SRI VENKATESWARA UNIVERSITY:: TIRUPATI

SVU COLLEGE OF SCIENCES

DEPARTMENT OF CHEMISTRY
ORGANIC CHEMISTRY

Syllabus for M.Sc. CHEMISTRY

Choice Based Credit System (CBCS)

Amended as per NEP-2020

(w.e.f. the Academic Year 2021-2022)

Vision

Impart quality education & training in the field of chemistry to enable successful careers for the post graduate students in the field of research, education & industry applications of chemical sciences.

Mission

The Department of Chemistry strives:

- To get an ideal balance between knowledge creation and knowledge dissemination in the chemical sciences with a focus to train and mentor students to become responsible scientists and scientifically literate professionals to attain National and International impact.
- To contribute to the improvement of scientific and technological literacy, and the development of critical-thinking and problem-solving skills of all students in order to compete for the world of work and responsible citizenship

PROGRAM EDUCATIONAL OBJECTIVES:

At the end of the program, the student wills be able to:

PEO1	To demonstrate broad knowledge of descriptive chemistry.
PEO2	To impart basic analytical and technical skills to work effectively in various fields of chemistry.
PEO3	To motivate critical thinking and analysis skills to solve complex problems viz., analysis of data, synthetic logistics, spectroscopy, structure and modeling, team based problem solving etc.
PEO4	To demonstrate an ability to conduct experiments in the above sub disciplines with mastery of appropriate techniques and proficiency using core chemical instrumentation and modeling method
PEO5	To develop laboratory competence in relating chemical structure to spectroscopic phenomena.
PEO6	To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment and modern instrumentation.

PROGRAM OUTCOMES: On completion of M.Sc. Chemistry programme, graduates will be able to –

PO1	Have a firm foundation in the fundamentals and application of current chemical and scientific theories in different areas of chemistry *viz*., Analytical, Environmental, Inorganic, Organic and Physical.
PO2	Understands the background of organic reaction mechanisms, complex chemical structures, and instrumental methods of chemical analysis, molecular rearrangements and separation techniques.
PO3	Familiarize with the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
PO4	Understand about the physical aspects of atomic structure, dual behavior, reaction pathways with respect to time, various energy transformations, molecular assembly in nano-level, significance of electrochemistry, molecular segregation using their symmetry.

PO5	Create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.
PO6	Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in the subject concerned. Ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adoptive objective, unbiased and truthful actions in all aspects.
PO7	Be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
PO8	Clearly communicate the results of scientific work in oral, written and electronic formats.
PO9	Explore new areas of research in both chemistry and allied fields of science and technology.
PO10	Design, analyze and carry out scientific experiments and interpret data to provide solutions to different industrial problems.
PO11	Independently carry out research to solve practical problems and present a substantial technical report.
PO12	Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning throughout life, through self- paced and self-directed learning aimed at personal development, and adapting to change academic demands of work place through knowledge/ skill development/ reskilling.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	**Scientific Problem solving skills**: Deep knowledge of the topic which can develop the problem solving skills using chemical principles.
PSO2	**Analytical skills**: Develop analytical skills such as synthesizing, separating, characterizing chemical compounds and chemical reactions with the help of sophisticated instruments
PSO3	**Research skills**: Develop research skills through dissertation/project work in different fields of chemistry such as organic, inorganic, analytical, physical and environmental.
PSO4	**Learning skills on life processes**: Acquire advanced level of knowledge in natural products as well as biological systems from the chemistry point of view.

SRIVENKATESWARAUNIVERSITY::TIRUPATI

DEPARTMENTOF CHEMISTRY

ORGANIC CHEMISTRY

TWO YEAR M.Sc. COURSE IN CHEMISTRY

(2021-2022)SCHEME

Semester -I

Sl. No.	Course Code	Components of Study	Title of the Course	Credit Hrs/ Week	No. of Credits	IA Marks	SEM End Exam Marks	Total
1	CHE-101	Core-Theory	Inorganic Chemistry- I	6	4	20	80	100
2	CHE-102	Core-Theory	Organic Chemistry I	6	4	20	80	100
3	CHE-103	* Compulsory Foundation	a)Physical Chemistry- I b)Chemistry of Nano materials	6	4	20	80	100
4	CHE-104	* Elective Foundation	a)General Chemistry- I b)Green Chemistry	6	4	20	80	100
5	CHE-105	Practicals (Core & Comp.)	a)Inorganic Practical-I b) Physical Chemistry-I	3 3	2 2	- -	- -	50 50
6	CHE-106	Practicals (Core & Elective)	a) OrganicChemistry- I b)General Chemistry-I	3 3	2 2	- -	- -	50 50
7	CHE-107	Audit Course	Values and Professional Ethics – I	0	0	100	-	
		Total		**36**	**24**			**600**

***Among the Compulsory and Elective Foundation a student shall choose anyone.**

SEMESTER-II

Sl. No.	Course Code	Components of Study	Title of the Course	Credit Hrs/ Week	No. of Credits	IA Marks	SEM End Exam Marks	Total
1	CHE-201	Core-Theory	Inorganic Chemistry- II	6	4	20	80	100
2	CHE-202	Core-Theory	Organic Chemistry -II	6	4	20	80	100
3	CHE-203	* Compulsory Foundation	(a)Physical Chemistry- II (b) Advanced Thermodynamics and Biophysical chemistry	6	4	20	80	100
4	CHE-204	* Elective Foundation	a)General Chemistry- II b)Chemistry of contemporary society	6	4	20	80	100
5	CHE-205	Practicals (Core & Comp.)	a)Inorganic Practical-II b) Physical Chemistry-II	3 3	2 2	- -	- -	50 50
6	CHE-206	Practicals (Core & Elective)	a)OrganicChemistry- II b)General Chemistry-II	3 3	2 2	- -	- -	50 50
7	CHE-207	Audit Course	Human Values and Professional Ethics – I	0	0	100	-	
		Total		**36**	**24**			**600**

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M.Sc. (ORGANIC CHEMISTRY)

SEMESTER-III

Sl. No	Course Code	Components of Study	Title of the Course	Credit Hrs/ Week	No. of Credits	IA Marks	SEM End Exam Marks	Total
1	CHE-OC-301	Core-Theory	Organic Chemistry-III	6	4	20	80	100
2	CHE-OC - 302	Core-Theory	Organic Spectroscopy	6	4	20	80	100
3	CHE-OC-303	*Generic Elective	(a) Inorganic Spectroscopy & Thermal Methods of analysis (b) Physical Chemistry III	6	4	20	80	100
4	CHE-OC-304	Core& Gen. Practical	Organic Estimations	6	4	-	-	100
5	CHE –OC-305 A	Skill Oriented Course (theory)	Chemotherapy and drug analysis	3	2	10	40	50
	CHE –OC-305 B	Skill Oriented Course (Practicals)	Multistep preparations	3	2	-	-	50
6	CHE- 306	Open Elective **(For other departments)**	(a) Spectral Techniques (b) Chromatographic Techniques	6	4	20	80	100
		Total		**36**	**24**			**600**

***Among the Generic Elective a student shall choose any one.**

SEMESTER-IV

Sl. No	Course Code	Components of Study	Title of the Course	Credit Hrs/ Week	No. of Credits	IA Marks	SEM End Exam Marks	Total
1	CHE-OC-401	Core-Theory	Organic Synthesis - I	6	4	20	80	100
2	CHE-OC-402	Core-Theory	Organic Synthesis - II	6	4	20	80	100
3	CHE-OC-403	Generic Elective* **(Related to subject)**	(a) Heterocycles and natural Products (b) Bioinorganic, Bioorganic & Biophysical Chemistry	6	4	20	80	100
4	CHE-OC-404	Core& Gen. Practical	Spectral Identification	6	4	-	-	100
5	CHE-OC-405	Core-Practicals/ Project work	Project work	6	4	-	-	100
6	CHE-406	Open Elective **(For other departments)**	(a)Drug Chemistry or (b) Electroanalytical Techniques	6	4	20	80	100
		Total		**36**	**24**			**600**

***Among the Generic Elective a student shall choose any one.**

(Mandatory Core)

CHE-101	INORGANIC CHEISTRY I	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of graduate level chemistry

Course Objectives:

- Comprehend the key features of coordination compounds, Crystal Field Theory, different properties and bonding by spectroscopic techniques
- Study the polymorphic forms of non-transition elements and their synthesis and properties
- Understand the basics of reaction mechanism and the mechanistic concepts of Dissociative (Id) and Associative interchange Mechanism (Ia), Taube's classification, Trans effect and Electron Transfer Reactions
- Familiarize with the methods of synthesis of metal carbonyls and metal nitrosyls, Synergistic effect, EAN and 18-electron rule

Course Outcomes: At the end of the course, the student will be able

CO1	To understand the key features of coordination compounds, Crystal Field Theory, magnetic properties and bonding in transition metal complexes.
CO2	To learn about the polymorphic forms of Carbon, Sulphur and Phosphorus, synthesis and properties of sulphur-nitrogen compounds, boranes, carbides, silicates and to know Wades rules.
CO3	To explain the reactivity of complexes in terms of Valence bond and Crystal Field theories, Taube's classification, Trans effect and Electron Transfer Reactions.
CO4	To gain knowledge on synthesis and structures of different metal carbonyls, synergistic effect and 18 electron rule.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	-	1	-	1	-	2	-	1
CO2	3	1	-	3	-	2	2	2	2	1	-	2
CO3	3	2	-	3	2	-	-	1	-	1	2	1
CO4	3	1	1	3	-	2	2	2	1	-	1	1

CHE 101: INORGANIC CHEISTRY I

UNIT-I: CO-ORDINATION COMPOUNDS 15 Hrs

Introduction to Crystal field Theory, CFSE and its calculation, Paring energy, Splitting of 'd' orbitals in Trigonal bi pyramidal, square planar, square pyramid and pentagonal bipyramidal geometries, Jahn –Teller effect, Application of CFT, OSSE, site Selection in Spinels, Short comings of CFT, Evidence for covalency – Nephelauxetic effect. MOT of co-ordinate bonds –M.O. Diagrams for octahedral, tetrahedral and square planar complexes. Experimental evidences for π- bonding – Crystallography, Infrared spectroscopy and Photoelectron spectroscopy.

UNIT-II: CHEMISTRY OF NON-TRANSITION ELEMENTS 15 Hrs

General characteristics of the non- transition elements special features of individual elements ; Synthesis' properties and structure of their Halides and Oxides, Polymorphism of Carbon, Phosphorus and Sulphur, Synthesis, properties and structure of boranes, Carboranes, borazines, Silicates, Carbides, Sulphur-nitrogen compounds. Electron counting in boranes, Wades rules (Poly hedral skeletal electron pair theory), Isopopoly and hetero poly acids.

UNIT-III: REACTION MECHANISMS IN COMPLEXES 15 Hrs

Reactivity of metal complexes. Inert and Labile complexes. Concept of Labile and Inert complexes in terms of Valence bond and Crystal Field theories. Taube's classification of complexes as labile and inert complexes. Dissociative (D) and Dissociative interchange Mechanism (Id) & Associative (A) and Associative interchange Mechanism (Ia). Substitution reactions in octahedral complexes- Acid Hydrolysis -factors affecting Acid Hydrolysis - Base Hydrolysis-conjugate Base Mechanisms - Anation Reactions -Substitution Reactions in Square Planar complexes- Trans effect – Mechanisms of Trans effect: polarization and π-bonding theories.Electron Transfer Reaction-Inner Sphere and outer Sphere Mechanisms- Marcus theory.

UNIT-IV: METAL πCOMPLEXES-I 15 Hrs

Nature of π bonding, Classification of π ligands, π donor ligands and π -acceptor ligands.

Metal Carbonyls: Synthesis of metal carbonyls, Structures of metal carbonyls of the types M(CO)n (M= Cr, Fe, Ni; n=4-6), $M_2(CO)n$ (M=Co, Fe, Mn; n=8-10), $M_3(CO)_{12}$ (M=Fe, Ru and Os), $M_4(CO)_{12}$ (M=Co, Rh, Ir). IR Spectraof metal carbonyls (i) Detection of bridging and terminal CO ligand, (ii) Synergistic effect, EAN and 18-electron rule. Electron counting methods (i) Oxidation state method and (ii) Neutral Atom method.

Metal Nitrosyls: Synthesis of metal Nitrosyls, bonding, Electron donation by nitric oxide, Models for NO bonding (i) Covalent model and (ii) Ionic models, Structures of metal nitrosyls (1) $[Fe_4S_3(NO)]$ (2)$[Fe_2(NO)_2I_2]$ (3) $[(\phi_3P)_2Ir(CO)Cl(NO)]^+$ (4) $[(\phi_3P)_2Ru(NO)_2Cl]$, Detection of bridging NO ligand, Applications of metal nitrosyls.

Books Suggested

1. F.A.Cotton and G. Wilkinson, Advanced In-organic chemistry VI Edition, 1999.John wiley & sons. Inc., New York.
2. James E. Huheey, Inorganic chemistry- Principles of structure and reactivity, VI Edition 1993. Harper Collins College Publishers, New York.
3. J.D. Lee: Concise Inorganic Chemistry (Blackwell)
4. Gary Wolfsburg: Inorganic Chemistry (5^{th} Ed. (Viva Books)
5. W.L. Jolly: Modern Inorganic Chemistry (McGraw-Hill)
6. B.N Figgis: Introduction to Ligand Fields (John-Willey)
7. S.F.A. Kettle: Coordination compounds.
8. Coordination Chemistry. Bassalo & Jahnson.

