and deeper understanding of chemical bonding, importance of symmetry and group theory, properties of main group elements, Lanthanides, actinides, bioinorganic chemistry and inorganic cages/clusters.

Credit: 4 **Semester-I** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Chemical Bonding** Basic principles of bonding - covalent, ionic and metallic bonds, lattice energy, VSEPR theory, dπ – pπ bonds, theory of hybridization. LCAO method, σ, π and δ molecular orbitals, MO diagram of heteronuclear diatomic and triatomic molecules. **HSAB concept and non aqueous solvents**: Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications of HSAB concept. Acid-base concept in non-aqueous media, reactions in non-aqueous solvents (ammonia, sulphuric acid), super acid and super bases. **Chemistry of Main group elements** Structure and bonding in boranes, carboranes, metallo carboranes, Wades rules, borazines, phosphazenes, S, N- compounds. Silicates- Classification, structures, isomorphous replacement, pyroxenes, layered and vitreous silicates, zeolites and molecular sieves. **Chemistry of d and f block elements** Electronic configuration, oxidation states; aqueous, redox and complex chemistry, spectral and magnetic properties of compounds in different oxidation states, horizontal and vertical trends in respect of 3d, 4d, and 5d elements with references to Ti-Zr- Hf , Cr- Mo- W, Mn- Tc-Re and Pt group metals	30

II	**Lanthanide and Actinide Elements**; Nuclear stability, terrestrial abundance and distribution, relativistic effect, electronic configuration, oxidation states, aqueous-, redox and complex- chemistry; electronic spectra and magnetic properties. lanthanide and actinide contractions and their consequences. **Group Theory** Molecular symmetry, elements of symmetry and symmetry operations, products of operation, point group, classification of molecules into point group, reducible and irreducible representations, orthogonality theorem, character theorem, symmetry aspects of molecular orbitals. **Bioinorganic Chemistry** Scope, inorganic elements in biological systems, basic bioenergetics and active transport of cations across membranes, Na+ / K+ pump. Metallo-enzymes. **Metallic Clusters** M-M bond and metal atom clusters, halide clusters, Metal carbonyl clusters, sandwich compounds. Metal carbenes, higher boranes, carboranes, metallobranes and metallocarboranes,	30

Course outcome: After learning this course the students will be able to:

i. Understand, explain/describe/rationalize molecular structure and bonding using group theory, inorganic cages and clusters.

Text Book(s)

1. J. D. Lee, Concise Inorganic Chemistry, 4th edition, ELBS.
2. F. A. Cotton, R.G. Wilkinson, Advanced Inorganic Chemistry, 6th edition, John-Wiley & Sons, 1999.
3. Puri, Sharma and Kalia

Reference Book(s)

1. J. E. Huheey, E. A. Keiter and R. L., Keite, Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Harper Collins 1993.
2. B. E. Douglas, D. H., McDaniel and J. J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley, 1993,
3. S. F. A. Kettle , Physical Inorganic Chemistry: A Coordination Chemistry Approach, Spektrum, 1996
4. Huheey, E. James, Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Harper Collins College, 1993.
5. N.N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd edition, Butterworth-Heinemann, A division of Read Educational & Professional Publishing Ltd., 2001.
6. B.N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd. New Delhi, 1976.

7. J.L. Stephen and M.B. Jeremy, Principles of Bioinorganic Chemistry, 2nd Edition, Panima Publishing Corporation, 2005.
8. Williams, An Introduction to Bioinorganic Chemistry
9. DC Harris and MD Bertolucci, Symmetry and Spectroscopy, Dover Publications, 1989.
10. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International, 2007.

MCHC0102 ORGANIC CHEMISTRY-I

Course objective: To introduce and develop the conceptual organic chemistry, chemical bonding, aromaticity, stereochemistry of organic molecules. Also to give deeper insight the application of name reactions in the formation of carbon-carbon bond, carbon-heteroatom bond and reaction mechanisms for it.

Credit: 4 **Semester-I** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Bonding, Nomenclature and Aromaticity** Delocalized chemical bonding, conjugation, Cross conjugation, resonance, hyper conjugation, tautomerism, aromaticity in benzenoid and nonbenzenoid compounds. alternant and non alternant hydrocarbons, Huckel's rule. annulenes, anti aromaticity, aromaticity, Homo aromaticity, bonds weaker than covalent, addition compound, crown ether complexes and cryptands, Inclusion compound, cyclo dextrins, Catenanes & rotaxanes. **Stability and Reactivity of Reaction Intermediates** Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. **Stereochemistry:** Conformational analysis of cycloalkanes, effect of conformation on reactivity. elements of symmetry, chirality, R-S nomenclature, diastereoisomerism in acyclic and cyclic systems, E-Z isomerisms, interconversion of Fischer, Newman and Sawhorse projections, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape, stereochemistry of the compounds containing nitrogen, sulphur and phosphorus, asymmetric synthesis.	30

II	**Structure and Reactivity** Resonance and field effects, steric effect, quantitative treatment: Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation, methods of determining reaction mechanism. **Addition to Carbon-Carbon Multiple Bonds** Mechanistic and stereochemical aspects of addition reaction 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 ring. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation. **Addition to Carbon-Heteroatom Multiple Bonds** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles. Addition of grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin, Robinson annulations, Dickmann, Hofmann-Loffler-Freytag, Stork-enamine Shapiro and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.	30

Course outcome: After learning this course the students will be able to:

i. Explain/demonstrate the unique features of organic reactions and its mechanism of carbon hetero and carbon carbon bond formation, stereochemistry,
ii. Identify and analyze the factors influencing the bond formation
iii. Apply the concept to solve related problems.

Text Book(s)

1. T. W. G. Solomons and C. B. Fryhle, *Organic Chemistry*, 9th edition, Wilely India Pvt. Ltd., 2009
2. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th edition, Pearson Com., 1992

Reference Book(s)

1. P. Volhardt and N. Schore, *Organic Chemistry: Structure and Function*, 5th edition, W. H Freeman & Co, 2006
2. L. G. Wade, *Organic Chemistry*, Pearson Education 6th edition, 2006.
3. R.M. Silverstein and F.X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th edition, Wiley Inc.
4. J. March, *Advanced Organic Chemistry*, John Wiley & Sons, 1992.
5. E. J. Eliel, *Stereochemistry of Carbon Compounds*, McGraw Hill.
6. S. H. Pine, *Organic Chemistry*, McGraw Hill, 1987.
7. D. Nasipuri, *Stereochemistry of Organic Compounds*, Wiley, 1994.
8. P. Sykes, *A Guide Book to mechanism in Organic Chemistry*, 6th edition, Longman, 1989.

9. P.S. Kalsi, *Organic Reactions and their Mechanisms*, 2nd edition, New Age International Publishers, 2000.
10. S.M. Mukherji, S.P. Singh, *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.
11. P.S. Kalsi, *Stereochemistry of Organic Compounds*, 2nd edition, New Age International, 1993.
12. W. Carruthers, *Modern Methods of Organic Synthesis*, 4th Edition Cambridge University Press, 2007.
13. C. K. Ingold, *Structure and mechanism of Organic Chemistry*,, Cornell University Press, 1999.
14. H. O. House, Modern Organic Reactions, , Benjamin, (1972).

MCHC0103 PHYSICAL CHEMISTRY-I

Course objective: To introduce to quantum mechanics, fundamentals of chemical kinetics and electro chemistry.

Credit: 4 **Semester-I** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Chemical Kinetics** Methods of determining rate laws, collision theory of reaction rates, steric factor, Arrhenius equation and activated complex theory, kinetic and thermodynamic control of reactions, ionic reactions, kinetic salt effects, steady state kinetics, unimolecular reactions and their treatments (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theory), Complex reactions (composite reactions, chain reactions), photochemical reactions, homogeneous catalysis, enzyme kinetics, effects of enzyme concentration, pH, temperature, activators and inhibitors on enzyme activity, studies of fast reactions by flow method, relaxation method, flash photolysis. **Electrochemistry** Debye-Huckel-theory and its applications, Electrolytic conductivity and the Debye-Hückel-Onsangar treatment, electrified interfaces, Electrochemical cells, Nernst equation, concentration cells with and without liquid junction, reversible and irreversible electrode, electrolysis and over-voltage, corrosion, electro-chemical sensors (glucose meter etc).	30
II	**Quantum Mechanics** Introduction to quantum mechanics, Schrödinger wave equation, eigen functions and eigen values, physical interpretation of wave function, concepts of operators: Laplacian, Hamiltonian, Linear and Hermition operators, angular momentum operators and their properties, commutation of operators, normalization, orthogonality and orthonormality of wave functions, average (expectation) values, postulates of quantum mechanics, solutions of Schrödinger wave equation for a free particle, particle in a ring, particle in a three dimensional box, application of Schrödinger equation to harmonic oscillator, rigid rotator, eigen functions and eigen values of angular	30

	momentum, Ladder operator method for angular momentum.	

Course outcomes: After learning this course the students will be able to:

i. Understand and evaluate quantum mechanics
ii. Analyze the fundamentals of chemical kinetics and electrochemistry and apply the concepts to solving problems

Text Book(s)

1. P. Atkins and J. Paula, *Atkins' Physical Chemistry*, Oxford University Press, 8th edition,2006.
2. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, New Delhi, 5th edition, 1992.
3. B. R. Puri, L.R. Sharma, and M.S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 45th edition, 2011.

Reference Book(s)

1. F. L. Pilar, *Elementary Quantum Chemistry*, Dover Publications, Inc. NY, 2nd edition.
2. A.K. Chandra, *Introductions to Quantum Chemistry*, Tata McGraw Hill, 4th edition, 1994.
3. D.R. Crow, *Principles and Applications of Electrochemistry*, Chapman and Hall, London,4th edition, 1994.
4. J.W. Moore, R.G. Pearson, *Kinetics and Mechanism*, John Wiley and Sons, 2nd edition, 1981.
5. J.O'M. Bockris and A. K. N. Reddy, *Modern Electrochemistry*, Plenum Press, New York, Vol. 2 A & B, 2nd edition, 1998.
6. K. J. Laidler, *Chemical Kinetics*, Harper & Row, New York, , 1987.
7. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 5th edition
8. K. L. Kapoor, *A Text Book of Physical Chemistry*, Macmillan India Ltd, Volumes 2 and 5, 3rd Edition 2004.

MCHC0104 ANALYTICAL CHEMISTRY

Course objective: To introduce concepts of various analytical and separation techniques.

Credit: 4 **Semester-I** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	Accuracy, precision, sensitivity, specificity, standard deviation, classification of errors and their minimization, significant figures, criteria for rejection of data, Q-test, T-test and F-test, control chart, sampling methods, sampling error, **Radiochemical methods** Tracers in chemical analysis, isotopic exchange, isotopic dilution technique, labeling experiments in studying reaction mechanism. **Thermoanalytical and Electroanalytical Methods** Theory, methodology and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC). principles, techniques and applications of thermometric titration methods,	30
II	**Electrochemical methods:** Coulometry, Polarography, anode-stripping voltammetry, pulse techniques, cyclic voltammetry, electrogravimetry, spectroelectrochemistry. ameperometric and bioamperometric titrations **Separation Techniques** Solvent extraction: partition law and its limitations, distribution ratio, separation factor, factor influencing extraction, principle of chromatography, classifications of chromatography, techniques of planar and column chromatography, gas chromatography, high-performance liquid chromatography.	30

Course Outcome: After learning this course the students will be able to:

1. Analyze data handling/ statistical treatment of data.
2. Analyze and compute the data obtained from Potentiometric, Coulometric, and Voltametric methods of analysis.
3. Apply the chromatographic techniques in separation of compounds from mixture applications

Text Book(s)

1. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, John Wiley, New York, 2nd edition, 1976.
2. G. D. Christian, *Analytical Chemistry*, John Wiley & Sons, New York, 5th edition, 1994.
3. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Analytical Chemistry - An Introduction*, Saunders College Publishing, Philadelphia, London, 7th edition 2000.
4. J. H. Kennedy, *Analytical Chemistry: Principles*, Saunders Holt, London, 2nd edition, 1990.
5. Ewing G.W, *Instrumental Methods of Chemical Analysis*, McGraw Hill, 5th edition.
6. Day and Underwood, *Quantitative Analysis*, PHI, 6th Edition, 2009.
7. David Harvey, *Modern Analytical Chemistry*, McGraw Hill, 2000.

Reference books

1. G. D. Christian, *Analytical Chemistry*, John – Wiley and Sons Inc., 5th edition, 1994.
2. H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Set, *Instrumental methods of Analysis.* CBS Publishers, 1996.
3. G. W. Ewing, *Instrumental methods of Chemical Analysis*, McGraw-Hill, New
4. York, 5th edition, 1988.
5. A.J. Bard & l. R. Faulkner, *Electrochemical methods*, Wiley, New York, 2nd edition, 2000.
6. Ed., Jeffery et., *Vogel's text book of Quantitative Chemical analysis* 5th edition, al ELBS/Longman, 1989.

MCHS0101 BIOLOGY FOR CHEMISTS

Course Objective: To introduce structure of cell, and understanding the function and organization of various bio-molecules present in the living cell.

Credit: 2 **Semester-I** **L-T-P: 2-0-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Cell structure and function** Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells, overview of metabolic processes-catabolism and anabolism, ATP- the biological energy currency, origin of life- unique properties of carbon, chemical evolution and rise of living systems, introduction to biomolecules, building blocks of bio-macromolecules. **Carbohydrates** Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinosital, amino sugars, N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides, structural polysaccharides-cellulose and chitin, storage of polysaccharides-starch and glycogen, structure and biological functions of glucosaminoglycans or mucopolysaccharides, carbohydrates of glycoproteins and glycolipids, role of sugars in biological recognition, blood group substances, ascorbic acid, carbohydrate metabolism-Krebs' cycle, glycolysis, glycogenesis and glycogenolysis, gluconneogenesis, pentose phosphate pathway.	15
II	**Proteins** Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing, secondary structure of proteins, forces responsible for holding of secondary structures, a-helix, b-sheets, super secondary structure, triple helix structure of collagen, tertiary structure of protein-folding and domain structure, quaternary structure, amino acid metabolismdegradation and biosynthesis of amino acids, sequence determination: **Lipids** Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophopholipids, sphingolipids, cholesterol, bile	15

	acids, prostaglandins, lipoproteins-composition and function, role in atherosclerosis, bilayers, liposomes and their possible biological functions, biological membranes, fluid mosaic model of membrane structure, lipid metabolism-b-oxidation of fatty acids. **Nucleic acids** Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding, structure of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids, the chemical basis for heredity, an overview of replication of DNA, transcription, transpation and genetic code, chemical synthesis of mono and tri nucleosides.	

Course Outcome: After learning this course the students will be able to:

i. Molecular structure of carbohydrates, proteins, DNA, RNA, Carbohydrates, Lipids nucleic acids and Vitamins.

ii. Compute the organization and working of various components present in living cell.

Text books

1. J. D. Rawn, *Biochemistry*, Neil Patterson.
2. Voet, Voet *Biochemistry*, John Wiley.
3. E.E. Conn, P.K. Stumpf, *Outlines of Biochemistry*, John Wiley.

Reference Book(s)

1. A.L. Lehninger, *Principles of Biochemistry*, Worth Publishers.
2. L. Stryer, L. *Biochemistry*, W.H. Freeman.

MMAS 0502: MATHEMATICS FOR CHEMISTS

Course Objectives: To make the students understand the concepts of algebra, calculus and statistics by giving more emphasis to their applications in the field of chemistry.

Credits: 02 **Semester I** **L–T–P: 2–0–0**

Module No.	Contents	Teaching Hours (Approx.)
I	**Algebra:** Introduction to matrices, Determinant, Adjoint and Inverse of a matrix, Elementary operations, Rank of a matrix by Echelon form, Solution of system of linear equations by rank test and Cramer's rule, Revision of vector products, Point functions, Gradient, Divergence and Curl.	10
II	**Calculus:** Differentiation and integration of standard functions, Product, quotient and chain rules for differentiation, Extrema of functions of one variable, Integration by substitution, by parts and by partial fraction, Definite integral and its properties. Simple applications.	10
III	**Statistics:** Measures of central tendency and dispersion, Correlation and Regression, Fitting of straight line by method of least squares. Introduction to probability, Binomial and Poisson distributions.	10

Learning Outcomes:

After studying these topics, the student will be able to

- Understand differentiation and integration
- Find rank of a matrix & its applications in solving systems of linear equations
- Calculate the measures of central tendency and dispersion
- Find the gradient of a scalar point function and divergence, curl of a vector field

Text Books:

- M. Goyal and N. P. Bali, A Text Book of Engineering Mathematics, Laxmi Pub., Delhi, 2014.
- Mathematics books for Class XI & XII, NCERT Publications

Reference Books:

- P. Gupta, Comprehensive Mathematics (for Class XI & XII), Laxmi Pub. (P) Ltd. Delhi.
- S. C. Gupta and V. K. Kapoor, Fundamentals of Statistics, Sultan Chand & Sons, Delhi, 2014.