(Mandatory Core)

CHE-102	Organic Chemistry I	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of graduate level Organic Chemistry

Course Objectives:

- Classify molecules based on stereo chemical aspects study on optical and geometrical isomerism by the application of Cahn-Ingold-Prelog rules.
- Familiarize with different types of substitution reactions, able to predict products, including stereochemistry in aliphatic and aromatic nucleophilic substitution reactions, effect of neighboring group participation
- Understand thermodynamic and kinetic requirements, kinetic and thermodynamic control, potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects in reactive intermediates
- Study about occurrence, isolation, structure establishment and synthesis of natural products-terpenoids.

Course Outcomes: At the end of the course, the student will be able

CO1	To detect stereochemical structures of the molecules, stereoselective and stereocontrolled reactions.
CO2	To ascertain the stereochemistry of the products with the effect of neighbouring group participation and to familiarize the various types of aromatic substitution reactions, their mechanism and the effect of substituents.
CO3	To know the concept of isotope effects, potential energy diagrams and transition states in different intermediates
CO4	To familiarize with stereospecific synthesis of naturally occurring terpenoids and degradation products of terpenoids

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	2	-	1	1	-	1	-	-
CO2	3	2	1	3	-	1	2		-	2	1	1
CO3	3	1	2	3	-	1	1	2	1	-	1	-
CO4	3	2	2	3	2	1	1	1	-	1	1	1

CHE102: Organic Chemistry I

UNIT-I: **Stereochemistry**

Sereoisomerism-Stereoisomers Classification – Configuration and conformation.

Molecular Three dimensional representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions.

Molecular Symmetry & Chirality: Symmetry operations and symmetry elements (Cn & Sn). Criteria for Chirality. Dissymmetrization.

Optical isomerism: Molecular Symmetry and Chirality-Cahn-Ingold-Prelog rules R, S-nomenclature, stereoisomerism resulting from more than one chiral center, meso and pseudoasymmetric compounds - **Axial Chirality** - Stereochemistry of allenes spiranes - biphenyl derivatives and atropisomerism - **Planar chirality** - Ansa compounds and trans - Cycloalkenes - **Helicity**. Helically chiral compounds

Geometrical isomerism - E, Z - nomenclature - Physical and Chemical methods of determining the configuration of geometrical isomers-Stereoisomerism in 3, 4 and 5-membered cyclic compounds.

UNIT-II: Substitution Reactions

i) Aliphatic Nucleophilic substitutions: The S_N2, S_N1, mixed S_N1 and S_N2, SET mechanisms. Reactivity- effects of substrates, attacking nucleophiles, leaving groups and reaction medium.Common carbocation rearrangements – primary, secondary and tertiary. The neighbouring group participation (NGP) -anchimeric assistance, NGP by σ and π- bonds, phenonium ions, norbornyl and norbornenyl systems, Classical and nonclassical carbocations, NGP by halogens and heteroatoms (O,N,S)

The S_N^i and S_N2' mechanisms. Nucleophilic substitution at an allylic, and vinylic carbons.

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: Reactive intermediates

Types of reactions, types of bond cleavage mechanisms, generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes and arynes. Thermodynamic and kinetic requirements, kinetic and thermodynamic control, potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects**.**

UNIT-IV: Terpenoids

Classification of terpenoids, occurrence, isolation, general methods of structure determination. Isoprene and special isoprene rule. Structure determination and synthesis of the following representative molecules: Farnesol, Zingeberine, Cadinene and Abietic acid.

Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
3. Structure and Mechanism in Organic Chemistry C.K. Inglod, Cornell University Press.
4. Organic Chemistry, R.T Morrison and R.N. Boyd, Prentice - Hall.
5. Principles of Organic Synthesis, R.O.C Norman and J. M. Coxon, Blackie Academic.
6. Stereochemistry, P.S. Kalsi, Wiley Eastern.
7. Text book of Organic Chemistry, M.C. Murry
8. Organic Chemistry, Vol I, I.L. Finar, ELBS Eds.

(Mandatory Core)

CHE-103	Physical Chemistry I	L-5,T-1,P-6	4Credits

Pre-requisite: Basic knowledge about Physical Chemistry

Course Objectives:

- Acquire knowledge in Quantum Chemistry, postulates of Quantum Mechanics., Applications of Schrodinger wave equation and Born-Oppenheimer approximation
- Study on Chemical Dynamics and theories in unimolecular, chain and fast reactions and determination of reaction rates.
- Familiarize with concepts of Thermodynamics and statistical thermodynamics, Gibbs- Duhem equation and Sackur-Tetrade equation
- Know about Thermodynamic and Kinetic concept of Electrochemistry and conductance, conductivity of electrolytes

Course Outcomes At the end of the course, the student will be able to

CO1	To know the concepts such as Operator algebra, Eigen values and Eigen functions, Degeneracy, Schrodinger wave equation and the postulates of Quantum Mechanics.
CO2	To learn about theories of reaction rates, Lindemann, Lindemann-Hinshel wood, and RRKM theories.
CO3	To know about Thermodynamic concepts and entropy change in reversible process and irreversible process, Gibbs- Duhem equation, calculation of thermodynamic properties.
CO4	To study the Thermodynamic and Kinetic Derivation of Nernst Equation and the derivation of Debye-Huckle Equation and its Verification

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	3	2	1	--	1	2	---	1	1
CO2	3	1	2	3	1		1		1	1	-	1
CO3	3	-	1	3	2	1	-	1		-	2	-
CO4	3	1	2	3	-	1	1	-	2	1	-	1

CHE-103: Physical Chemistry I

UNIT-I: Quantum Chemistry-I

(A)**Introduction to Exact Quantum Mechanical Results**

Operator algebra, Eigen values and Eigen functions, Operators for momentum and energy, Degeneracy, Linear combination of Eigen functions of an operator, well behaved wave functions, Normalized and orthogonal functions, The schrodinger wave equation and the postulates of Quantum Mechanics, (B) **Applications of Schrodinger wave equation:** Particle in one dimensional and three dimensional box, harmonic oscillator, rigid rotor, hydrogen atom and its applications. Hydrogen like wave function, hydrogen like orbitals and their representation, polar plots, contour plots and boundary diagram. (C)**Approximate Methods:** The variation Theorem, Linear variation principle, perturbation Theory (first Order and non-degenerate), Application of variation Method and perturbation theory to the helium atom, The Born-Oppenheimer approximation.

UNIT-II: Chemical Dynamics

(A)**Theories of reaction rates:** Collision theory, steric factor. Theory of Absolute Reaction Rates-Reaction coordinate, activated complex and the transition state. Thermodynamic formiulation of reacton rates.

(B) **Unimolecular reactions:** Lindemann, Lindemann-Hinshel wood, and RRKM theories. Termolecular reactions. Complex reactions-Rate expressions for opposing, parallel and consecutive reaction (all first order type) (C) **Chain reactions:** Dynamic chain, hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane, photochemical reactions- H_2-Br_2, H_2-Cl_2 reactions, Autocatalysis, H_2-O_2 reaction explosion limits. (D) **Fast Reactions:** Flow system – Temperature and pressure Jump Methods – Relaxation Techniques.

UNIT – III : Thermodynamics

(A) **Brief review of Thermodynamic concepts:** Enthalpy, entropy, free energy. Concept of Entropy – Entropy as a state function –Entropy change in reversible process and irreversible process – Temperature – Entropy diagrams – Entropy change and phase change – Entropy of mixing – Entropy and disorder. (B) **Statistical thermodynamics:** Partial molar properties: their significance and determination of partial molar properties, fugacity and its determination. Concept of distribution, thermodynamic probability and most probable Distribution, Ensemble averaging, postulates of ensemble averaging, canonical, grand canonical and micro- canonical ensembles, partition functions, translational, rotational, vibrational and electronic partition functions, Gibbs- Duhem equation, calculation of thermodynamic properties in terms of partition functions, Entropy of monatomic gases (Sackur-Tetrade equation)

UNIT-IV : Electrochemistry I

(A) **Thermodynamic and Kinetic concept of Electrochemistry**

Thermodynamic and Kinetic Derivation of Nernst Equation, Chemical and Concentration Cells with and without Transference, Liquid Junction Potential, Derivation of the Expression for Liquid Junction Potentials-its determination and elimination, Applications of EMF Measurements: (i)Solubility product, (ii)pH Determination, (iii) Potentiometric Titrations.; (B)**Conductivity:** Theory of Electrolytic Conductance, Derivation of Debye-Huckle Equation and its Verification, Debye- Falkenhagen Effect, and Wein Effect, kohlrausch law. Calculation of Solubility of Sparingly soluble Salt from Conductance Measurements.

Conductometric Titrations : Titration of Strong Acid Vs Strong Base (HCl vs NaoH) ; Titration of Weak Acid Vs Strong Base (AcoH vs NaoH); Titration of mixture of Strong and Weak Acids vs Strong Base ; Precipitation Titrations.

Books Suggested

1. physical chemistry, P. W. Atkins (ELBS)
2. Quantum Chemistry, Ira N. Levine (Prentice Hall)
3. Atomic Structure and Chemical bond, Manas Chandra.
4. Chemical Kinetics, K.J. Laidler (Mc Graw Hill)
5. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose (Mcmilan)
6. Thermodynamics for chemists, S. Glasstone
7. Chemical thermodynamics, I.M. Klotz
8. Statistical Thermodynamics, M. Dole
9. Modern Electrochemistry, Vol. I & II, J.O. M. Bockris and A.K.N. Reddy (plen
10. An Introduction to Electrochemistry (3^{rd}ed.), S. Glasstone (Affiliated East-West).

(Compulsory Foundation)

CHE-104 (A)	General Chemistry I	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of graduate level Chemistry

Course Objectives:

- Gain knowledge on precision and accuracy, Limit of detection, Limit of determination, Sensitivity and selectivity, statistical evaluation of data
- Familiarize with principles and concepts of flame emission spectroscopy and atomic absorption spectroscopy and their applications.
- To know about ecosystem, nutrient cycle and dessert ecosystem and forest ecosystem and aquatic ecosystem.
- Gain knowledge on air pollution, water pollution, soil pollution, marine pollution, noise pollution and solid waste management.

Course Outcomes: At the end of the course, the student will be able

CO1	To know about mean and median values, standard deviation and coefficient of variation.
CO2	To acquire knowledge on principle and instrumentation of AAS and difference between flame AAS and furnace AAS.
CO3	To know about the principle and concept of ecosystem and their functioning
CO4	To have an idea on environmental pollution and environmental impact assessment.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	-	1	-	-	2	1	1
CO2	3	2	-	3	1	-	2	1	-	1	1	-
CO3	3	3	2	3	2	1		1	2	1	1	2
CO4	3	2	1	2	3	1	1	1	-	2	1	1

CHE104-A: General Chemistry I

UNIT-I: TREATMENT OF ANALYTICAL DATA 15 Hrs

Precision and accuracy –mean and median values –Standard deviation – coefficient of variation, Types of errors: Determinate and indeterminate errors, confidence limits, significant figures, computations, minimization of errors, statistical evaluation of data –T-test ,F- test , and X^2 –test. Correlation coefficient and coefficient of determination; Limit of detection (LOQ); Limit of determination(LOD) Sensitivity and selectivity of an analytical method.

UNIT-II: FLAME EMISSION AND ATOMIC ABSORPTION SPECTROSCOPY 15 Hrs

(a) **Flame Emission Spectroscopy**: Principles, chemical reactions in flames, Interferences, evaluation methods, flame photometer and experimental technique, procedure for determinations, limitations and disadvantages. Applications

(b)**Atomic Absorption Spectroscopy: Flame AAS:** Principle, Instrumentation – Sources of radiation (HCL and EDL), Different types of burners, Interferences- Physical, Chemical, spectral and back ground correction, and methods of minimization

GF AAS: Principle and technique –Comparison between Flame AAS and furnace AAS, Applications of AAS, Comparison between Atomic Absorption & Flame Photometry.

UNIT-III: ECOSYSTEMS **15 Hrs**

Concept of an ecosystem (Abiotic and biotic environment), structure and function of an ecosystem Producers, Consumers and decomposers. Energy flow in the ecosystem, (Nutrient cycle in the ecosystem) Ecological succession Food Chain, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems, Forest ecosystem, Grassl and ecosystem, Desert ecosystems aquatic ecosystems [ponds, streams, lakes, rivers, ocean estuaries].

UNIT-IV: ENVIRONMENTAL POLLUTION **15 Hrs**

Definition a) Air pollution b) Water pollution c) Soil pollution d) Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear pollution Solid waste management : Causes, effects and control measures of urban and industrial wastes. Environmental impact assessment.

Books Suggested

1. H.W. Willard, LL. Merritt and J.A. Dean: Instrumental Methods of Analysis
2. Vogel's Text book of Quantitative Inorganic Analysis.
3. Analytical Chemistry
4. Instrumental Methods of Analysis H. Kaur

CHE 104B	General Chemistry I	L-3,T-1,P-2	4Credits
Pre-requisite: Understanding of graduate level Chemistry			
Course Objectives: • To familiarize with the significance of green chemistry and assessment of the impact. • To gain knowledge on biocatalyst in oxidation, reduction and hydrolytic reactions • To have an idea on solvent free reactions and modern reaction techniques. • To familiarize with the use of ionic liquids as green solvents.			
Course Outcomes: At the end of the course, the student will be able			
CO1	To get knowledge on green reaction conditions and their impact on environment.		
CO2	To know about use of different biocatalysts as environmentally friendly reagents.		
CO3	To acquire knowledge on the use of modern techniques like ultrasound, microwave etc.		
CO4	To have an idea on the use of ionic liquids in different reactions.		

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	1	1	-	1	-	1	1
CO2	3	1	1	3	1	-	1	1	-	1	-	1
CO3	3	3	2	3	2	1		2	-	1	1	1
CO4	3	2	1	2	3	1	1	1	1	-	1	1

CHE 104B: General Chemistry I

UNIT-I

Fundamentals and significance of Green Chemistry: Discussion of the current state of chemistry and the environment and the definition of green chemistry. Assessment of the impact of chemistry in the environment and definition of risk hazard. An introduction to the tools of green chemistry and its fundamental principles.

Principles of Green Chemistry: Prevention of waste / by-products, Hazardous products- Designing of safer chemicals- Selection of appropriate solvents and starting materials- Use of protecting groups and catalysis- Designing of biodegradable products.

UNIT-II

Catalysis for Green Chemistry: Use of biocatalysts- Biochemical Oxidation, Biochemical Reduction, Enzyme Catalyzed Hydrolytic Process, Modified biocatalysis- transition metal catalysis- Reformatsky reaction, Wurtz reaction, Pinacol coupling, Simmons-Smith reaction, Mukaiyama reaction, Heak reaction, Ullmann's coupling.

UNIT-III

Solvent Free Reactions: Solvent free techniques- Reactions on solid mineral supports, Phase Transfer Catalysis- C-alkylation, N-alkylation, S-alkylation, Darzen's reaction, Wittig reaction. Ultrasound assisted green synthesis- Oxidation, Reduction, Hydroboration, Bouveault reaction, Strecker reaction, Microwave assisted green synthesis- Biginelli reaction, Aza-Michael reaction, Suzuki reaction, Stille reaction, Sonogashira reaction.

UNIT-IV

Ionic liquids: Definition- Types of Ionic Liquids-Synthesis of Ionic Liquids- Selection of ionic liquids- physical properties- Application in organic synthesis- alkylation, allylation, oxidation, reduction, polymerization, hydrogenation, hydroformylation, alkoxycarbonylation, carbon-carbon bond forming reactions, alkene metathesis.

Books suggested:

1. New Trends in Green Chemistry by V.K. Ahluwalia, M. Kidwai.
2. Green Chemistry: Environment Friendly Alternatives by Rashmi Sanghi, M M Srivastava
3. Green Solvents for Organic Synthesis by V.K. Ahluwalia, Rajender S. Varma
4. Green Analytical Chemistry by Mihkel Koel and Mihkel Kaljurand

CHE 105 A & B	**Core practical I: Inorganic & Physical Chemistry**	**L-5,T-1,P-0**	**4 Credits**

Pre-requisite: Understanding of graduate level Inorganic & Physical Chemistry practical.

Course Objectives:

- Basic laboratory techniques of titration and analysis.
- Quantitative estimation of inorganic compounds through volumetric techniques.
- Calibration of volumetric apparatus and statistical analysis of the data.
- Determination of critical solution temperature of phenol-water system.

Course Outcomes: At the end of the course, the student will be able

CO1	To demonstrate mastery of basic semi-micro qualitative analysis of simple salts and interprets analytical data and will make scientific claims that are supported by the observations.
CO2	To familiarize with techniques of titration and calculation of errors.
CO3	To study the determination of critical solution temperature, eutectic composition, distribution coefficient, adsorption of different systems.
CO4	To calibrate the statistical data

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	2	-	1	2	1	2	-
CO2	3	2	2	2	-	2	1	1	-	2	2	1
CO3	3	2	1	2	2	1	-	2	1	1	2	1
CO4	3	2	2	1	2	1	-	2	2	1	1	1

CHE 105 A & B: Core practical I: Inorganic & Physical Chemistry

Semi Micro Qualitative Analysis

Qualitative Analysis of a mixture containing four cations including two less common cations (viz., W, Mo, Se, Te, V, Ce, Th, Zr, Li and U).

1. Determination of critical solution temperature, eutectic composition and temperature of binary system.
2. Calibration of volumetric apparatus and statistical analysis of the data.
3. Determination of critical solution temperature of phenol-water system and study the effect of electrolyte on CST.
4. Determination of Eutectic composition and temperature of binary system
5. Determination of distribution coefficient of benzoic acid between water and benzene.
6. Study the adsorption of acetic acid on charcoal and analysis of the data on the basis of Langmuir and Freundlich adsorption isotherms.
7. Determination of rate constant of acid hydrolysis of an ester and investigate the effect of catalyst concentration, reactant concentration and temperature.

CHE 106A & B	Core practical I: Organic & General Chemistry	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of graduate level Organic & General Chemistry practical.

Course Objectives:

- Identification of single organic component by systematic qualitative analysis
- Preparation of derivatives and purification process
- Single step preparations
- Calibration of spectral analysis to this structures

Identification of single organic component by systematic qualitative analysis.

Course Outcomes: At the end of the course, the student will be able

CO1	To familiarize the systematic procedures of analysis of organic components.
CO2	To know the conformational tests for various functional groups.
CO3	To understand the mechanisms and familiarize with methodologies to prepare biologically important molecules.
CO4	Purification of compounds by different process

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	2	-	1	-	1	1	-
CO2	3	2	2	3	-	2	-	1	1	-	1	2
CO3	2	2	2	1	2	1	2	1	-	1	-	2
CO4	1	2	2	1	1	1	1	-	1	1	1	2

CHE : 106 B : PRACTICAL – II : ORGANIC CHEMISTRY

Single step preparations

1. Preparation of aspirin
2. Preparation of p-nitroacetanilide
3. Preparation of p-bromoacetanilide

CHE 107	Human Values and Professional Ethics-I	L-3,T-1,P-2	4 Credits

Pre-requisite: Understanding of graduate level Human Values and professional ethics

Course Objectives:

- Analyze values in various ethical professions
- Understand moral concepts, character and conduct multiple
- Concept of ethical values with respect to individual and society
- ethical interests at stake in areal-world situation or practice and assess own ethical values with respect to social context and problems

Course Outcomes: At the end of the course, the student will be able to

CO1	To know about the needs and importance of professional ethics.
CO2	To analyze nature of Values, basic Moral Concepts character and Conduct.
CO3	To gain knowledge on individual and society ethical values, ahimsa, satya and brahmacharya.
CO4	To understand values of Bhagavd Gita, various religions, religious tolerence, Gandhian ethics.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	3	2	-	1	2	3	1	1	2
CO2	3	2	2	3	1	1	1	2	3	-	-	2
CO3	3	1	2	3	2	-	1	-	-	1	1	3
CO4	3	1	1	3	-	1	2	2	2	2	-	3

CHE 107: ELECTIVE FOUNDATION (HUMAN VALUES AND PROFESSIONAL ETHICS – I)

Chapter I: Definition and Nature of Ethics – Is relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics – Goals – Ethical Values in Various Professions.

Chapter II: Nature of Values – Good and Bad, Ends and Means, Actual and Potential Values, Objective and Subjective Values, Analysis of Basic Moral Concepts – Right, Ought, Duty, Obligation, Justice, Responsibility and Freedom, Good Behavior and Respect for Elders, Character and Conduct.

Chapter III: Individual and Society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non Possesion) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues) - Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation), Crime and Theories of Punishment – (a) Reformative, Retributive and Deterrent, (b) Views on Manu and Yajnavalkya

Chapter IV: Bhagavd Gita – (a) Niskama Karma, (b) Buddhism – The Four Nobel Truths – Arya astanga marga, (c) Jainism - Mahavratas and Anuvratas. Values Embedded in Various Religions, Religious Tolerence, Gandhian Ethics.

Books for study:

1. Johns S Mackenjie: A Manual of ethics
2. “The Ethics of Management” by Larue Tone Hosmer, Richard D. Irwin Inc.

3. “Ethics in Management” by S.A. Shelekar, Himalaya Publishing House.
4. Harold H. Titus: Ethics for Today
5. Maitra, S.K: Hindu Ethics
6. William Lilly: Introduction to Ethics
7. Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
8. Sasruta Samhita: Tr. Kaviraj Kunjanlal, Kunjanlal Brishagratha, Chowkamba Sanskrit Series, Vol I,II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
9. Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
10. Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
11. Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
12. I.C. Sharma Ethical Philosophy of India. Nagin& Co Julundhar.

(Mandatory Core)

CHE - 201	Inorganic Chemistry II	L-5, T-1, P-0	4 Credits

Pre-requisite: Understanding of graduate level chemistry

Course Objectives:

- Understand magnetic properties of transition metal complexes and various reactions on ligands with respect to synthesis.
- Gain knowledge on electronic spectra of complex molecules of octahedral and tetrahedral geometry
- Understand magnetic properties viz., diamagnetism and paramagnetism and other related properties of complex molecules
- Familiarize with different catalytic reactions of complex molecules and factors effecting the reactions.

Course Outcomes: At the end of the course, the student will be able

CO1	To familiarize with the general methods of complex preparations and properties, nature of bonding and structural features of metal complexes.
CO2	To know about Russel-Saunders coupling, splitting of energy levels in octahedral field and differentiate between Orgel diagrams and Tanabe-Sugano diagrams.
CO3	To understand about the laws of Hunds, Curie and Weiss, magnetism and magnetic susceptibility determination by Gouy's and Farady methods.
CO4	To gain knowledge on Induced reactions, Free radical reactions, Thermal decomposition reactions, Chain reactions.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	-	2	1	-	2	1	-	1
CO2	3	2	-	3	1	2	1	-	1	2	1	1
CO3	3	-	2	3	-	2	1	1	-	1		1
CO4	3	1	1	3	-	2	-	1	1	1	1	-

CHE 201: INORGANIC CHEISTRY II

UNIT – I: TRANSITION METAL II – COMPLEXES II 15 Hrs

Transition metal π – complexes with unsaturated organic molecules – alkenes, alkynes, diene, dienyl and Cyclopentadienyl complexes and arene complexes-general methods of preparation, properties, nature of bonding and structural features – Important reactions relating to Nucleophilic and Electrophilic attack on ligands and to organic synthesis.

UNIT – II: ELECTRONIC SPECTRA OF COMPLEXES 15 Hrs

Russel-Saunders coupling – Spectroscopic term symbols- Derivation of term symbols of p^2 and d^2 configuration, Hole Formulation, Energy ordering of terms (Hund's Rules), Splitting of energy levels and spectroscopic states in Octahedral field, Selection rules – Break – down of selection rules, Orgel diagrams, Definition and utility–Orgel Diagrams for d^1 to d^9 configurations in Octahedral and tetrahedral fields. Interpretation of electronic spectra of high spin octahedral and tetra hedral complexes of Ti(III), V(III), Cr(III), Mn(III), Mn(II), Fe(II), Fe(III), Co(III), Co(II), Ni(II) and Cu(II) complexes, Calculation of Dq and B^1 parameters for Cr(III) and Ni(II) complexes. Tanabe – Sugano diagrams, Differences between Orgel diagrams and Tanabe – Sugano diagrams, Tanabe – Sugano diagrams of d^2 to d^6 and d^8 configurations. Charge transfer spectra- LMCT and MLCT.

UNIT – III: MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES 15 Hrs

Diamagnetism and paramagnetism-orbital and spin contributions, spin-orbit coupling, Hunds third rule and Energies of J levels – Curie law and Curie – Weiss law- Ferromagnetism and antiferromagnetism – Temperature independent magnetism Magnetic susceptibility and its determination by Gouy's and Faraday methods.Calculation of magnetic moment from magnetic susceptibility, spin-only formula, Orbital contribution to magnetic moment (Oh and Td Complexes) –Paramagnetism and crystalline fields – Ti (III), V (III), VO^{2+}, Cr (III), Mn (II), Fe (III), Co(II), Ni (II) and Cu (II). Magnetic Exchange in copper acetate and other dimmers – spin cross over in complexes.

UNIT –IV: CATALYSIS 15 Hrs

Homogeneous catalysis, Metal ion catalyzed reactions – Redox potentials and processes – Mechanism of redox processes involving ligands – Factors affecting redox potentials - other types of metal catalyzed reactions – Reactions involving Ag (I) , Cu (II) and Os (VIII) – Reactions of Oxyanions – Factors affecting rate (General discussion only) – Induced reactions – Free radical reactions – Thermal decomposition of peroxy disulphate – Fe(III) $–S_2O_8$ reactions – chain reactions – H-Br reactions, H_2O_2 $–S_2O_8$reactions.

Books Suggested

1. Inorganic Chemistry principles of Structure and Reactivity 6th Edition. James E. Huheey.
2. Organometallic Chemistry: R.C. Mehrotra and Singh.
3. R. S. Drago: Structural methods in Inorganic Chemistry.
4. H. H. Willard, L. L. Merritt, Jr., J. A. Dean and F. A. Settle, Jr.: Instrumental Methods of Analysis (CBS Publishers).
5. R. L. Carlin: Magnetic Chemistry. R. L. Datta and A. Syamal: Elements of Magnetic Chemistry.