BCSO0005: FUNDAMENTALS OF COMPUTER

(Open Elective)

Objective: *This course on fundamental of computers and data handling would ensure that the students get first-hand exposure to the fundamentals of computers and get acquainted with handling of the same.*

Credits: 02 **Semester I** **L–T–P: 2–0–0**

Module No.	Content	Teaching Hours
I.	**Computer fundamentals:** Definition of computer, characteristics of computer, generation of computers, classification of computers, block diagram of computers. **Software and hardware:** Application and system software, Hardware-I/O devices, CPU components, storage devices. **Understanding of Word processor:** Opening and closing of word document, text creation and manipulation, formatting of text, table handling, spell check, printing of word document.	9
II.	**Number System:** Bit, Byte, Binary, Decimal, Hexadecimal and Octal number systems and their inter-conversions. **Translator:** Assembler, compiler, interpreter, linker and loader **Introduction to Operating system:** definition, functions, CUI and GUI based operating systems. **Introduction to spreadsheet:** manipulation of cells, formulas and functions, printing of spreadsheet.	9
III.	**Introduction to Computer Network:** definition, advantages, network topologies, communication media. **Making Presentation:** creating presentation, preparation of slides, slide show, taking printouts of presentation. **Internet and its applications:** E-mail-sending and receiving emails, file attaching with email, WWW, web browsers, search engine, internet and applications. **Cybercrime:** Introduction and its types.	8

Course outcome: *After completion of course, student will be able to:*

- Familiar with the basic knowledge of computer.
- Able to use M.S. Office (M.S. Word, M.S. Power point, M.S. Excel and M.S. Access) and Internet efficiently.

Text Book:

1. P.K. Sinha, (2008), "Computer fundamentals", BPB Publisher, New Delhi, 4th edition.

Reference Books:

1. Anita Goel, "Computer fundamentals", Pearson Education.
2. Peter Nortron, "Inside PC", TMH, New Delhi.
3. Alexis Leon, Methews Leon, (1999), "Fundamentals of Information Technology", Vikas Publishing, New Delhi.

BCSO0074: FUNDAMENTALS OF COMPUTER LAB

(Open Elective)

Objective: To provide hands-on experience in Microsoft Office tools.

Credits: 01 **Semester I** **L–T–P: 0–0–2**

Module No.	Content	Lab Hours
I+II	**Word Processing (MS Word)** • **Introduction to MS Word:** Menu Bar, Menus, Submenus, Tool Bar, Tools, Customizing Toolbar, Hiding Toolbar etc., Creating and Saving Documents, Working with an Existing Document, Auto Text, Auto Complete and Auto Correct. • **Formatting a Document:** Change the Appearance of Text & Paragraph, Copy, Paste and Paste Special Functions, Creating and Modifying a List, Page Break Options and Orientation, Changing the Look of Documents with Styles. • **Using Tables and Columns:** Table Creation and Modification Giving Stress to Auto-Fit, Auto-Format and Table Sort. Working with Data in Table Giving Stress to Formulas, Presenting Text in Columns, Object Linking and Embedding, Inserting and Sizing Graphics, Hyperlink Envelopes & Label Creation, Grammar & Spell Check, Previewing and Printing Documents. **MS Excel** • **Introduction to Electronic Spreadsheet and Microsoft Excel:** Creating and Formatting a Worksheet, Features of Excel, Inserting and Formatting Data in a Worksheet, Working with an Existing Data List, Auto Fill, Fill Series and Auto - complete Options, Formatting Cells; Sorting & Filtering Data, Conditional Formatting, Formulas and Functions (Details Usage of Important Data Functions Like Sum, If, Average etc.); Interlinking Worksheets and Files, Setting Filters and Performing Calculations on Filtered Data etc **Presentation (Power Point Presentation)** • **Introduction to Power Point:** Creating A Presentation: Features of Power Point - Editing Master Slides, Viewing and Editing a Presentation, Inserting, Sorting, Hiding and Deleting Slides, Inserting Pictures. Clip Art and Movies in a Slide: Creating and Enhancing a Table, Slide Layouts, Modifying the Slides and Title Master, Adding Transition and Animation Effect, Hyper Linking Slides & Files • **Internet and its applications:** E-mail-sending and receiving emails, file attaching with email.	24

Course Outcome: After completion of Lab, student will be able to:

- Effectively use Microsoft Office tools such as MS Word, MS Excel and Power Point Presentation.

MCHC0801 ADVANCED CHEMISTRY LAB

Course Objective: To develop experimental skills of various separation and purification techniques, synthesis of smaller molecules, apply the concepts learnt about complexometric titrations and to optimize errors arising from various sources in titrimetric estimations, quantitative determination of viscosity, pH values and rate constant of a chemical reaction.

Credit: 2 **Semester I** **L-T-P: 0-0-4**

Module No.	Content	Teaching Hours (Approx.)
I+II	**Organic Chemistry** 1. Estimations of organic functional groups, e.g.: (i) glucose (ii) phenol (iii) glycine etc. 2. To determine corrected melting points of an unknown organic compound (calibration of thermometer). 3. Dibenzal acetone from benzaldehyde (Claisen-Schmidt reaction). 4. Nitration of nitro benzene and its reaction to M-nitro aniline 5. Acetanilide, bromoacetanilide, bromoaniline from aniline 6. Synthesis of methyl orange or methyl red. **Inorganic Chemistry** 7. Semi-micro qualitative analysis involving 4 radicals including interfering radicals. 8. Estimation of metal ions by gravimetric-cum-volumetric analysis (iii) Ba(II) gravimetrically and Ca(II) volumetrically. 9. Synthesis of simple coordination compounds: Chrome alum, tetraamine copper(II) sulphate. 10. Analysis of two cation-system using EDTA. 11. Conductometric titration of a weak acid with strong base. **Physical Chemistry** 12. Determination of pk_1 and pk_2 of dibasic acids. 13. Kinetics of saponification of an ester. 14. Determination of the equilibrium constant for $Kl + I_2 = KI_3$ reaction using partition method. **15.** Study of variation of angle of rotation with concentration of sucrose/tartaric acid using polarimetry. 16. Determination of percentage composition of a liquid mixture by viscosity measurement. 17. To compare cleansing power of two detergents.	

	18. To determine the critical micelle concentration of a soap by surface tension method.	

Course Outcome: After learning this course the students will be able to:

i. Apply Chromatographic separation techniques and identification of organic compounds.
ii. Apply Purification, Crystallization, and different Distillation processes
iii. Calculate enantiomeric composition by a polarimeter.
iv. Analyze and calculate physical properties of liquid and chemical kinetics of chemical reaction

MCHC0201 INORGANIC CHEMISTRY-II

Course objective: To understand the chemistry behind coordination of compounds, mechanism of metal complexes formation, analyze behavior and organometallic compounds, their stability and properties.

Credit: 4 **Semester-II** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Coordination Chemistry** Crystal-Field theory, d-orbital splitting in octahedral, tetrahedral, square planar geometries, molecular orbital theory, p-bonding, Jahn-Teller effect, spectrochemical series, nephelauxetic series., ionic radii and heat of hydration, electronic Spectra, d-d transitions, Orgel and Tanabe-Sugano diagrams, charge-transfer spectra. Magnetism: Types, determination of magnetic susceptibility, spin-only formula, spin-orbit coupling, spin crossover. **Reaction mechanism of transition metal complexes**: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, Conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage,	30
II	Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction, redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-hush theory, inner sphere type reactions. **Organometalic Chemistry** Organic-transition metal chemistry, Complexes with π-acceptor and σ-donor ligands, 18-electron and 16-electron rules, metal carbonyls, nitrosyls, carbenes, alkenes and allyl complexes, metallocenes, metal arene complexes, Reaction of organometallic complexes: substitution,	30

	oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands. Fluxional molecules, Industrial important organometalic catalyst: Wilkinsons catalyst, Ziegler-Natta catalyst, Monsanto process, Fischer-Tropsch process, Wacker process.	

Course outcome: After learning this course the students will be able to:

i. Understand the Chemistry of coordination compounds its stability and various theories of transition of electrons.
ii. Formulate the reaction mechanism of transition metal complexes.
iii. Evaluate the stability of organometallic compounds and clusters, and their applications as industrial catalysts.

Text Book(s)

1. J. D. Lee, *Concise Inorganic Chemistry*, 4th edition, ELBS.
2. F. A. Cotton, G. Wilkinson, P. G. Gans, *Basic Inorganic Chemistry*, 5th edition, John-Wiley & Sons, 1988.
3. Puri, Sharma and kalia

Reference Book(s)

1. J. E. Huheey, E. A. Keiter and R. L., Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th edition, Harper Collins 1993.
2. S. F. A. Kettle, *Physical Inorganic Chemistry: A Coordination Chemistry Approach*, Spektrum, 1996.
3. A. B. P. Lever, *Inorganic Electronic Spectroscopy*, Elsevier, 1984, 2nd Ed.
4. R. R. Jordan, *Reaction Mechanism in Inorganic Chemistry*, Oxford Univ. Press, 1998. 2nd Ed.
5. L.T. Martin, J.Burgess, *Inorganic Reaction Mechanisms*, Longmans Ist Edn., (1999).
6. F. Basalo, R. G. Pearson, *Mechanism of Inorganic Reactions*, 2nd Edn (1967), Wiley
7. Eastern Ltd., New Delhi.
8. R. H. Crabtree, *Organometallic Chemistry of the Transition Metals*, John Wiley, 1993, 2nd Ed.
9. A.Yamamoto, *Organotransition Metal Chemistry: Fundamental Concepts and Applications*, John Wiley 1986.

MCHC0202 ORGANIC CHEMISTRY-II

Course Objective: To impart deeper understanding of substitution reactions, rearrangement reactions, applications of oxidizing and reducing agents in organic synthesis and advanced knowledge of pericyclic and photochemical reactions.

Credit: 4 **Semester-II** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Rearrangements** Rearrangement reactions involving carbocation (Wagner-Meerwein, Pinacol-Pinacolone rearrangement), carbenes (Wolff & Arndt- Eistert synthesis), nitrenes (Hoffman, Curtius, Schmidt, Lossen, Beckman) and Fries rearrangement, Benzil-benzilic acid rearrangement, Arndt-Eistert reaction, Tiffeneau- Demjanov reaction, Firtsch-Buttenberg-Wiechell rearrangement, Stevens, Wittig and Favorskii rearrangements, Dienone-phenol, Baker-Venkatraman rearrangement, Baeyer-Villiger oxidation. Neber rearrangement, Benzidine rearrangement,	30
II	**Common Organic Reagents** Synthesis and applications of BF_3, NBS, Diazomethane, Lead tetra-acetate, Osmium tetraoxide, Woodward Prevorst hydroxylation reagent, $LiAlH_4$, Grignard reagent, organozinc and organolithium reagent. Gilman's reagent, DCC, LDA, 1,3–dithiane (reactivity umpolung), trimethyl silyl iodide, Baker's Yeast, Phase-transfer catalysts. **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 disrotatory motions 4n, 4n +2 and allyl system, cycloadditions-antarafacial suprafacial additions, 4n and 4n+2 systems, 2+2 additiion of ketenes, 1,3-dipolar cycloadditions, sigmatropic rearrangements, suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, [3, 3]-and [5, 5]-	30

	sigmatropic rearrangements, Claisen, Cope and aza-Cope rearrangement. Ene reaction. **Photochemistry** Photochemistry: Cis-trans isomerisation, Paterno-Buchi reaction, Norrish type I & II reaction, photoreduction of Ketones, dipimethane rearrangement, photochemistry of arenes, Barton reaction.	

Course Outcome: After learning this course the students will be able to:

i. Understand various aliphatic and aromatic substitutions and elimination reactions
ii. Conceptual understanding of rearrangement reactions.
iii. Synthesize and apply various reducing agents, oxidizing agents, in organic synthesis.
iv. Design molecular orbital symmetry and possibility of thermally and photochemically pericyclic reactions
v. Understand the basics of photochemical reactions of alkenes, carbonyl and aromatic compounds.

Text Book(s)

1. T. W. G. Solomons and C. B. Fryhle, *Organic Chemistry*, 9th edition, Wilely India Pvt. Ltd., 2009
2. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, 6th edition, Pearson Com., 1992

Reference Book(s)

1. P. Volhardt and N. Schore, *Organic Chemistry: Structure and Function*, 5th edition, W. H Freeman & Co, 2006
2. L. G. Wade, *Organic Chemistry*, Pearson Education 6th edition, 2006.
3. J. March, *Advanced Organic Chemistry*, John Wiley & Sons, 1992.
4. E. J. Eliel, *Stereochemistry of Carbon Compounds*, McGraw Hill.
5. S. H. Pine, *Organic Chemistry*, McGraw Hill, 1987.
6. P. Sykes, *A Guide Book to mechanism in Organic Chemistry*, 6th edition, Longman, 1989.
7. P.S. Kalsi, *Organic Reactions and their Mechanisms*, 2nd edition, New Age International Publishers, 2000.
8. S.M. Mukherji, S.P. Singh, *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.
9. W. Carruthers, *Modern Methods of Organic Synthesis*, 4th Edition Cambridge University Press, 2007.
10. C. K. Ingold, *Structure and mechanism of Organic Chemistry*,, Cornell University Press, 1999.
11. H. O. House, Modern Organic Reactions, , Benjamin, (1972).

12. S.M. Mukherji, S.P. Singh, *Pericyclic Reactions*, Macmillan India New Delhi, 1985.
13. O.P.Agarwal , Reaction and reagents

MCHC0203 PHYSICAL CHEMISTRY-II

Course Objective: To develop fundamentals of statistical thermodynamics, colligative properties, surface chemistry and to impart the knowledge of microwave, IR and Raman spectroscopy and their applications.

Credit: 4 **Semester-II** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Statistical Thermodynamics** Thermodynamic probability and entropy, Maxwell-Boltzmann statistics, justification of the laws of thermodynamics, translational, rotational, vibrational and electronic partition functions of diatomic molecules, calculation of the thermodynamic functions including 'chemical potential', equilibrium constants and the 'Saha Ionization' formula, salient features of Bose-Einstein and Fermi-Dirac statistics, specific heat of solids. **Colligative Properties** Vapour pressure lowering, osmosis and osmotic pressure, vapour pressure lowering of an ideal solution, theories of semi-permeability, effect of osmosis and semi-permeability, reverse osmosis, boiling point elevation, freezing point depression, abnormal results and Vant's Hoff factor. **Surface Chemistry** Thermodynamics of surfaces, adsorption phenomena (mono- and multi-layer), Langmuir and B.E.T. isotherms, determination of surface area of solids, adsorption from solution, electrical phenomenon at interfaces, classification and properties of surfactants, hydrophobic interactions, micellization, thermodynamics of micellization, 'phase separation' and 'mass action' models, emulsion and 'reverse micelles', effect of micellization on the rate of chemical reactions, characterization of the surface of a solid by different experimental techniques, including photoelectron spectroscopy, ESCA, auger spectroscopy. Langmuir-Blodgett films, catalytic activity at surfaces	30

II	**Spectroscopy: Microwave, IR and Raman** **Microwave spectroscopy:** Classification of molecules, molecular requirement for rotational spectra, the molecule as a rigid rotor, non-rigid rotor, effect of isotopic substitution on the transition frequencies, intensities, stark effect, nuclear and electron spin interaction and effect of external field, application. **Infrared spectroscopy:** linear harmonic oscillator, features of vibrational rotational spectra, vibrational energies of diatomic molecules, zero point energy, frequency, force constant and bond strengths, molecules as an harmonic oscillator, morse potential energy diagram, the interaction of rotations and vibrations, molecules as vibrating rotator: fine structure of infra red bands, P, Q and R branches, breakdown of oppenheimer approximation, vibration of polyatomic molecules, selection rules, normal modes of vibration, group frequencies, overtones, Thermal distribution of vibrational & rotational levels, factors affecting the band positions and intensities, analysis and application of infrared spectroscopy. **Raman spectroscopy:** Classical and Quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational raman spectra, coherent anti stokes and stokes lines, selection rules, mutual exclusion principle, resonance Raman spectroscopy, infra red *vs* raman spectroscopy.	30

Course Outcome: After learning this course the students will be able to:

- Understand the basic principles of statistical mechanics, which correlates the microscopic properties of systems with the macroscopic observables.
- Apply the concepts of surface chemistry in developing system.
- Understand Compute and analyze the date received from Microwave, Infrared-Vibration-rotation Raman and infra-red Spectroscopy and its applications for chemical analysis

Text Book(s)

1. P. Atkins and J. Paula, *Atkins' Physical Chemistry*, Oxford University Press, 8th edition,2006.
2. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, New Delhi, 5th edition, 1992.
3. B. R. Puri, L.R. Sharma, and M.S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 45th edition, 2011.

Reference Book(s)

1. L.K. Nash, *Elements of statistical thermodynamics*, Addison Weesley, 2nd edition, 1974.

2. S. Glasston, V.D. Nostrand, *Thermodynamics for chemists*, 1965.
3. A.W. Adamson, *Physical Chemistry of surfaces*, Interscience New York, 1972.
4. J.J. Bikerman, *Surface Chemistry: Theory and applications*, Academic press New York, 1972.
5. C.N. Banwell, McCash, *Fundamentals of Molecular Spectroscopy*, 4th Edition, Tata McGraw Hill, 2010.
6. G.M. Barrow, Introduction to molecular spectroscopy, McGraw Hill, 1964.