(Mandatory Core)

CHE-202	Organic Chemistry II	L-3, T-1, P-2	4 Credits

Pre-requisite: Understanding of Organic Chemistry

Course Objectives:

- Able to recognize, classify, explain, and apply fundamental organic reactions such as E2, E1, E1CB.
- Familiar with molecular rearrangements involving electron deficient carbon, nitrogen and oxygen atoms and electron rich carbon atom.
- Provide Hantzsch-Widmann nomenclature for the three and four membered heterocycles. Be able to predict synthetic routes and chemical reactions of these heterocycles.
- Be familiar with occurrence, isolation, structural elucidation and synthesis of natural products-alkaloids

Course Outcomes: At the end of the course, the student will be able

CO1	To familiarize the mechanisms of E_1, E_2 and E_{1CB} reactions, steroselectivity and synpyrolytic eliminations and use of isotopes, chemical trapping and crossover experiments.
CO2	To learn the rearrangements involving electron deficient carbon, nitrogen and oxygen atoms and electron rich carbon atom and familiarize with the limitations and applications of reactions.
CO3	To learn the synthesis of three and four membered heterocycles, mechanism of ring opening reactions and the effect of electron donating and withdrawing substituents in selectivity of ring opening reactions.
CO4	To understand the structural elucidation and synthesis of alkaloids using specific reagents.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	-	2	1	-	1	1	1	-
CO2	3	2	2	3	2	2		1	1	-	1	1
CO3	3	2	2	3	2	2	1	1	-	1	-	1
CO4	3	2	2	3	-	2	-	1	-	1	1	1

CHE- 202 : ORGANIC CHEMISTRY II

UNIT-I: Reaction mechanism-I **15 Hrs**

Electrophilic addition to carbon carbon double bond: Stereoselective addition to carbon carbon double bond; anti addition- Bromination and epoxidation followed by ring opening. Syn addition of OsO_4 and $KMnO_4$.

Elimination reactions Elimination reactions E_2, E_1, E_{1CB} mechanisms. Orientation and stereoselectivity in E_2 eliminations. Pyrolytic syn elimination and α-elimination, elimination Vs substitution. Facors influencing the elimination reactions

Determination of reaction mechanism: Determination of reaction mechanism: Energy profiles of addition and elimination reactions, transition states, product isolation and structure of intermediates, use of isotopes, chemical trapping, crossover experiments. Use of IR and NMR in the investigation of reaction mechanism.

UNIT-II: Molecular Rearrangements: **15 Hrs**

Rearrangements to electron deficient Carbon atom:
Pinacol-Pinacolone, Wagner-Meerwein, Dienone-Phenol and Demjonove Rearrngements
Rearrangements to electron deficient Nitrogen atom:
Hofmann, Curtius, Schimidt and Beckmann Rearrangements.
Rearrangements to electron deficient Oxygen atom: Baeyer-Villiger and Dakins Rearrangements
Rearrangements to electron rich Carbon atom: Favorski and Neber Rearrangements
Aromatic and Sigmatropic Rearrangements: Fries and Claisen Rearrangements

UNIT III: Three and four membered heterocycles: 15 Hrs

Systematic nomenclature (Hantzsch-Widmann system) and Replacement nomenclature for monocyclic heterocycles (Three and four membered rings). Synthesis and chemical reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes, and thietanes.

UNIT-IV: Alkaloids 15 Hrs

Occurrence, isolation, general methods of structure elucidation and physiological action, degradation, classification based on nitrogen heterocyclic ring, structure elucidation and synthesis of the following: Atropine, Papaverine and Quinine.

Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
3. Structure and Mechanism in Organic Chemistry C.K. Inglod, Cornell University Press.
4. Organic Chemistry, R.T Morrison and R.N. Boyd, Prentice - Hall.
5. Modern Organic Reactions, H.O. House, Benjamin.
6. Principles of Organic Synthesis, R.O.C Norman and J. M. Coxon, Blackie Academic.
7. Stereochemistry, P.S. Kalsi, Wiley Eastern.
8. Text book of Organic Chemistry, M.C. Murry
9. Text book of Organic Chemistry, Fessendon and Fessendon.
10. Text book of Organic Chemistry, T.W. Solomon,
11. Organic Chemistry, Vol II, I.L. Finar, ELBS Eds.
12. Heterocyclic chemistry T.L Gilchrist, Longman Scientific Technical
13. An Introduction to the Heterocyclic compounds, R M Acheson, John Wiley.

(Mandatory Core)

CHE -203	Physical chemistry II	L-5,T-1,P-6	4Credits

Pre-requisite: Basic knowledge about Physical Chemistry

Course Objectives:

- Learn Angular momentum and Molecular Orbital Theory and application of Huckel theory to organic molecules.
- Know about concepts in Surface Chemistry, concept of electric double layer model and Micelles.
- Get knowledge on symmetry and group theory their use in spectroscopy, Mulliken character tables.
- Understand Irreversible Electrode phenomenon controlled potential electrolysis and polarography.

Course Outcomes At the end of the course, the student will be able

CO1	To know about Pauli Exclusion principle and Slater determinant, atomic orbitals, Simple molecular orbitals and Huckel theory of conjugated systems.
CO2	To learn Gibbs adsorption isotherm, BET equation and correlate limitations, critical micellar concentration (CMC) and factors affecting the CMC of surfactants.
CO3	To identify Relation between order of a finite group and its sub-group, conjugacy, Symmetry point group (MLS, MHS and MSS) and orthogonality theorem.
CO4	To acquire knowledge on DC-Polarography, AC-Polarography, Controlled Potential Electrolysis, to derive equation for Tafel plots, half-wave potentials for reversible system.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	-	2	-	1	1	1	2	-
CO2	3	2	2	3	2	2	-	1	1	1	-	1
CO3	3	2	2	3	-		1	-	-	1	1	-
CO4	3	2	-	2	1	1	-	1	1	1	1	-

CHE-AC-203 Physical Chemistry III

UNIT-I: Quantum Chemistry-II **15 Hrs**

(A) Angular momentum: Angular momentum, Rotations and angular momentum, Eigen functions and Eigen values of angular momentum, Ladder operator, addition of angular momenta, spin, antisymmetry and pauli Exclusion principle. Slater determinant. ;

(B) Molecular Orbital TheoryAtomic Orbitals, Simple Molecular Orbitals, Hybrid Atomic Orbitals, Shapes and energies of Molecular Orbital, Systems of Organic Molecules (Ex: Methane, Ethylene, Acetylene). Huckel theory of conjugated systems, Π-bond order and charge density calculations, application of Huckel theory to ethylene, butadiene and benzene.

UNIT-II: Surface Chemistry **15 Hrs**

Surface tension, capillary action, pressure difference across curved surface, (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET adsorption isotherm, derivation of BET equation , limitations of BET equation, estimation of surface area from BET equation, Surface films on liquids. Concept of electric double layer model- Helmholtz perrin, Gouy- Chapman and stern models (no derivation)

Micells: Surface active agents, classification of surface active agents micellisation, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellisation, emulsions, reverse micelles.

UNIT-III: SYMMETRY AND GROUP THEORY **15 Hrs**

Definition of a group, rules that are set for a group, sub-group, order of a group, Relation between order of a finite group and its sub-group, conjugacy relation and class of a group, symmetry elements and symmetry operation. Symmetry point group (MLS, MHS and MSS), Schoenflies symbols - Representation of groups by matrices (representation for C_n, C_{nv}, D_{nh} etc. groups to be worked out explicitly), character of a representation, group multiplication tables, reducible - irreducible representations The great orthogonality theorem (without proof) - character tables (H_2O,NH_3) and their use in spectroscopy, Mulliken character tables.

UNIT-IV: ELECTROCHEMISTRY- II **15 Hrs**

Irreversible Electrode phenomenon: Reversibility and irreversibility, Dissolution and deposition potentials, Decomposition voltage, overvoltage, diffusion overvoltage, charge transfer overvoltage, concentration overvoltage-hydrogen and oxygen overvoltages, Tafel plots, Exchange current density and Transfer coefficient, Butler-Volmer equation for one electron transfer processes.

Polarography: Theory, classification , principle , Instrumentation of Polarography, DME, HMDE diffusion current, Ilkovic equation, DC-Polarography, AC-Polarography, Controlled Potential Electrolysis, Millicoulometry, Equation for half-wave potentials, for reversible system when oxidant alone, reductant alone and both are present.

Books Suggested

1. P.W. Atkins: Physical Chemistry (ELBS).
2. Ira N. Levine: Quantum Chemistry (Prentice Hall).
3. R. Mcweeny: Coulson's Valence (ELBS).
4. J.O.M. Bockris and A.K.N. Reddy, Modern Electrochemistry, vol.I & II (Plenum).
5. S. Glasstone; An Introduction to Electrochemistry (3rd ed.)(Affiliated East-West).
6. V. Moroi: Micelles, theoretical and applied aspects (Plenum).
7. Maron and prutton: principles of physical Chemistry.
8. Silbey, Alberty, Bawendi. Physical Chemistry.Jhon-Wiley & Sons. 4th edition-2006.
9. D.N. Bajpai: Advanced physical Chemistry: S. Chand & Company, 1998.

(COMPULSORY FOUNDATION)

CHE-204 A	General Chemistry II	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of graduate level Chemistry

Course Objectives:

- Gain knowledge on the principles of different electro analytical methods
- Familiarize with chromatographic techniques.
- To study on biodiversity and conservation of biodiversity
- To know about natural resources and non-renewable resources

Course Outcomes: At the end of the course, the student will be able

CO1	To acquire knowledge on ion selective electrodes, solid membrane electrodes and glass electrodes and principles of amperometric titrations.
CO2	To learn general principles and classifications of chromatographic separations and applications of TLC, GLC and HPLC.
CO3	To know about biodiversity, ecosystem diversity and conservation of biodiversity.
CO4	To acquire knowledge on natural resources related to food, water, mineral, energy and land.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	2		1	-	1	1	2
CO2	3	-	2	3	-	2	1	-	2	1	1	1
CO3	3	3	2	2	1	2	-	1	-	-	1	2
CO4	3	3	2	2	2	2	1	1	-	1	1	1

CHE 204-A: General Chemistry II

UNIT-I: ELECTRO ANALYTICAL METHODS

Theory of potentiometry, calculation electrode potential at the equivalence. Finding of equivalence volume, derivative and linear titration plots. Ion-sensitive electrodes –types of ion sensitive electrodes – metal based cation and anion sensitive electrodes, solid membrane electrodes, glass electrodes. Liquid ion-exchange electrodes, gas sensing membrane electrodes, Amperometric titrations - Anodic stripping voltammetry, chronoamperometry, chronopotentiometry, Cyclic Voltammetry, Differential Pulse Polarography, linear sweep voltammetry, square wave voltammetry.

UNIT-II: CHROMATOGRAPHY

General principles and classifications of chromatographic separations

Thin layer chromatography: Classification, principle, experimental technique, sample application, development of plate, retardation factor.

Gas liquid chromatography: Gas liquid chromatography - instrumentation (columns and detectors), retention time and retention volume. Chromatographic behaviour of solutes, column efficiency and resolution, column processes and band broadening, time of analysis and resolution, Van-Deemter equation.

High performance liquid chromatography: Theory and instrumentation-column performance, gradient elution, delivery system, sample introduction, separation columns, detectors and applications of HPLC.

Unit – III : Biodiversity

Conservation introduction definition genetic species and ecosystem diversity, hot spots of biodiversity, threats to biodiversity habitat loss poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India, conservation of biodiversity in – situ an ex-situ conservation of biodiversity.

Unit – IV Natural resources and non-renewable resources

An overview of natural resources and associated problems with references to a) Forest resources b) Water resources c) Mineral resources d) Food resources e) Energy resources f) Land resources.

Books Suggested

1. H.W. Willard, LL. Merrit and J.A.Dean: Instrumental Methods of Analysis. Affiliated East-West).
2. G.H. Jeffery J. Bassett, J. Mendham and R.C. Denny. Vogel"s Text Book of Quantitative Chemical Analysis (ELBS).
3. D.A. Skoog and D.M. West: Principles of Instrumental Analysis (Holt, Rinehart and Wilson).
4. J.G. Dick : Analytical Chemistry (McGraw Hill).
5. D. Midgley and K. Torrance : potentiometric Water Analysis (John Wiley).
6. Silbey, Alberty, Bawendi. Physical chemistry. Jhon-Wiley & sons. 4th edition-2006.

CHE 204B	Chemistry in Contemporary Society	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of graduate level Chemistry

Course Objectives:

- To know about quality control and impurities in Pharmaceuticals.
- To have an idea on body fluids, blood, enzymes and forensic.
- To gain knowledge on composition of milk, oil, fats etc.
- To familiarize with different types of fuels, soils and its ingredients.

Course Outcomes: At the end of the course, the student will be able

CO1	To acquire knowledge in pharmaceutical chemicals
CO2	To familiarize with blood fluids, blood, enzymes and forensic
CO3	To know about fermentation, detection of purity, beverages
CO4	To acquire knowledge on gaseous fuels, soil ingredients and analysis of trace elements

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	2	-	2	2	-	1	1
CO2	3	1	2	3	1	2	1	-	2	2	1	-
CO3	3	2	2	3	1	2	2	1	-	2	1	1
CO4	3	2	3	2	1	2	1	2	-	1	1	1

CHE 204B: Chemistry in Contemporary Society

UNIT – I : PHARMACEUTICALS 15 Hrs

Pharmaceuticals : Importance of quality control, drugs and pharmaceuticals, sources of impurities in pharmaceutical chemicals, analytical quality control in finished / final products, common methods of assay.

Common drugs and their uses: Analgesics – aspirin, paracetamol; Antheimentics – mebendazole ; Antiallergies – chlorpenneramine malleate; Antibiotics-pencillin, chloromecytin; Anti-inflammatory agents-oxyphenbutazone; **Antimalarials** – primaquine phosphate; Antituberculosists – INH; Narcotics – nicotine, morphine; Expectorants – Benadryl; Sedatives – diazepam; Vitamins – B**1**, B**2**, B**6**, niacin and folic acid.

UNIT – II : FORENSIC AND BIOMEDICALS 15 Hrs

Body fluids: Composition and detection of abnormal level of certain constituents leading to diagnosis, sample collection and preservation of physiological fluids, analytical methods for the constituents of physiological fluids (blood, urine).

Blood: Estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.

Urine: Urea, uric acid, creatinine, calcium phosphate, sodium, potassium and chloride.