MCHC0204 SPECTROSCOPY-I

Course objectives: To apply the concept of molecular spectroscopy an important tool in molecular structure determination and characterization. To acquire the skills to elucidate the molecular structure by using UV-Visible, FTIR, NMR and Mass spectroscopy

Credit: 4 **Semester-II** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Ultraviolet and Visible Spectroscopy** Introduction, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser – Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds, steric effect in biphenyls. **Infrared Spectroscopy** Introduction, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds), effect of hydrogen bonding and solvent effect on vibrational frequencies, FT-IR. **Nuclear Magnetic resonance spectroscopy** Theory of NMR, instrumentation, equivalent and non equivalent protons, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, relaxation process, factors influencing coupling constant 'J', classification to AX, A_2, AMX, ABC etc, spin decoupling, shift reagents, 2D-NMR, NOESY, FTNMR, advantages of FTNMR, use of NMR in medical diagnostics.	30
II	**NMR –^{13} C and Others** General considerations, multiplicity of signals, ^{13}C-proton coupled spectra, spin-spin splitting, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants, $^{13}C(^{1}H)$ decoupled spectra, Two dimension NMR Spectroscopy – COSY, NOESY, techniques, NMR studies of nuclei - ^{19}F and ^{31}P **Mass Spectroscopy** Theory, modes of ionization-EI, CI, FD and FAB, Instrumentation,	30

	factors affecting fragmentation, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, base peak, isotopic mass peak, Mc-Lafferty rearrangement, nitrogen rule, high resolution mass spectrometry, examples of mass spectral fragmentation of organic compounds with respect to their structure determination. **Combined problems on UV, IR, NMR and MASS spectroscopy.**	

Course outcome: After learning this course the students will be able to:

i. Understand the basic principle of spectroscopy and will able to apply the concept in getting the information about the material
ii. Solve structural problems based on UV-Vis, IR, proton NMR, 13CNMR and mass spectral data.

Text Book(s)

1. R.M. Silverstein and F.X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th edition, Wiley Inc.
2. D.L. Pavia, G.M. Lampman and G.S. Kriz, *Introduction to Spectroscopy*, 3rd edition, Harcourt Inc.

Reference Book(s)

1. P.S. Kalsi, *Spectroscopy of organic compounds*, New age international, 6th edition, 2004.
2. Y.R. Sharma, *Elementary organic spectroscopy- principles and applications*, S. Chand, 5th edition, 2007.
3. A.U. Rahman, *One and two dimensional NMR spectroscopy*, Elsevier, 2010.
4. W. Kemp, *Organic spectroscopy*, Macmillan, 3rd edition. 2009.
5. F.W. McLafferty, F. Turecek, *Interpretation of mass spectra*, 4th edition, , California, 1993.
6. J. R. Chapman, *Practical organic mass spectroscopy*, 2nd edition, , John Wiley, NY, 1993.
7. J.W. Copper, *Spectroscopic techniques for organic chemists*, John Wiley, NY, 1980.

MCHC08002 PHYSICAL CHEMISTRY LAB

Course Objectives: To develop skills & hand on experience in physical chemistry involving experiments of chemical kinetics, surface chemistry, thermodynamics, spectrophotometry, determination of viscosity and concentration of liquids etc.

Credit: 02 **Semester II** **L-T-P: 0-0-4**

Module No.	Content	Teaching Hours (Approx.)
I+II	1. To study the inversion of cane sugar by optical rotation measurement. 2. Conductometric titration of a weak acid with strong base. 3. Potentiometric titration of a strong acid with strong base using quinhydrone electrode. 4. Spectrophotometric determine the concentration of copper sulphate, potassium permanganate and potassium dichromate in their solution. 5. Verification of Freundlich adsorption isotherm for I_2, acetic acid and oxalic acid on charcoal. 6. Estimation of heat of neutralization for strong acid strong base, weak acid strong base or vice – versa, heat of hydration and solution of salts. 7. Determination of molecular weight of a high polymer (say polystyrene) by viscosity measurement. 8. Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH. 9. Determination of isoelectric point by viscosity measurement. 10. Determination of solubility and solubility product of sparingly soluble salts ($BaSO_4$) and AgCl.	40

Course outcome: After learning this course the students will be able to:

i. Understand physical chemistry from experimental point of view.
ii. Develop skills in titration techniques for quantitative analysis.
iii. Design the spectrophotemetirc experiments for concentration determination

Text Book(s)

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
2. Experimental Physical Chemistry: V. Athawale and P. Mathur.

Reference Book(s)

1. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.
2. Practical in Physical Chemistry: P.S. Sindhu

MCHC0803 INORGANIC CHEMISTRY LAB-I

Course objectives: To understand and design experiments for qualitative analysis of complex inorganic mixture and also to estimate various ions present in alloys, prepare different complexes

Credit: 2 **Semester II** **L-T–P: 0-0-4**

Module No.	Content	Teaching Hours (Approx.)
I+II	**1.** Semi-Micro Qualitative Inorganic Analysis of Complex Inorganic Mixtures containing not more than six (6) inorganic radicals. 2. Analysis of the given alloys: Coin, Gunmetal, Brass and Bronze. 3. To prepare a pure and dry sample of the following compounds: 1. Potassium tris(oxalato)aluminate(III) 2. Sodium hexa(nitro)cobaltate(III) 3. Potassium tris(oxalato)cobaltate(III) 4. Hexa(ammine)cobalt (III)chloride 5. Tetrapyridine copper(II)persulphate 6. Dinitrotetrapyridine nickel(II) 7. Lead tetraacetate 8. Mercury (tetraisothiocyanato)cobaltate(II).	

Course outcomes: After learning this course the students will be able to:

- **i.** Analyze various ions present in alloys
- **ii.** Estimate the amount of ions by complexometric and gravimetric methods
- **iii.** Design, formulate and characterize various complexes.

Text Book(s)

1. A text Book of Quantitative Inorganic Analysis: A.I.Vogal.

Reference Book(s)

1. Applied Analytical Chemistry: Vermani.
2. Commercial Methods of Analysis: Shell & Biffen

MCHC0804 ORGANIC CHEMISTRY LAB-I

Course Objectives: To develop common organic chemistry laboratory practices & techniques for carrying out and monitoring a synthesis & extraction of natural products, and quantitative estimation/characterization of organic compounds.

Credit: 2 **Semester II** **L-T–P: 0-0-4**

Module No.	Content	Teaching Hours (Approx.)
I+II	1. Separation of the compounds and their identification through various steps, derivative preparation, checking the purity of components by melting point and TLC. **2. Isolation of** (i) Caffeine from tea leaves (ii) Lactose and casein from milk (iii) Cystine from human hair (iv) D (+) Glucose from cane sugar **3. Multi-step synthesis** (i) Benzanilide from benzene (ii) Benzilic acid from benzaldehyde (iii) Acetylaminocinnamic acid from glycine (iv) Acridone from anthranilic acid (v) Meta - Nitroaniline from benzene (vi) 5-Acetoxy-1,2-benzoxathiole-2 - one from hydroquinone (vii) 2' - Hydroxy - 4 - methoxyphenyl styryl ketone from resorcinol (Viii) p-nitrobenzanilide from Benzophenone **4.** Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography. 5. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.	

Course outcomes: After learning this course the students will be able to:

i. Understand organic chemistry from experimental techniques to perform qualitative analysis of organic compounds and mixtures.
ii. Synthesize some important organic compounds through known procedures
iii. Isloate and characterize natural products.

Text Book(s)

1. J. C. Gilbert, S.F. Martin, "Experimental Organic Chemistry. A Miniscale and Microscale Approach", Thomson 2006
2. A. I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford , P. W. G. Smith "Vogel's Textbook of practical organicchemistry", Prentice Hall 1996

Reference Book(s)

1. J. W. Zubrick "The Organic Chem Lab Survival Manual", Wiley 2010
2. L. M. Harwood, C. J. Moody, J. M. Percy "Experimental Organic Chemistry, Standard and Micro scale", 2nded., Blackwell Science 1999
3. P. G. M. Wuts, T. W. Greene "Greene's Protective Groups in Organic Synthesis", any edition, Wiley & Sons
4. W. L. G. Armarego, C. L. L. Chai, "Purification of Laboratory Chemicals" any edition, Elsevier
5. C. F. Wilcox, „Experimental Organic Chemistry, A Small-Scale Approach", MacMillan Publishing Company, New York 1988

MCHC0301 SPECTROSCOPY II

Course objectives: To introduce the fundamental principles of NMR, Mossbauer, photochemical fluorescence spectroscopy and laser spectroscopy with emphasis on its application in material development and characterization.