Enzymes: Biological significance, assay of enzymes (pepsin, tyrasinase), vitamins (thiamine ascorbic acid, vitamin A) and harmones (progesterone, oxytocin, insulin), chemical, instrumental and biological assays to be discussed wherever necessary.

Forensic : General discussion of poisons with special reference to mode of action of cyanide organophosphates and snake venom, poisonous materials such as lead, mercury and arsenic in biological materials.

UNIT – III : FOOD AND BEVERAGES **15 Hrs**

Milk and milk products : Composition, alcohol test, fermentation, dye reduction-methylene blue and resazurin tests, analysis of fat content, minerals in milk and butter, estimation of added water in milk.

Oils and fats: General composition of edible oils, detection of purity, tests for common edible oils and groundnut oil, cottonseed oil and mustard oil, tests for adulterants like argemone oil and mineral oils,

Beverages: Soft drinks, alcoholic drinks, tea, coffee and fruit juice, analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, food preservatives like benzoates, propionates, sorbates, bisulphites, artificial sweetners, like saccharin, dulcin and sodium cyclamate, flavours – vanillin, esters (fruit flavours) and monosodium glutamate, artificial food colourants-coal tar dyes and non-permitted colours and metallic salts, control of food quality – codex alimentarices, Indian standards.

UNIT – IV : FUEL AND SOIL **15 Hrs**

Fuels : Definition, classification and characteristics of fuels, sampling, determination of calorific value. Liquid fuels-determination of flash point, fire point, aniline point. Knocking of petrol and diesel – octane and cetere numbers carbon residue. **Gaseous fuels** : Coal gas, waste gas, producer gas, gober gas and blast furnace gas, calorific value determination by Junker's gas calorimeter, relatice merits of solid, liquid and gaseous fules. **Soil** : Ingradiants of soil-organic matter, nitrogen, sulphur, sodium, potassium and calcium, analysis of trace elements, copper, molybdenum, zinc and boron.

Reference Books :

1. Pharmaceutical Analysis, T. Higuchi and E.B. Hanseen, John Wiley and Sons, New York.
2. Quantitative Analysis of drugs, P.D. Sethi, 3rd edition, CBS Publishers, New Delhi, 1997.
3. Practical Clinical biochemistry methods and interpretations, R. Chawala, J.P. Brothers Medical Publishers (P) Ltd., 1995.
4. Laboratory manual in biochemistry, J. Jayaraman. New Age International Publishers, New Delhi, 1981.

CHE 205 A & B	Core practical I: Inorganic & Physical Chemistry	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of graduate level Inorganic & Physical Chemistry practical.

Course Objectives:

- Separation and determination of the two component mixtures
- Preparation of metal complexes
- Familiarize with conductometric, potentiometric and redox methods of analysis
- colorometric and pHmetric methods of analysis

Course Outcomes: At the end of the course, the student will be able

CO1	To separate and determine the two component mixtures
CO2	To acquire knowledge in the preparation of metal complexes
CO3	To study the determination of cell constant and verification of Onsagar equation, strength of strong acid by Titration of a strong acid with a strong base and vice versa
CO4	To get knowledge on the applications of conductometry, potentiometry, coulometry and pHmetry.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	1	-	2		1	1	-
CO2	3	2	2	3	2	2	1	-	1	-	1	2
CO3	3	2	2	3	3	1	1	2	-	1	1	-
CO4	3	2	2	3	2	-	1	-	1	1	-	2

CHE 205 A & B: Core practical I: Inorganic & Physical Chemistry

I . Quantitative Analysis:

Separation and determination of two component mixtures:

(i) Separation of Al(III) and Determination of Fe (III)
(ii) Separation of Cu(II) and Determination of Zn (II)
(iii) Separation of Ca(II) and Determination of Mg (II)
(iv) Separation of Cu(II) and Determination of Ni (II)
(v) Determination of Ferrocyanide and Ferricyanide

II. Physical Chemistry

1. Conductometry:
   (a) Determination of cell constant
   (b) Verification of Onsagar equation
   (c) Determination of dissociation constant of a weak acid
   (d) Titration of a strong acid with a strong base
   (e) Titration of a weak acid with a strong base
2. Potentiometry:
   (a) Titration of a strong acid with a strong base
   (b) Titration of a weak acid with a strong base
   (c) Redox titration
3. Coulometry: Estimation of Manganese
4. pHmetry: Strong acid, Strong base titrations.

CHE 206A & B	Core practical I: Organic & General Chemistry	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of graduate level Organic & General Chemistry practical.

Course Objectives:

- Familiarize with two component mixture separation and identification.
- Preparation of derivatives.
- Purification by components by different methods.
- Calibration of products by spectral methods.

Course Outcomes: At the end of the course, the student will be able

CO1	To familiarize with binary mixture separation
CO2	To gain hands-on-experience in purification of the components, preparation of derivatives.
CO3	To get knowledge about the chemical behavior of different components and mechanisms
CO4	Purification and calibration of data

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	-	1	1	-	3	3	1
CO2	3	2	2	3	-	1	-	2	1	3	3	-
CO3	3	2	2	3	1	1	2	1	-	2	-	2
CO4	3	2	2	3	1	2		1	1	2	1	2

CHE 206 A & B: Core practical II: Organic & General Chemistry

CHE-206 A : PRACTICAL – II : **ORGANIC CHEMISTRY**

Separation and Identification of two component organic mixture by systematic qualitative analysis.

CHE-206 B : PRACTICALS – II : GENERAL CHEMISTRY

Preparation of Metal Complexes:

(i) Tetra(ammine) copper (II) sulphate.
(ii) Mercury tetra(thiocyanato) cobaltate(II).
(iii) Hexa(ammine) Nickel (II) chloride.
(iv) Tris(acetylacetonato) Manganese (III) chloride.
(v) Tris (ethylenediammine) Nickel (II) thiosulpha

CHE 207	Human Values and professional ethics-II	L-3,T-1,P-2	4 Credits

Pre-requisite: Understanding of Human Values and professional ethics

Course Objectives:

- Gain knowledge on value education, family values and adjustability
- Develop ethics towards medical, health care professionals and ethical issues in genetic engineering
- Understand the importance of social ethics towards organ trade, human traffic king human rights violation and social disparities.
- Know about environmental ethics, ecological crises, pollution and protection of environment

Course Outcomes: At the end of the course, the student will be able to

CO1	To understand the concepts of human values, responsibilities of family values and status of women in family and society.
CO2	To acquire knowledge on different medical ethics the views of charaka and sushruta on moral responsibilities of medical practitioners.
CO3	To gain knowledge on social ethics and understand the characteristics of ethical problems in management.
CO4	To familiarize environmental ethics, ethical theory and ecological crisis.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	1	2	2	2	3	1	1	1
CO2	3	1	2	3	1	2	2	3	3	1	1	1
CO3	3	2	1	3	-	2	1	2	2	3	-	1
CO4	3	1	1	3	1	2	1	1	2	3	1	1

CHE 207: ELECTIVE FOUNDATION (HUMAN VALUES AND PROFESSIONAL ETHICS-II)

Chapter I: Value Education – Definition – Relevance to present day – Concept of human values - Self introspection – Self-esteem. Family values-Components, Structure and responsibilities of family Neutralization of anger – Adjustability – Threats of family life – Status of women in family and society – Caring for needy and elderly – Time allotment for sharing ideas and concerns.

Chapter II: Medical ethics – Views of Charaka, Sushruta and Hippocratus on moral responsibility of medical practitioners. Code of ethics for medical and healthcare professionals. Euthanasia, Ethical obligation to animals, Ethical issues in relation to health care professionals and patients. Social justice in health care, human cloning, problem of abortion. Ethical issues in genetic engineering and Ethical issues raised by new biological technology or knowledge.

Chapter III: Social ethics – Organ trade, Human trafficking, Human rights violation and social disparities, Feminist ethics, Surrogacy/pregnancy. Ethics of media – Impact of Newspapers, Television, Movies and Internet, Business ethics – Ethical standards of business – Immoral and illegal practices and their solutions. Characteristics of ethical problems in management, ethical theories, causes of unethical behavior, Ethical abuses and work ethics.

Chapter IV: Environmental ethics – Ethical theory, man and nature - Ecological crisis, Pest control, Pollution and waste, Climate change, Energy and pollution, Justice and environmental health.

Books for study:

1. Johns S Mackenjie: A Manual of ethics
2. "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3. Management Ethics – Integrity at work by Joseph A. Petrick and John F. Quinn, Response Books, New Delhi.
4. "Ethics in Management" by S.A. Shelekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
10. Sasruta Samhita: Tr. KavirajKunjanlal, KunjanlalBrishagratha, Chowkamba Sanskrit Series, Vol I,II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
11. Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
12. Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13. Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Eduction – Telugu Academy, Hyderabad.
14. I.C. Sharma Ethical Philosophy of India. Nagin& Co Julundhar.

CHE OC 306	Spectral Techniques	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Spectral Techniques

Course Objectives:

- Familiarize with the instrumentation of UV and visible spectroscopy, applications of identifying the structures of the molecules.
- Understand IR spectrometry and applications to ascertain the fundamental groups by observing absorption bands
- Study on the applications of NMR spectroscopy in ascertaining the stereochemical structures of the molecules.
- Understand the working principle and fragmentation rules of different molecules in Mass spectroscopy

Course Outcomes: At the end of the course, the student will able

CO1	To get experience to calculate λ max values for dienes, enones, polyenes, aromatic and heteroaromatic compounds.
CO2	To familiarize with the absorption bands of the molecules with specific functional groups
CO3	To interpret the data to different types of protons and carbons present in a molecule so as to ascertain the structure of the
CO4	To acquire knowledge about specific fragmentation rules of different molecules which are unique.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	2	1	-	2	2	-
CO2	3	2	2	3	2	2	-	2	1	2	2	-
CO3	3	2	2	3	2	2	-	2	-	2	2	2
CO4	3	2	2	3	2	2	1	-	2	2	2	-

CHE-OC 302: CORE THEORY: ORGANIC SPECTROSCOPY AND APPLICATIONS

UNIT-I: ULTRAVIOLET AND VISIBLE SPECTROSCOPY: 15Hrs

Various electronic transitions (185-800 nm), effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fisher-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

UNIT – II: INFRARED SPECTROSCOPY 15Hrs

Instrumentation and sample handling. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ether, 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, overtones, combination bands and fermi resonance, FT-IR

UNIT –III: NMR SPECTROSCOPY: 15Hrs

^{1}H NMR spectroscopy: Magnetic properties of nuclei, Principles of NMR. Instrumentation, CW and pulsed FT instrumentation, equivalent and nonequivalent protons, enantiotopic and diastereotopic protons, Chemical shifts, factors affecting the chemical shifts, electronegativity and anisotropy, shielding and deshielding effects, Signal integration, Spin-spin coupling: vicinal, germinal and long range, Coupling constants and factors affecting coupling constants.

Applications of ^{1}H NMR spectroscopy: Reaction mechanisms (cyclic bromonium ion, electrophilic and nucleophilic substitutions, carbocations and carbanions), E, Z isomers, conformation of cyclohexane and decalins, keto-enol tautomerism, hydrogen bonding, proton exchange processes (alcohols, amines and carboxylic acids), C-N rotation. Stereochemistry, hindered rotation, Karplus curve variation of coupling constant with dihedral angle. Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents, nuclear Overhauser effect (NOE).

^{13}C NMR spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimensional NMR spectroscopy-COSY.

UNIT-IV: MASS SPECTROMETRY 15Hrs

Introduction, ion production, type of ionization, EI, CI, FD, and FAB-factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular-ion peak, metastable peak, Mc. Lafferty rearrangement. Nitrogen rule, isotope labeling. High resolution mass spectrometry, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books suggested:

1. Organic spectroscopy, W. Kemp 5th Ed, ELBS
2. Spectroscopy of organic compounds, RM Silversteen and others, 5th Ed,John Wiley
3. Spectroscopy of organic compounds, P.S. Kalsi, Wiley, 1993.
4. NMR in chemistry-A multi nuclear introduction, William Kemp, Mc Millan, 1986.
5. Spectroscopic methods in Organic chemistry, DH Williams & I Flemmi.

(Mandatory Core)

CHE-OC-303A	Inorganic Spectroscopy and Thermal Methods of Analysis	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of Basic Inorganic Spectroscopy and Thermal Methods of Analysis

Course Objectives:

- Gain knowledge on thermal methods of analysis and principles and applications to inorganic materials.
- Familiarize with basics of Mossbauer and NQR spectroscopy.
- Learn the properties like g-factor, nuclear spin, hyperfine coupling constants
- Study the ESR instrumentation, various applications and photoelectron spectroscopy.

Course Outcomes : At the end of the course, the student will be able

CO1	To know the basic principles of instrumental methods of analysis.
CO2	To gain knowledge on chemistry of alloys.
CO3	To Understand the complexity, theory and working principle of colourimetry
CO4	To familiarize with laws of colorimetric titrations.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	-	2	3	2	-	1	1	-
CO2	3	2	2	3	2	2	3	2	2	1	-	2
CO3	3	1	-	3	-	2	-	2	1	-	1	-
CO4	3	2	2	3	2	-	1	2	-	1	-	2

CHE-OC- 303A: Inorganic Spectroscopy and Thermal Methods of Analysis

UNIT –I: THERMAL METHODS OF ANALYSIS 15 Hrs

Thermo gravimetry –Principle, Factors affecting the results, instrumentation. Application with special reference to $CuSO_45H_2O$, $CaC_2O_4\,2H_2O$. Different thermal analysis – principle, instrumentation, difference between TG and DTA, applications with special reference to the clays and minerals.Different scanning calorimetry –principle, and applications to inorganic materials like chlorates and perchlorates, ammonium nitrate.

UNIT –II: MOSSBAUER SPECTROSCOPY and NQR 15 Hrs

Mossbauer spectroscopy: Basic principles, Recoil energy, Doppler shift, Chemical shift, Quadrapole effects, Magnetic effects. Instrumentation, spectral parameters and spectrum display.

Aapplication of the technique to the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds, (2) Sn^{2+} and Sn^{4+} compounds.

NQR spectroscopy: Basic principles of NQR spectroscopy, quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant and applications.

UNIT –III: ELECTRON SPIN RESONANCE SPECTROSCOPY 15 Hrs

Basic Principles, Hyper fine splitting, Factors affecting the ‘g’ value. Isotropic and anisotropic hyperfine coupling constants, Hamiltonian and spin densities. Zero field splitting and Kramer’s degeneracy, Relaxation process and line widths. Instrumentation and Applications.The EPR spectrum of bis(salicylidimine)-copper(II) complex, study of inorganic free radicals, biological applications of Electron Spin Resonance (Study of free radicals and Iron-sulfur proteins)

UNIT –IV: PHOTO ELECTRON SPECTROSCOPY **15 Hrs**

Photoelectric effect, Koopmans's theorem, ionization energy.

X-ray photoelectron spectroscopy (ESCA): Principle, Binding energies, Chemical shift, Applications of XPES to Qualitative analysis, to surface studies and structural analysis. Ultraviolet photoelectron spectroscopy- Principle, application of UPES in studying the molecular orbitals of O_2 and N_2 molecules. Block diagram of photoelectron spectrophotometer. Sources of radiation, detectors. Auger spectra – Principle, Applications of Auger spectra to surface studies and use of Auger spectra as a finger print tool.

Books Suggested

1. F.A. Cotton and G. Wilkinson, Advanced In-organic chemistry VI Edition, 1999. John wiley & sons. Inc., New York.
2. J.E. Huheey, E.A. Keiter and R.L. Keiter: Inorganic Chemsitry, Principles of Structure and Reactivity (4^{th} Ed.) (Addison-Wesley)
3. Gary Wulfsberg: Inorganic Chemistry (5^{th} Ed. (Viva Books)
4. J.D. Lee: Concise Inorganic Chemistry (Blackwell)
5. W.L. Jolly: Modern Inorganic Chemsitry (McGraw-Hill)
6. R.L. Carlin: Magneto-chemsitry (Springer-Verlag)
7. R.L. Dutta and A. Syamal: Elements of Magnetochemsitry (Affiliate East-West).
8. K. Hussain Reddy – Text book of Bioinorganic chemistry

CHE-OC- 303B	Physical Chemistry III	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of graduate level Physical Chemistry

Course Objectives:

- Learn applications of Group Theory, symmetry criteria and symmetry restrictions.
- Applications of X-ray Diffraction and Electron Diffraction on solid state chemistry.
- Familiarize with the applications of Microwave spectroscopy, infrared spectroscopy and Raman spectroscopy.
- Get knowledge on concept of Thermodynamics of polymer dissolution and Flory-Huggins theory of polymer solutions.

Course Outcomes: At the end of the course, the student will be able to

CO1	To know the determination of Character Co-ordinate of C_2V point group based on 3N Coordinates and to learn the Mutual exclusion Principle.
CO2	To learn the Bragg conditions-Miller Indices- Laue method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals.
CO3	To study the rigid rotator model, stark effect, vibration-rotation spectroscopy, PQR branches, selection rules and Vibrational- rotational Raman spectroscopy.
CO4	To study the concepts on heat of dissolution, regular solution theory, Hildebrand solubility parameter, concept of Flory-Huggins theory of polymer solutions

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	-	2	1	-	2	1	2	-
CO2	3	2	2	3	2	2	1	2	-	2	1	1
CO3	3	2	2	3	2	2	1	1	2	-	1	2
CO4	3	2	2	3	-	2	1	-	1	2	1	2

CHE-AC-303B CORE-THEORY PHYSICAL CHEMISTRY III

UNIT-I Applications of Group Theory **15 Hrs**

Construction of reducible and irreducible representations, Determination of Character Co-ordinate of C_2V point group based on 3N Coordinates. Standard reduction formula, Determination of normal modes of vibrations of SO_2, NH_3, $POCl_3$, $PtCl_4^{2-}$, H_2O_2 molecules. Mutual exclusion Principle, Direct Product, Accidental Degeneracy and Fermi resonance Group Theory and Spectroscopy: IR Spectral activity of NH_3 molecule, selection rules, symmetry Criteria for optical activity, symmetry restrictions on dipole moments, symmetry and stereo isomerism. Prediction of IR and Raman Spectral activity of H_2O and CO_2.

UNIT-II: X-ray Diffraction: **15 Hrs**

(A) Solid State Chemistry Dislocation of Solids, Schottky and Frenkeldefects, insulaters, a,d semiconductors, Band theory of solids,solid state reactions.

(B) Bragg conditions-Miller Indices- Laue method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals. Index reflections, identification of unit cells from systematic absences in diffraction pattern- structure of simple lattices and X-ray intensities- structure factor and its relation to intensity and electron density- Description of procedure for X-ray structure analysis (NaCl and KCl)

(C) Electron Diffraction: Scattering intensity Vs scattering angle, Wierlequation, and its importance. Measurement techniques, Elucidation of structures of simple gas phase molecules, Low energy electron diffraction (LEED) for the study of surfaces.

UNIT-III: SPECTROSCOPHY **15 Hrs**

Microwave spectroscopy: classification of molecules, rigid rotator model, effect of isotopic substitution on the transition frequencies, intensities- stark effect.

Infrared spectroscopy: Linear harmonic oscillator, zero point energy, anharmonity, Mores potential energy diagram, fundamental and overtone transitions, hot bands and combinations bands. Vibration-rotation spectroscopy, PQR branches, selection rules, factors affecting the band positions and intensities for IR region. **Raman spectroscopy:** Classical and quantum theories of Raman effect, pure rotational, pure vibrational Raman spectroscopy, selection rules, mutual exclusion principle, resonance Raman spectroscopy and coherent antistokes Raman spectroscopy. Vibrational- rotational Raman spectroscopy.

UNIT-IV: POLYMER SOLUTIONS **15 Hrs**

Thermodynamics of polymer dissolution, effect of molecular weight on solubility, solubility of crystalline and amorphous polymer, heat of dissolution, regular solution theory, Hildebrand solubility parameter, Flory-Huggins theory of polymer solutions, conformational entropy, osmotic pressure and viscosity of polymer solutions. Molecular weight determination by light scattering, ultra-centrifugation and sedimentation equilibrium method. Liquid Crystals- synthesis and applications

Books Suggested

1. F.A. Cotton : Introduction to Group theory for chemists.
2. Geroge Davidson Elsevier : Introductory Group Theory for Chemists.
3. Gurdeep Raj , Ajay Bhagi&Vinod Jain : Group Theory and Symmetry in Chemistry
4. Instrumental methods of analysis – M.H. Willard, Meritt Jr. and J.A. Dean
5. Principles of instrumental analysis – Skoog and West
6. F. W. Billmeyer, Jr.: Text Book of Polymer Science. Wiley Interscience.
7. V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar.: polymer Science. New Age international Publishers.

CHE OC 304	Core practical I: Organic Estimations - Practical	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Organic Chemistry - Practical.

Course Objectives:

- Estimation of phenol
- Estimation of glucose
- Estimation and percentage purity of aspirin
- Estimation and percentage purity of paracetamol

Course Outcomes: At the end of the course, the student will be able

CO1	To gain knowledge about the estimation/percent purity of different organic molecules.
CO2	To get hands-on-experience with the synthesis and determination of concentrations and purity.
CO3	To acquire knowledge in handling of toxic chemicals in estimation process.
CO4	To gain experience in the calculating the percentage purity.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	1	2	1	-	2	-
CO2	3	2	2	3	2	2	2	2	-	2	2	2
CO3	3	2	2	3	2	1	-	2	2	1	-	2
CO4	3	2	2	3	2	-	1	2	1	2	-	2

CHE : OC : 304 : Practicals (Core & Gen.) Organic Estimations

1) Estimation of phenol
2) Estimation of glucose
3) Estimation of percentage purity of aspirin
4) Estimation of percentage purity of paracetamol.

CHE OC 305A	Chemotherapy and Drug Analysis	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Chemotherapy and Drug Analysis

Course Objectives:

- Gain knowledge on chemotherapy and analysis of drugs.
- Analysis of drugs chemically and biologically.

Course Outcomes: At the end of the course, the student will be able

CO1	To know about the classification and synthesis of drugs.
CO2	To familiarize with the qualitative and quantitative analysis of drugs.
CO3	
CO4	

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	-	2	3	2	2	-	1	1
CO2	3	2	2	3	2	2	2	2	-	1	-	2
CO3												
CO4												

CHE OC 305A: (SKILL ORIENTED COURSE : THEORY) : CHEMOTHEROPY AND DRUG ANALYSIS

UNIT-I: Chemotherapy

Definition, History, and Evolution of Chemotherapy; Discovery, Classification, Nomenclature, Mode of action and synthesis of the following classes of compounds with special references to specific drugs mentioned under each class

a) Sulfa drugs- Sulfanilamide and Sulfamethoxazole.
b) Antibacterials
c) Lactum group of antibiotics – Penicillin, Ampicillin and Amoxycillin.
d) Cephalosporin-C and Ciprofloxacin.
e) Anticancer drugs – 5-Flurouracil, Methotrexate.
f) Antifungals – Griseofulvin
g) Antimalarials – Chloroquin

UNIT-II: Chemical and Biochemical analysis of Drugs

Qualitative and Quantitative Analysis of drugs: Uses of IR, UV, GLC and HPLC methods.
Drug Assay by Biochemical Analysis – ELISA (Cortisol, alcohol, opiates).
Radio Immuno Assay (RIA) – Enalapril, Insulin; Kidney, Lungs and Liver function tests; Use of isotopes in the Bioanalysis of drugs and in drug design programmes.

Book Suggested

1. Medicinal Chemistry and Pharmaceutical Chemistry – Harikishan Singh and Kapur
2. Medicinal Chemistry and Biochemistry – R.L.Nath
3. Introduction to Medicinal Chemistry – Patrick
4. The Organic Chemistry of Drug Synthesis Vols. 1-6 - Ledneicer Top drugs top synthetic

routes – John Saunders
5. Medicinal Chemistry – Ashutoshkar
6. Synthetic Organic Chemistry and Drugs – Gurideep R Chetwal
7. Biochemistry – Harper, Conn & Stumpf, Lehninger
8. Biochemistry – Western Jodd
9. Biochemistry – Cann & Stumpf
10. Bergers Medicinal Chemistry Vols. 1-5 – Manfred E. Wolf
11. Introduction to drug design – Siverman
12. Biochemical approach to Medicinal Chemistry – Thomas Nogrady
13. Prinicples of Medicinal chemistry – William Foye
14. Text book of organic medicinal and pharmaceutical chemistry – Delgrado and William A
15. Industrial Microbiology – Casida

CHE OC 305B	Instrumental Methods of Analysis	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Instrumental Methods of Analysis Practical

Course Objectives:

- Multistep preparations of biologically important organic molecules.
- Familiarize to identify the synthesized compounds by spectral methods.

Course Outcomes: At the end of the course, the student will be able

CO1	To acquire knowledge in handling of toxic chemicals in multistep preparation of biologically important molecules in good percentage of yield.
CO2	To gain experience in the proposal of synthetic routes to functionalized derivatives.
CO3	
CO4	

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	-	2	3	2	1	-	1	1
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3												
CO4												

CHE : OC: 305 (B) : Practicals (Skill Oriented Course) : Multistep preparations

1) Preparation of benzilic acid
2) Preparation of benzanilide
3) Preparation of o-chlorobenzoic acid
4) Preparation of symmetric tribromobenzene

CHE OC 306	Spectral Techniques	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Spectral Techniques

Course Objectives:

- Familiarize with the instrumentation of UV and visible spectroscopy, applications of identifying the structures of the molecules.
- Understand IR spectrometry and applications to ascertain the fundamental groups by observing absorption bands.
- Study on the applications of flame atomic absorption spectroscopy.
- Understand the working principle and fragmentation rules of different molecules in Mass spectroscopy.

Course Outcomes: At the end of the course, the student will able

CO1	To know the basic principles of spectroscopy.
CO2	To familiarize with the analysis of various functional groups by using different spectroscopic techniques.
CO3	To Understand the applications of AAS.
CO4	To gain knowledge about Mass spectral fragmentation of organic compounds and common functional groups.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	3	-	2	3	2	-	-	1	-
CO2	3	1	2	2	2	2	2	2	1	1	-	2
CO3	3	2	1	2	2	1	2	-	2	-	1	1
CO4	3	1	2	3	1	2	-	-	1	1	-	2

CHE : OC : 306(A): (OPEN ELECTIVE) SPECTRAL TECHNIQUES

UNIT – I: ULTRAVIOLET AND VISIBLE SPECTROSCOPY 15 Hrs

Various electronic transitions (185-800nm.), Beer-Lambert Law, effect of solvent on electronic transitions , ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds

UNIT – II : INFRARED SPECTROSCOPY 15 Hrs

Instrumentation and sample handling, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, ketones, aldehydes, esters, amides, acids and anhydrides. Effect of hydrogen bonding.