Credits: 04 **Semester III** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**NMR spectroscopy** Basics of Nuclear Magnetic Resonance Spectroscopy, and of Nuclear spin, idea about Nuclear resonance, Saturation, Shielding of magnetic nuclei, Larmor frequency, Block equation. Chemical shift, Factors influencing chemical shift and its measurements, Deshielding, Spin-spin interactions, spin-spin coupling, Factors influencing coupling constant 'J', Classification of various systems (ABX, AMX, ABC, A2B2 etc.), Spin decoupling. COSY, DEPT, NOSY, NOE, FT-NMR, 2D-NMR, Basic ideas about instrumentation. Use of NMR in medical diagnostics. **Mossbauer Spectroscopy:** Basic principles, Application of the technique to the studies of bonding, structures and oxidation state of Fe^{+2} and Fe^{+3} compounds.	30
II	**Photophyscial and Photochemical Fluorescence Spectroscopy**: Basics of fluorescence and phosphoresce spectroscopy. Measurement of fluorescence and phosphorescence and lifetimes, Introduction to time-resolved techniques for absorption and emission measurements, modern techniques, TCSPC, Fluorescence upconversion, Flash photolysis, pump-probe spectroscopy. Detection and kinetics of reactive intermediates, Photochromic reactions. **Laser** spectroscopy: Basic principle of laser, Einstein equation, and related coefficients, two level, three level and four level system. Solid state laser, Gas Laser, dye laser, quantum-dot laser, Random laser. CO2 laser, He-Ne laser, diode laser, Ti: Sapphire laser. Applications of laser, in research, medical science and industry.	30

Course outcome: After learning this course the students will be able to:

i. Apply the principles of magnetic resonance and other advanced spectroscopic techniques in elucidation of organic, inorganic and organometallic compounds.

ii.

Text Books:

1. Banwell and McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw Hill, 2010.
2. Peter Atkins , Julio de Paula, Ronald Friedman, Quanta, Matter, and Change: A molecular approach to physical chemistry, W. H. Freeman and Company, New York.
3. Virender K. Sharma, MOSSBAUER SPECTROSCOPY, John Wiley & Sons, Inc.

Reference Book

4. Donald A. McQuarrie, john D. Simon, PHYSICAL CHEMISTRY, A MOLECULAR APPROACH, University Science Books, Sausalito, California.

MCHC0302: NANOSCIENCE AND NANOTECHNOLOGY

Course Objectives: To understand and develop significance of nanoscale and types of CNT, different methods of preparation of nanomaterials and various tools for characterizing nanomaterials

Credits: 04 **Semester III** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Basic Concept** Nanoscience and Nanotechnology - Basic concept, history, definitions. Concepts of nano scale and nano effects with suitable examples. Nanomaterials, classification and their properties - One-dimensional, Two-dimensional and Three-dimensional and zero-dimensional nano materials with examples. Quantum mechanics for particle in one dimentional box to explain quantum confinement. Energy levels of nanoparticle with different dimensions, concept of quantum well, toxicity and green nanoscience. **Characterization of nanomaterials:** Fundamentals of various techniques, Basic principle of Powder XRD and their applications in nano-materials characterization: Extended x-ray absorption technique,	30
II	**Electron microscopy**: SEM/TEM, high resolution imaging (HRI), defects in nanomaterials, UV-Vis Spectroscopy electron energy-loss mechanisms, prospects of scanning probe microscopes (SPM), AFM, optical spectroscopy of metal / semiconductor nanoparticles and quantum-dot, surface Plasmon Raman spectroscopy. **Nanostructured Materials and their applications:** Quantum wells, Dots and wires, Metal/oxide nanoparticles, nanorods, nanowires, and nanofibers, Nanocrystals, Nanoshells, Semiconductor Quantum Dots- Excitons, Polymer nanoparticles, Core-Shell Structures of nanomaterials. Their synthesis, characterization and properties. Applications in material science, engineering, medical science, Bio-medical science, pharmaceutical science, Nano-spectroscopy, paint industry	30

Course Outcomes: After learning this course the students will be able to:

i. Understand the significance of nanoscale & its dimensions
ii. Aacquire knowledge of various characterization techniques
iii. Valuate the short term and longer term applications of nanomaterials

Text Books:

1. Textbook of Nanoscience and Nanotechnology, by B.S. Murty , P. Shankar, Baldev Raj, B.B. Rath, James Murday, Springer publication.
2. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press.

Reference Book:

1. Basic Principles of Nanotechnology, Wesley C. Sanders, CRC Press.

MCHC0303 HETEROCYCLIC CHEMISTRY

Course objectives: To introduce nomenclature, properties, reactivities and synthesis, aromatic, and non aromatic heterocycles compounds and fused heterocyclic compounds.

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Nomenclature of Heterocycles:** Replacement and systematic nomenclature (Hantzsch-Widman system) of monocyclic, fused and bridged heterocycles. **Aromatic Heterocycles:** General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMRspectra, emperical resonance energy, delocalization energy and Dewar resonance energy). Heteroaromatic reactivity and tautomerism in aromatic heterocycles. **Non- aromatic Heterocycles:** Strain-bond angle and torsional strains and their conseqences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular Geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. Stereo-electronic effects- anomeric and related effects Attractive interactions-hydrogen bonding and intermolecular nucleophilic-electrophilic interactions	25
II	**Heterocyclic synthesis:** Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition Reactions. Four-membered heterocycles: Synthesis and reactions of azetidines, oxetanes and thietanes. **Five membered rings:** with two heteroatoms: pyrazole, imidazole, oxazole, thiazole, isothiazole and benzofused analogs. **Benzo-Fused Five-Memberd Heterocycles**: Synthesis and reaction including medicinal applications of benzopyrroles, benzofurans and benzothiophenes **Benzofused six membered** rings with one, two and three heteroatoms: benzopyrans, quinolines, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines, pteridines. **Large membered heterocycles:** azepines, oxepines, thiepines. Chemistry of porphyrins and spiro heterocycles.	23

Course Outcome: After learning this course the students will be able to:

i. Apply nomenclature rules to different heterocyclic compounds
ii. Understand reactivity of fused, five, six membered and smaller & larger heterocyclic compounds.
iii. Develop experimental techniques for synthesis of heterocyclic compounds

Text Books:

1. Gupta, R.R.; Kumar, M.; Gupta, V Heterocyclic Chemistry, Vol.1-3, Springer Verlag, 1998.
2. Katrizky, A.R.; Rees, C.W. Comprehensive Heterocyclic Chemistry, Pergamon Press.
3. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
4. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).
5. Acheson, R. M. Introduction to the Chemistry of Heterocyclic Compounds John Wiley & Sons (1976).
6. Alhuwalia, VK and Kidwai, M. New trends in Green Chemistry. Anamaya Publishers, New Delhi (2003).

Reference Books

1. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
2. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
3. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical
4. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.

MCHE0316 CORROSION CHEMISTRY

Course objectives: To provide conceptual basis of corrosion chemistry, mechanism and its applications in preventing the objects from corrosion.

Credits: 04 **Semester III** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Introduction and fundamental concept:** Redox reaction, Definition, Consequence, cause and classification of corrosion. Mechanism of dry corrosion, Oxide layer, Pilling-Bed worth rule. Corrosion due to other gases, liquid metal corrosion. **Mechanism of Wet / electrochemical corrosion**: release of hydrogen type, Absorption of oxygen type. Application of the thermodynamics and kinetics of electrochemical reactions to the understanding of corrosion phenomena such as, stress corrosion, Galvanic, water line, Caustic embrittlement, hydrogen embrittlement, concentration cell corrosion, pitting corrosion, Crevice corrosion, microbiological and soil corrosion.	**25**
II	**Corrosion in industries:** Factors influencing corrosion,: Steam Power Plant, Boiler. **Corrosion control:** Design and principle of selection of material, corrosion inhibitors: Anodic and Cathodic inhibitors, modification of environment, Surface coatings: metallic coating, inorganic coating and organic. Methods of coating application. Passivity. Electrochemical methods of corrosion inspection and monitoring.	**25**

Course outcome: After learning this course the students will be able to:

i. Understand the fundamental concepts of corrosion and mechanism involved in it.
ii. Identify and analyze the factors affecting corrosion.
iii. Design the structure to reduce intensity of corrosion.
iv. Apply the principle to develop new coating materials for prevention of corrosion.

Text Books:

1. M G Fonlana & N D Greene, Corrosion Science and Engineering. McGraw Hill Book Co., New York.

2. S N Banerjee, An introduction to corrosion and corrosion inhibition, Oxonian Press Ltd., New Delhi.

Reference Books

1. D Jones, Principles and prevention of corrosion Macmillan Publications New York, 1992.
2. D.Pletcher and F C Walsh, Industrial Electrochemistry, Vol. II, Blakrid Academic Professional, London, 1993.

MCHC0805 INORGANIC CHEMISTRY LAB II

Course objectives: To develop experimental skills of latest and greener multistep synthesis of nanoparticles, survey research literature, and collect/compile the information for preparing a scientific report.

Credits: 02 **Semester III** **L–T–P : 0–0–4**

Module No.	Content	Teaching Hours (Approx.)
I+II	1. Synthesis of gold nanoparticle, its characterization and particle size determination. 2. Synthesis of silver nanoparticle, its characterization and particle size determination. 3. Green synthesis of metal nanoparticle. 4. Synthesis of metal nanoparticle as a function of temperature and their size effect on temperature. 5. Synthesis of high molecular weight polymer. 6. Determination of hardness of polymer	

Course Outcome: After learning this course the students will be able to:

i. Develop green synthesis of metal nanoparticles
ii. Evaute and analyse the parameters influencing the sysnthesis of metal nanoparticles
iii. Design an experiment for the development of perfect experimental skills of multistep synthesis of nanoparticles.

Text Books :

1. Textbook of Nanoscience and Nanotechnology, by B.S. Murty , P. Shankar, Baldev Raj, B.B. Rath, James Murday, Springer publication.

Reference Books

1. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press.

MCHC0806 ORGANIC CHEMISTRY LAB II

Course objective: To develop experimental skills of multistep organic synthesis through conventional methods and latest tools for literature survey literature, and collect/compile the information for preparing report.

Credits: 02 **Semester III** **L–T–P : 0–0–4**

Module No.	Content	Teaching Hours (Approx.)
I+II	1. Synthesis and reaction of following ring systems a) Four membered rings like Azetidines and their 2-Oxo-derivatives b) Five membered rings containing two heteroatoms: Pyrozaoles, Isoxazoles, Imidazoles and thiazoles 2. Synthesis of Paracetamole, Aspirin and Ibrufene drugs 3. Preparation (multistep synthesis) and characterization through spectroscopic techniques. a) Synthesis of Acridone b) Benzanilide from benzophenone c) Anthranilic acid from phthalic acid 4. Determination of Iodine value by Wij's solution 5. Formation of soap from vegetable oil.	

Course Outcome: After learning this course the students will be able to:

i. Design experiments for multistep synthesis of organic molecules.
ii. Formulation of soap from oil for various purpose
iii. Design experiment for synthesis of carbon-heteroatom bond formation.

Text Books:

1. Text book of practical organic chemistry, A. I. Vogel, Pearson, 5th Edition, Delhi, 2004.
2. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
3. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
4. Tewari, K.S.; Vishnoi, N.K.; Mehrotra, S.N. A Textbook of Organic Chemistry, 2nd edition, Vikas Publishing House, 1976.

Reference Books:

5. Mann, F.G.; Saunders, B.C. Practical Organic Chemistry, 4th edition, New Impression, Orient Longman Pvt. Ltd., 1981.

MCHJ0960 GRADUATE SEMINAR

Course Objectives: To develop presentation skills and proficiency in group discussion, understanding a scientific problem to provide information about the process, types and patterns of communication.

Credits: 02 **Semester III** **L–T–P : 0–0–2**

Course outcome: After learning this course the students will be able to:

i. Develop self introduction and role play facilitate cultivation firmness of mind and empathy
ii. Design group discussion infuses team spirit and sense of competition
iii. Develop skills to listen regenerate transformations empathetically
iv. Develop body language enhances personality grooming
v. Develop reading enhances stylish accent productivity

MCHC0401 POLYMER CHEMISTRY

Course Objectives: To introduce the basic concepts of polymers, molecular weight determination and distribution. Understand kinetics and mechanism of addition, coordination and condensation polymerization, various polymerization techniques and learn evaluate the effect of polymer structure on mechanical, electrical and optical properties,

Credits: 04 **Semester IV** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours
I	**Introduction of Polymer Chemistry** History of Polymers; Classifications of Polymers, Sources of raw materials–Monomers–Polymers–Polymerization. **Types of Polymerizations**: Addition and Condensation Polymerizations. Definition and Classification of Plastics – General Properties – Historical development of plastic industry- future trends, Thermoplastics, Thermosetting, Engineering and High performance plastics. **Polymerization reactions with its Mechanism** Addition Polymerization – Free radical Polymerization, Step-wise Ionic Polymerization (Anionic Polymerization and Cationic Polymerization), Controlled polymerization reaction including Atom Transfer Radical Polymerization (ATRP), Group Transfer Polymerization (GTP), Reversible Addition Fragmentation Termination**,** Co-ordination polymerization **–** Condensation Polymerization , Ring opening Polymerization. **Polymerization techniques** Bulk, Solution, Emulsion, Suspension, Melt polymerization, Interfacial polycondensation techniques. **Molecular Weight(MW) and Molecular Weight Distribution(MWD)** Number Avg. MW, Weight Avg. MW, Viscosity Avg. MW and Sedimentation Avg. MW, Derivation of Mn and Mw. Degree of Polymerization and MW, Polydispersity and MWD in polymers. Determination of MW – Osmometry, Viscometry, Cryoscopy, Ebulliometry, Gel permeation chromatography (GPC) etc.	22
	Phases of Polymers: Glass transition temperature(Tg), Factors affecting the Tg, Melting point of polymers Characterization of phases: Thermogravimetric analysis(TGA), Diffferential scanning calorimetry(DSC) **Characteristics and uses of polymers** Purification & separation techniques of polymer, Polyamides – Nylon	

II	6, 66 etc.; Acetal-Homopolymer & Co-polymer, Saturated polymers – PETP & PVTP; Polymers containing fluorine – PTFE, PVDF etc.; Polycarbonate; Thermoplastics Polyester, Poly urethane. **Advance Polymeric Materials** High tech-areas for applications of plastics. High temperature polymers. Polymer concretes and polymer reagents. Introduction-basic chemistry-General properties and applications of Ultra-high modulus fibers. **Plastic waste management** Introduction-Sources of plastics waste-Separation technologies, viz. sorting-Manual, automated, Density separation, Flotation, Solvent separation, Melt filtration, Separation of resin from fiber in waste FRP. Mechanical recycling of commonly used plastics, such as PP, PE, PET, etc. mixed waste recycling-co-extruded films waste, commingled waste Extrusion flow moldings for production of plastics lumbers, chemical recycling/feedstock recycling processes for recovery of oil. **Green plastics** – an overview. Environmental issues, policies and legislation in India. Plastics – Energy saving, Eco-friendly – Case studies, Life cycle analysis-a model.	25

Course outcomes: After learning this course the students will be able to:

- **i.** Develop basic concepts of polymers, understand mechanism and kinetics of polymerization, polymerization techniques, molecular weight determination.
- **ii.** Apply knowledge for synthesis of polymers and design the mechanism involved in it.
- **iii.** Enable to interpret experimental data using the characterization techniques and structure-property relationship for their final semester research project.

Text Books:

1. R. Johanner Brandrup, Recycling and recovery of plastics, Hanser Publishers, New York, 1996.
2. Nabil Mustafa, Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc. New York, 1993.
3. Anthony L. Andrady (Ed.), "Plastics and the Environment", Wiley Interscience New York (2003).
4. R.J. Ehrig, Plastics Recycling, Products and Processes, Hanser Publishers, New York, 1992.
5. RP.Singh, C.K.Das, S.K. Mustafi, Polymer Blends and Alloys an Overview, Asian Books Pvt.Ltd, New Delhi, 2002.
6. Polymer Science – V. R. Gowariker

Reference Books

1. Polymer Science – J. Fried
2. Principles Of Polymer Systems- Rodrigue
3. Principles Of Polymer Chemistry- Ravve
4. Introduction Of Polymer Science- Georgelias
5. Principles of Polymer science – Bahadur and Sastry

MCHC0402 ENVIRONMENTAL AND GREEN CHEMISTRY

Course Objectives: To understand the importance of environmental and green chemistry in, remediation and perspective about environment and the global challenges. Also to understand different aspects of environmental, chemistry of atmosphere, soil, water and fundamental aspects of green chemistry.