UNIT – III:ATOMIC ABSORPTION SPECTROSCOPY: FLAME AAS: 15 Hrs

Principle, Instrumentation – Sources of radiation (HCL and EDL), Different types of burners, Interferences- Physical, Chemical, spectral and back ground correction, and methods of minimization
GF AAS: Principle and technique –Comparison between Flame AAS and furnace AAS, Applications of AAS, Comparison between Atomic Absorption & Flame Photometry.

UNIT –IV: MASS SPECTROMETRY **15 Hrs**

Principle, instrumentation, different methods of ionization, EI, CI, FD and FAB, Mass spectra-molecular ion, base peak, meta-stable peak, nitrogen rule and Mc Lafferty rearrangement. Mass spectral fragmentation of organic compounds and common functional groups. Normal and branched alkanes, alkenes, cycloalkanes, benzene and its derivatives, alcohols and phenols, ethers, aldehydes and ketones, carboxylic acids and their derivatives , amines and nitro compounds. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Suggested:

1. Organic spectroscopy, W.Kemp 5th Ed, ELBS .2.
2. Spectroscopy of organic compounds, RM Silversteen and others 5th Ed, John Wiley 1991
3. Spectroscopy of organic compounds, PS Kalsi, Wiley, 1993
4. NMR in chemistry – A Multi nuclear introduction, William Kemp, Mc Millan 1986
5. Spectroscopic methods in Organic Chemistry, DH Williams & I Flemmi TMH . 2005

CHE OC 306	Chromatographic Techniques	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of graduate level Chromatographic Techniques

Course Objectives:

- Familiarize with Classification of Chromatographic methods.
- Understand Demonstration experiment in TLC.
- Study on the applications of High-Performance Liquid Chromatography (HPLC).
- Understand the working principle of gas chromatography.

Course Outcomes: At the end of the course, the student will able to

CO1	To know the stationary and mobile phases in chromatographic techniques.
CO2	To familiarize applications of different chromatographic methods.
CO3	To Understand the principle of chromatographic techniques.
CO4	To gain knowledge on the normal phase and reverse phase.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3		2	3	2	-	-	1	-
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2		2	-	-	-	1	-
CO4	3	2	2	3	-	2		-	-	1	-	2

CHE OC 306 : Chromatographic Techniques

Unit –I: Introduction - Classification of Chromatographic methods – Column chromatography-Adsorption phenomenon: Nature of adsorbents-Solvent systems-Differential migration-Separation of mixture of o-/p-nitro anilines (A demonstration experiment).

Unit –II: Thin-Layer Chromatography (TLC)-Coating materials and preparation of TLC plates-Solvents for development-Detection of compounds in TLC- R_f values in TLC-Applications of TLC in chemistry-Preparative TLC – Demonstration experiment in TLC.

Unit –III: High-Performance Liquid Chromatography (HPLC) - Application of HPLC- HPLC instrument-Stationary phases in HPLC-Normal and reversed phase HPLC: A comparison- Normal phase HPLC: Principle-Retention times in Normal and reversed phase HPLC- Reversed phase HPLC: Principle.

Unit –IV: Gas-Liquid Chromatography- Instruments for Gas-Liquid Chromatography- Gas-Chromatographic Columns and the Stationary Phase- Application of Gas-Liquid Chromatography- Gas-Solid Chromatography.

Reference Books:

1. Analytical chemistry: G L David Krupadanam, D. Vijaya prsad, K. Varaprasad Rao, KLN Reddy, C. Sudhakar.
2. . Analytical chemistry: Skoog West Holler.
3. Modern Analytical Chemistry : David Harvey DePauw University.
4. J.G. Dick. Analytical Chemistry, Mc Grraw Hill, New Delhi, (1973).

(Mandatory Core)

CHE-OC- 401	Organic synthesis I	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of Organic synthesis

Course Objectives:

- Acquire knowledge in the applications of Boron, Phosphorus, Sulfur and Silicon reagents in organic synthesis and their special behavior.
- Study photochemical reactions of olefins, carbonyl compounds, aromatic compounds, rearrangements and stereochemistry of the products.
- Understand the concept of pericyclic reactions, determination of allowed and forbidden transitions and prediction of stereochemistry of the products.
- Study different polymer reactions, Stereospecific polymers, Thermoplastics, Fibers, Elastomers and Ion exchange resins.

Course Outcomes : At the end of the course, the student will be able to

CO1	Familiarize with the unique reactivity of Boron, Phosphorus, Sulfur and Silicon reagents
CO2	Learn about photolytic reactions of carbonyl compounds, conjugated carbonyl derivatives, olefins, conjugated dienes CO_3:To gain knowledge in the determination of allowed or forbidden of chemical reactions *viz*., cycloaddition and
CO3	Learn the methods of preparation, properties, and industrial applications of various addition and condensation
CO4	Familiarize with the unique reactivity of Boron, Phosphorus, Sulfur and Silicon reagents

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	3	-	2	-	2	-	1
CO2	3	3	3	3	3	2	-	1	-	2	-	3
CO3	3	3	3	3	3	2	-	1	-	-	1	3
CO4	3	3	3	2	-	2	-	-	2	2	1	2

CHE OC-401: CORE THEORY: ORGANIC SYNTHESIS-I

UNIT-I: Chemistry of Organo Boran, Phophorus, Sulfur and Silicon reagents 15Hrs

Electronic structure and bonding in Boron, Phosphorus, Sulphur and Silicon compounds-Their reactivity and applications in Organic Synthesis.

Boron Reagents-Hydroboration-Organoboranes in the formation of C-C bonds, alcohols, amines, halogen and carbonyl compounds-Free radical reactions of organoboranes.

Phosphorus Reagents- Formation of carbon-carbon double bonds-Functional group transformations – deoxygenation reactions-reactivity as electrophiles- conversitoon of alcohols to alkyl halides, Witting reaction and nucleophiles - Corey-Winters reaction, Michaelis-Arbusov reaction-Perkow reaction and Mitsnobu reaction.

Sulphur Reagents- Sulphur ylides, stabilized and non-stabilized – Preparation and reactivity Pummerer reaction – sulphonyl carbanions-Julia reaction

Silicon reagents-Peterson's olefination, influence of trialkyl silyl reagents in electrophilic reactions, aryl silanes, alkenyl silanes, alkynyl silanes, allyl silanes.

UNIT-II: PHOTOCHEMISTRY **15Hr**

Photochemical energy, photochemical excitations, Franck-Condon principle, electronic transitions, Jablonski diagram, singlet and triplet states, energy transfer in photochemical reactions - photosensitization reactions and quantum yield.

Photochemistry of carbonyl compounds - Norrish Type-I and Norrish Type-II reactions, Photo Reduction and Paterno-Buchi reaction. Photochemistry of α,β-unsaturated ketones, enones, dienones and p-benzoquinones.

Photochemistry of unsaturated systems (olefins), cis-trans isomerization and dimerization reactions, Photochemistry of conjugated dienes - 1,3-butadiene, aromatic compounds, Photoaddition (1,2- & 1,4-additions) and Photosubstitution reactions of benzene derivatives. Photo-Fries rearrangement and Barton reaction.

UNIT III: PERICYCLIC REACTIONS **15 Hrs**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3 butadiene, 1,3,5-hexatriene and allyl and pentadienyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO (Mobius Huckel) approach. Electrocyclic reactions-Conrotatory and disrotatory. 4n, 4n+2 and allyl systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketene, 1,3 dipolar cycloadditions and cheleotropic reactions.

Sigmatropic rearrangements - Suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3 and 5,5 Sigmatropic rearrangements. Claisen, Cope and Oxy-Cope rearrangements. Ene reaction

UNIT IV: SYNTHETHETIC POLYMERS **15 Hrs**

Polymer Reactions-Addition and condensation polymerization processes- Bulk, Solution, Suspension and Emulsion polymerization.

Stereospecific Polymers-Preparation and significance- classification of polymers based on physical properties-Thermoplastics-Thermosetting plastics-Fibers and elastomers- General applications.

Preparation of Polymers-Preparation of Polymers based on different types of monomers Industrial applications-olefin polymers-Diene polymers-nylons-Glyptal resins-Urea-formaldehyde, phenol-formaldehyde and melamine resins- Epoxy resins - Ion exchange resins.

Book References:

1. Modern Synthetic Reactions, H.O. House, W.A Benjamin.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge University Press.
3. Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Blackie
5. Advanced Organic Chemistry Part A & B, F.A Carey and R. J Sunderg, Plenum Press.
6. Structure and Mechanism in Organic Chemistry C.K. Inglod, Cornell University Press.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
9. Chemistry of Organic Natural Products, O.P. Agrawal, Vols., 1 & 2, Goel Pubs.
10. Natural Products Chemistry K.B.G. Torssell, John Wiley, 1983.
11. Principles of biochemistry, A.L. Lehninger worth publishers
12. A Text book of Biochemistry, A.V.S.S. Rama Rao

(Mandatory Core)

CHE-OC 402	Organic Synthesis II	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of Organic Synthesis

Course Objectives:

- Use disconnection approach and retrosynthetic analysis and control of stereochemistry to design efficient multi-step syntheses involving different types of disconnection approaches
- Applications to synthesis complex naturally occurring compounds
- Familiarize with synthesis and pharmacological properties of antimalarials and antibiotics
- Understand structure and synthesis of proteins and nucleic acids

Course Outcomes: At the end of the course, the student will be able to

CO1	Familiarize with functionalization and interconversion of functional groups and the concept of organic synthesis by retrosynthetic approach.
CO2	Gain knowledge in the formulation of synthetic routes for naturally occurring drugs.
CO3	Understand quinoline, acridine and guanidine group of alkaloids as antimalarials and to familiarize with the role of functioning of broad spectrum antibiotics.
CO4	Acquire knowledge about the classification, properties, structure & conformation and biological functions of peptides/proteins.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	1	-	-	1	-	3
CO2	3	3	3	3	2	1	-	-	-	1	-	2
CO3	3	3	3	3	2	-	-	2	-	1	1	3
CO4	3	3	3	3	2	2	-	2	-	-	2	3

CHE OC-402: CORE THEORY: ORGANIC SYNTHESIS-II

UNIT-I: DESIGNING OF ORGANIC SYNTHESIS 15 Hrs

Disconnection Approach-Classification of organic reactions. Functionalisation and interconversion of functional groups, formation of carbon-carbon single and double bonds, general strategy, disconnection and synthon approach, retrosynthetic analysis, key intermediates and starting materials in designing a synthesis, linear and convergent synthesis, reconnections. The importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

Protecting Groups-Principles of protection of alcohol, amine, carbonyl and carboxyl groups.

One Group C-C Disconnections-Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenic compounds in organic synthesis.

Two Group C-C Disconnections-Diels-Alder reaction, 1,3-difunctionalised compounds, unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds, Michael addition and Robinson annulation.

UNIT II: MULTI STEP SYNTHESIS 15 hrs

Multi step synthesis of some complex naturally occurring compounds involving through retrosynthetic analysis and control of stereochemistry, Longifolene, Taxol, Juvabione, Fediricamycine A.

UNIT III: ANTIMALARIALS AND ANTIBOTICS 15 hrs

Antimalarials: Synthesis and activity of Quinoline group – Quinine, Plasmoquine and Chloroquine –

Acridine group – Quinacrine – Guanidine group – Paludrine.
Antibiotics: Synthesis and activity of Penicillin, Chloramphenicol and Streptomycin – Broad spectrum antibiotics – Tetracyclines, Novobiocin.
Chemotherapy: Structure – activity relationships.

UNIT-IV: BIOMOLECULES **15 Hrs**

Peptides and Proteins-Methods of peptide synthesis, sequence determination, structure of oxytocin, proteins-classification, structure, conformation and properties. Nucleic acids- Nucleosides, Nucleotides, DNA and RNA, structure and conformations, replication, translation of genetic material, genetic code, gene expression, gene mutation, protein synthesis.

Book References:

1) Modern Synthetic Reactions, H.O. House, W.A Benjamin.
2) Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge University Press.
3) Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
4) Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Blackie
5) Advanced Organic Chemistry Part A & B, F.A Carey and R. J Sunderg, Plenum Press.
6) Structure and Mechanism in Organic Chemistry C.K. Inglod, Cornell University Press.
7) Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8) Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
9) Chemistry of Organic Natural Products, O.P. Agrawal, Vols., 1 & 2, Goel Pubs.
10) Natural Products Chemistry K.B.G. Torssell, John Wiley, 1983.
11) Principles of biochemistry, A.L. Lehninger worth publishers
12) A Text book of Biochemistry, A.V.S.S. Rama Rao

(Mandatory Core)

CHE-OC-403A	Heterocycles and Natural Products	L-3,T-1,P-2	4 Credits

Pre-requisite: Understanding of Heterocycles and Natural Products

Course Objectives:

- Familiarize with Hantzsch- Widmann nomenclature of Fused heterocycles. Synthesis and reactivity of five membered heterocycles with two hetero atoms
- Understand synthesis and reactivity of benzofused five membered and six membered heterocycles
- Gain knowledge on structural elucidation, synthesis and biosynthesis of steroids and hormones
- Familiarize with on structural elucidation, synthesis and biosynthesis of flavonoids and isoflavonoids

Course Outcomes: At the end of the course, the student will be able to

CO1	Familiarize with the synthetic routes of five membered heterocycles with two heteroatoms and to justify the site of
CO2	Acquire knowledge on the synthetic methodologies of benzofused and six membered heterocycles and the effect of
CO3	Familiarize with the structural elucidation and synthesis of naturally occurring steroids and hormones
CO4	Know about isolation, structural determination and synthesis of flavonoids and isoflavonoids.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	-	2	-	2	-	3
CO2	3	3	3	3	2	2	-	2	-	2	1	3
CO3	3	3	3	3	2	-	-	2	-	-	1	3
CO4	3	3	3	3	2	-	-	2	-	-	1	3

CHE : OC-403(A) : (GENERIC ELECTIVE): HETEROCYCLES AND NATURAL PRODUCTS

UNIT-I: NOMENCLATURE AND FIVE MEMBERED HETEROCYCLES 15 HRS

Systematic nomenclature (Hantzsch-Widman nomenclature) for fused and bridged heterocycles, Five membered heterocycles with two heteroatoms: Synthesis and reactions of pyrazole, imidazole, isoxazole, oxazole, isothiazole and thiazole

UNIT-II: BENZOFUSED FIVE MEMBERED AND SIX MEMBERED HETEROCYCLES 15 HRS

Benzofused five membered heterocycles: Synthesis and reactions of Benzopyrazoles, Benzimidazoles and Benzoxazoles

Six Membered heterocycles with two or more heteroatoms: Synthesis and reactions of diazines (pyridazine, pyrimidine & pyrazine) and triazines (1,2,3-, 1,2,4- 1,3,5- triazines)

UNIT-III: STEROIDS AND HORMONES 15 HRS

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol (total synthesis not expected), Bile acids, Androsterone, Testosterone, Estrone, Progesterone. Biosynthesis of steroids.