Credit: 4 **Semester-IV** **L-T-P: 3-1-0**

Module	Content	Teaching Hours (Approx.)
I	**Environmental Chemistry**: Chemistry of Atmosphere: Composition and structure of atmosphere, global warming, Greenhouse effect, Ozone depletion, Photochemical smog, acid rain, Air sampling techniques, Sources, effects and monitoring of air pollutants by Instrumental methods, Control of air pollution, analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter. **Hydrosphere:** Water Pollution, Different types of water pollutants, Sources, characteristics and effects of water pollutants, ground water pollution, surface water pollution lake and river water, eutrophication, marine pollution, water pollutants, Monitoring of Water Pollutants. **Soil pollution**: Soil humus, soil fertility, inorganic and organic components in soil acid base and ion exchange reactions in soils, micro and macro nutrients wastes and pollutants in soil, introduction to geochemistry, solid waste management, treatment and recycling soil analysis, radioactive pollution, disposal of radioactive waste. **Water Treatments and analysis:** Principles of water and waste water treatment aerobic and anaerobic treatment, industrial waste water treatment heavy metal pollution, hard water, softening, purification of water for drinking purposes water treatment for industrial use electro-dialysis reverse osmosis other purification methods chemical speciation of elements. Treatment of Municipal Waste Water, Treatment of Industrial Waste Water, Environmental Impact	25

	Assessment process in India Color, odor, conductivity, TDS, pH, acidity, alkalinity, chloride, residual chlorine, hardness, trace metal analysis, elemental analysis ammonia nitrite, nitrate fluoride, sulphide, phosphate, surfactants, BOD, COD, non-dispersive IR spectroscopy, Chromatography etc.	
II	**Green Chemistry:** Basic principles of Green Chemistry, twelve principles of green chemistry and implementations, Toxicology and Green Chemistry, Atom Economy, Climate and Green Chemistry, Plastics and Green Chemistry, Energy and Green Chemistry. **Green Solution:** Use of degradable chemicals, Selection of starting materials, Designing biodegradable products, Green reaction conditions, Green catalysis, Ionic liquids, Supercritical fluids, Flourous phase reactions, Sustainable development, atom economy, environmental, E-factor, traditional and alternative commercial syntheses of ibuprofen, adipic acid and maleic acid etc, green chemistry in action developing foam, whitening agent, detergent builders, green insecticides, biosynthesis of synthetic chemical, Microwave and Ultrasound assisted reactions, Heterogeneous catalysis: Biocatalysis: Green analytical methods, Proliferation of solventless reactions; Noncovalent derivatization; Biomass conversion. Hazard assessment and mitigation in chemical industry.	**25**

Course Outcome After learning this course the students will be able to:

i. Demonstrate an understanding of environmental chemistry, viz. air, water and soil pollution and their relationships vis-a-vis environment.
ii. Apply the concept of green and sustainable chemistry in resolving the environmental issues.
iii. Develop critical thinking for speculating the forthcoming challenges to the environment and develop green solution in saving the planet.

Text Books:

1. G.S. Sodhi, Fundamental Concepts of Environmental Chemistry, 2nd Edition, Narosa publishing House, 2005.
2. M.N. Rao and A.K. Datta, Waste Water Treatment, 2nd Edition, Oxford Publications, 2007.
3. H. Kaur, Environmental Chemistry, 6th Edn, Pragathi Prakashan, Meerut, 2011.
4. K.H.Mancy and W,.J.Weber Jr. Wiley, Analysis of Industrial Waste Water, Interescience

New York, 1971.
5. L.W. Moore and E. A. Moore, Environmental Chemistry, McGraw Hill Publication, New York, 2002.
6. S. M. Khopkar, Environmental Pollution Analysis, New Age International (P) Ltd, 1993.
7. V. K. Ahluwalia, M. Kidwai, New trends in Green Chemistry, New Age Publications, 2004.
8. Green Chemistry: Introductory Text. M. Lancaster Royal Society of Chemistry (London).
9. M. Benaglia, Recoverable and Recyclable Catalysts, Wiley publication.
10. J. Clark and D. Macquarrie, Handbook of Green Chemistry & Technology, Blackwell Publishing.

Reference Book(s):

1. Green Chemistry: Theory and Practice. P.T. Anastas and J.C. Warner. Oxford University Press.
2. Solid-Phase Organic Synthesis. K. Burgess. Wiley-Interscience.

MCHE0401 CHEMISTRY OF SELECTED NATURAL PRODUCTS

Objectives: To learn and understand the nomenclature techniques in heterocyclic compounds. To develop the conceptual understanding of isolation, structural and physiological action of alkaloids, steroids, terpenes, carbohydrates in living beings.

Credits: 04 **Semester IV** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Carbohydrates:** Introduction. Kiliani-Fischer synthesis, Determination of configuration of the monosaccharides, conformational analysis of monosaccharides. Synthesis of amino sugars (β-D- Glucosamine, galactosamine, N-acetylmuramic acid (NAMA), N-acetyl neuraminic acidNANA). C- and Nglycosides. Synthesis of aldonic, uronic, aldaric acids and alditols.Structure elucidation of sucrose and maltose.Structures of lactose, gentiobiose, and meliobiose.Photosynthesis of carbohydrates.	23
II	**Steroids:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, Cortisone. Biosynthesis of steroids. **Alkaloids & Terpenoids** Definition, nomenclature, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring. Role of alkaloids in plants and their physiological action. Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, (+)- Coniine, Quinine and Morphine. Isolation synthesis and general methods of structure elucidation of Geraniol, α-Pinene, Camphor, Menthol, Zingiberene and Phytol. Biosynthesis of terpenoids.	27

Course Outcomes: After learning this course the students will be able to:

i. Understand chemistry of carbohydrates
ii. Perform the basic classification and role of alkaloids.
iii. Structural elucidation and degradation of alkaloids.
iv. Synthesis structure of alkaloids, isolation and structural determination of alkaloids, to learn about terpenoids and its classification.
v. To learn about carbohydrates and its types and application in living tissues.

Text Books:

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol, I.L. Finar ELBS.
3. Stereoselective Synthesis: A Practical Approach, jM. Norgradi, VCH.
4. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.
5. Nogradi, M. Stereoselective Synthesis: A Practical Approach, VCH.
6. Hostettmann, Kurt; Gupta, M.P.; Marston, A. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers.

Reference Books

1. Dev, Sukh Insecticides of Natural Origin, Harwood Academic Publishers.
2. Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B. Natural Products: Chemistry and Biological Significance, Longman, Essex.

MCHE0402 METHODS IN ORGANIC SYNTHESIS

Course Objective: To develop the concepts and critical thinking in bond forming/breaking reactions in organic synthesis and molecular rearrangements. Understand and region, stereo specific application of reagents in organic synthesis.

Credits: 04 **Semester IV** **L–T–P: 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Reagents in Organic Synthesis:** Recent methodologies using organometallic chemistry, Specially Pd, Ni, Rh, Cr, Fe complexes organic synthesis . Use of the following reagents in organic synthesis and functional group transformations: complex metal hydrides, Gilman's reagent (Lithium dimethyl cuprate), lithium di-isopropylamide (LDA), dicyclohexyl carbodiimide (DCC) and selenium dioxide (SeO2). **Protection of the following groups:** Principles of protection of carbon-carbon double bonds, alcohol, amine, carbonyl and carboxyl groups.	**20**
II	**Disconnection approach to syntheses of organic molecules:** An introduction to synthons and synthetic equivalents, conversion and FGI, selective reactions (Chemo-, regio- and stereoselective), formation of CC, C-O and C-N bonds. **(a) One Group C-C Disconnection:** Alcohols and carbonyl compounds, consideration of regioselectivity. Alkene synthesis and uses of acetylenes in organic synthesis. **(b)Two Group C-C Disconnection:** Diels Alder reaction, 1,3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, 1,5-difunctionalised compounds. Michael addition and Robinson annulation. N-2-chloroethyl piperidine, cyclohexylpropanol, 3,4-diphenyl-3-hydroxy-butane-2-one, cyclohexane-1, 3-dione, carboxymethylcyclohexanone, α, β–unsaturated ketone, nitrocinnamaldehyde, citral, □-terpenol.	**30**

Course Outcomes: After learning this course the students will be able to:

i. Design and apply specific reagents and protection of various functional groups
ii. Develop mechanistic pathways of organic reactions.
iii. Develop retrosynthetic approach to planning organic syntheses.
iv. Design and synthesize the compound based on retro as well as synthetic routes developed.

Text Books:

1. Organic Chemistry, Vol, I.L. Finar ELBS.
2. Stereoselective Synthesis: A Practical Approach, jM. Norgradi, VCH.
3. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.
4. Nogradi, M. Stereoselective Synthesis: A Practical Approach, VCH.

Reference Books:

1. Hostettmann, Kurt; Gupta, M.P.; Marston, A. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers.
2. Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B. Natural Products: Chemistry and Biological Significance, Longman, Essex.

MCHJ0971 PROJECT (DISSERTATION)

Course objective:

i. To encourage the students in research and innovation in frontier areas of chemistry.

ii. To introduce to various stages of research planning and implementation.

iii. To perform scientific research under the supervision of a faculty and learn to coordinate to work in group and independently.

iv. To learn different synthetic methodology and analytical techniques for carrying out scientific research problems particularly to collect and interpret data.

Credits: 8 **Semester IV**

Outcomes: After learning this course the students will be able to:

i. Demonstrate ability to plan and strategize a scientific research problem, and implement it with in areas in limited timeframe.

ii. Develop ability to work both in group as well as independently.

iii. Develop skills in keeping accurate/readable record of their experimental work.

iv. Apply knowledge of chemistry to handle laboratory equipment and hazardous chemicals.

v. Utilize sophisticated instruments for analysis, data collection and interpretation.

vi. Critically examine research articles, and improve their scientific writing/communication skills.