UNIT-IV: FLAVONOIDS AND ISOFLAVONOIDS **15 Hrs**

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Kaempferol, Quercetin, Butein, Daidzein, Biosynthesis of flavonoids and isoflavonoids: Acetate Pathway and Shikimic acid Pathway. Biological importance of flavonoids and isoflavonoids.

Reference Books:

1. Heterocyclic chemistry Vol. 1-3, R.R. Gupta, M.Kumar and V. Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introduction to the Heterocyclic Compounds, R.M. Acheson, Jonn Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon Press.
8. Organic Chemistry, Vol. 2, I. L. Finar, ELBS.
9. Introduction to Flavonoids TA Geissman.

(Compulsory Foundation)

CHE-OC-403B	Bioinorganic, Bioorganic, Biophysical Chemistry	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Bioinorganic, Bioorganic, Biophysical Chemistry

Course Objectives:

- Highlighten metal complexes as oxygen carriers and electron transfer in biology.
- Metal ion transport and storage in biological systems and importance of trace metals in biology.
- Learn physiological functions of carbohydrates, lipids, enzymes classification, stereospecificity.
- The basic concepts of biophysical chemistry in biochemical reactions, exergonic and endergonic reactions.

Course Outcomes: At the end of the course, the student will be able to

CO1	Gain knowledge on metallo proteins in electron transfer processes.
CO2	Know the applications of trace metal ions and metal ions as chelating agents in medicine.
CO3	Achieve and develop highly stereoselective synthesis of organic compounds and drugs by adopting environmentally.
CO4	Understand thermodynamics of biopolymer reactions and to correlate free energy and biopolymer parameters.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	2	-	2	-	3
CO2	3	3	3	3	3	2	3	-	-	-	3	3
CO3	3	3	3	3	3	3	-	2	-	2	-	3
CO4	3	3	3	3	3	3	2	2	-	3	3	3

CHE AC-403(B): (GENERIC ELECTIVE): BIOINORGANIC, BIOORGANIC, BIOPHYSICAL CHEMISTRY

UNIT-I: **BIO-INORGANIC CHEMISTRY- I** **15 Hrs**

Metal complexes as oxygen carriers –Heme proteins –Hemoglobin and myoglobin –Non heme proteins –hemerythrin and hemocyanin – model synthetic complexes of iron, cobalt and copper.Co-enzymes Vitamin B_{12},carboxy peptidase and superoxidedismutase.

Electron Transfer in Biology: Structure and functions of metalloproteins in electron transfer processes –catalase –peroxidose –cytochromes and iron –sulphur proteins –synthetic models.

UNIT – II: BIOINORGANIC CHEMISTRY- II: Metal ion transport and storage in biological systems**,** Metal ions in Biology, Molecular mechanism of ion transport across membranes: ionophores, photosynthesis.

Hydrolytic metalloenzymes: Carbonic anyhdrase, carboxy peptidase, calcium in control processes, calcium and muscle contraction, calcium and secretion, calcium in blood clotting mechanisms. Therapeutic uses of enzymes.

Importance of trace metals in biology: Metal ions as chelating agents in medicine, trace metal ions and metal and non-metal deficiency. Biological nitrogen fixation,in-vivo and in-vitro nitrogen fixation.

UNIT-III: BIOORGANIC CHEMISTRY

Carbohydrates: Structure and biological functions of mucopolysaccharides, glycoproteins, and glycolipids- Role of sugars in biological recognition-Blood group substances

Lipids: Essential fatty acids-structure and function of triglycerols, Glycerophospholipids, cholesterol, bile acids prostaglandins- composition and functioning of lipoproteins

Enzymes: Nomenclature and classification, properties, factors affecting enzyme catalysis, enzyme inhibition- reversible and irreversible inhibition. Uses of enzymes in food drink industry and clinical laboratories.

UNIT-IV: BIOPHYSICAL CHEMISTRY:

Standard free energy change in biochemical reactions, exergonic and endergonic reactions, hydrolysis of ATP, thermodynamics of biopolymer solutions, chain configuration of bio polymers, and calculation of average dimensions. Membrane equilibrium, ion transport through cell membrane. dialosis and its function. Structure and functions of proteins, enzymes, DNA and RNA in living systems, forces involved in bio polymer interactions, electrostatic forces, hydrophobic forces, molecular expansion, and dispersion forces.

Books Suggested

1. M.N. Hughes, The Inorganic chemistry of Biological Processes, John wiley and Sons, New York 2nd Edition, 1981.
2. A Text book of Biochemistry, A.V.S.S. Rama Rao
3. Physical chemistry by Atkenes
4. Physical chemistry by Albertz.
5. Bio physical chemistry by Van Holde
6. Bio Physics by Narayanam
7. Organic Chemistry, Vol. 2, I. L. Finar, ELBS.
8. Chemistry of Natural Products, P.S. Kalsi, Kalyani Publishers.
9. Chemistry of Organic Natural Products, O. P. Agarwal, Vols., 1 & 2, Geol Pubs.
10. Natural products Chemistry K.B.G. Torssell, John Wiley, 1983.
11. Burger's Medicinal Chemistry, M.E. Wolff, John Wiley
12. Medicinal Chemistry, A. Kar, New Age International

CHE OC 404	Core practical I: Spectral Identification of Organic Compounds	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Spectral identification of organic compounds

Course Objectives:

- Spectral identification of organic compounds by UV by calculating λ max values
- Identification of absorption bands by IR and ascertain to the functional groups
- Unambiguous assignment of structures by interpreting NMR values
- Predict the characteristic cleavage processes by Mass.

Course Outcomes: At the end of the course, the student will be able to

CO1	Calculate λ max values.
CO2	Ascertain functional groups.
CO3	Interpret the spectral data to the structure and stereochemistry of the molecules.
CO4	Analyse the fragmentation patern of the molecules.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	2	-	-	2	3
CO2	3	3	3	3	-	2	-	2	-	2	-	3
CO3	3	3	-	3	-	3	-	2	-	3	-	3
CO4	3	-	3	-	3	2	-	-	-	2	-	3

CHE OC 403: PRACTICAL-I

Spectral identification of organic compounds by UV, IR, NMR (^{1}H & ^{13}C) & Mass spectroscopy.

DEMONSTRATION EXPERIMENTS

1 IR – Interpretation of IR spectrum of alcohols, ketones, aldehydes and other standard materials

2 AAS: Demonstration of AAS – Determination of Zn, Cd, Pb, Mn, Fe and Ni in effluents using AAS.

3 Spectrofluorimetry – estimation of quinine and fluoroscene

4 Ion selective electrodes – estimation of F^-, S^{2-} and CN^- in effluents using ion selective electrode meter.

5 Polarography and Anode stripping voltametry

(a) Polarography and Anode stripping voltametry – behavior of Cd, Zn, Pb in a mixture.

(b) Determination of Pb and Cd in samples using Anode stripping voltametr

6 Gas chromatography- Determination of pesticides

7 HPLC- Determination of pesticides

8 NMR

a). Demonstration of NMR spectrometer and study of hydrogen bonding in a given alcohol or phenol.

b). Interpretation of NMR chemical shifts of ethyl benzene, ethyl alcohol

9 TGA, DTA, DSC – Demonstration of TG, DTA and DSC and study of decomposition of calcium oxalate, calcium carbonate, copper sulfate, oxalic acid.

10 pH metry

a) Determination of alkalinity in a colored effluent using pH metric end point.
b) Determination of purity of commercial HCl, H_2SO_4, H_3PO_4 and CH_3COOH using pH metric end point

CHE OC 405	Practical II: Project Work	L-5,T-1,P-0	4 Credits

Pre-requisite: Organic Chemistry Project Work

Course Objectives:

- Identification of problem by literature survey
- Ability to carry out independently with competency in research design and synthesis
- Interpretation of spectral data to the structures of the molecules
- Communication of research results through presentations and preparation of dissertation

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify the problem, to collect the literature and understanding parameters to design the problem.
CO2	Perform experiments to synthesize the molecules with desired stereochemistry adopting modern techniques.
CO3	Collect and interpretation of the data to the structures.
CO4	Presentation of the data in the form of dissertation.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	-	2	2	2	-	2	2	3
CO2	3	3	3	3	3	2	2	2	-	2	2	3
CO3	3	3	3	3	3	3	3	2	-	2	-	3
CO4	3	3	3	3	3	2	3	2	-	-	2	3

CHE OC 404: PRACTIAL II/ PROJECT WORK

CHE OC 406A	Drug Chemistry	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Drug Chemistry

Course Objectives:

- To learn about the natural products as leads for new drugs
- Determination of cardiovascular drugs
- To study Autacoids
- Interpretation of Antipyretics

Course Outcomes: At the end of the course, the student will be able to

CO1	Know about natural products.
CO2	Know Interpretation of cardiovascular drugs.
CO3	Know the Analyzing about prostaglandins.
CO4	Know the Definition, Classification, Nomenclature, Structure and Synthesis of anti-inflammatory drugs.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	2	-	-	2	3
CO2	3	3	3	3	-	2	-	2	-	2	-	3
CO3	3	3		3	-	3	-	2	-	3	-	3
CO4	3	-	3	-	3	2	-	-	-	2	-	3

CHE : OC : 406 (A): (OPEN ELECTIVE) : DRUG CHEMISTRY

UNIT – I: NATURAL PRODUCTS AS LEADS FOR NEW DRUGS

Occurrence, Structure and therapeutic uses of Drugs acting on Central Nervous System

Morphine alkaloids (morphine, codeine, thebaine, heroin, pethidine)

Cannabinoids (9-cannabinol, Tetrahydrocannabinol)

Neuromuscular Blocking Agents (Curare, Decamethonium)

Vinca Alkaloids (Vincristin and Vinblastin), Taxol and Taxotere, podophyllotoxin, Etoposide, Teniposide.

UNIT – II: CARDIOVASCULAR DRUGS

Definition, Classification, Nomenclature, Structure and Synthesis.

Cardiac glycosides (ex: Digoxin, Digitoxin);

Antihypertensive drugs (ex: Methyl dopa, Clonidene hydrochloride);

Antiarrhythmic agents (ex: Quinidine sulfate);

Antisympathetic drugs (ex: Propranolol hydrochloride, Verapamil hydrochloride);

Vasopressor drugs (ex: Prenylamine, Buphenine).

UNIT – III: AUTACOIDS

Definition, Occurrence, Isolation, Nomenclature, Classification, Synthesis, Biosynthesis and Stereochemical structures of Prostaglandins. Structural elucidation of PGE_1, PGE_2; Synthesis and biosynthesis of PGE_2, $PGF_{2\alpha}$.

Structure and Biosynthesis of Thromboxane A2 and Prostacyclin (synthesis not

expected).

UNIT – IV: ANTI-INFLAMMATORY DRUGS

Definition, Classification, Nomenclature, Structure and Synthesis of Paracetamol, Aspirin (Antipyretic), Salol, Cinchophen, Antipyrene, Phenylbutazone, Indomethacin, Tolmetin, Ibuprofen, Diclofenac and Naproxen.

Books suggested:

1. Medicinal Chemistry by Ashitosh Kar
2. Medicinal Chemistry by D. Sriram, P. Yogeeswari
3. Medicinal Chemistry by David A. Williams, Thomas L. Lemke
4. Medicinal Chemistry by V**.** Alagarsamy
5. Biochemistry by U. Satyanarayana
6. Natural Products Chemistry and Applications by Sujata V. Bhat, B.A. Nagasampagi,
   S. Meenakshi
7. Medicinal Chemistry by V.K. Ahluwalia, Madhu Chopra
8. Medicinal Chemistry by Balkishen Razdar
9. Advanced Practical Medicinal Chemistry by Ashutosh Kar
10. Chemistry of Organic Natural Products by O. P. Agarwal, Vols., 1 & 2, Geol Pubs.
11. Chemistry of Natural Products by S. V. Bhat, B.A. Nagasampagi, M. Sivakumar
12. Natural Products Chemistry by K.B.G. Torssell, John Wiley, 1983.

CHE OC 406	**Electroanalytical Techniques**	**L-5,T-1,P-0**	**4 Credits**
Pre-requisite: Understanding of Electroanalytical Techniques			
Course Objectives: • To learn about the classification of electroanalytical methods • Determination of types of currents • Principle, instrumentation, reversible and irreversible cyclic voltammograms.. • Interpretation of Ion selective electrodes			
Course Outcomes: At the end of the course, the student will able to			
CO1	Ability to interpret potentiometry and conductometry		
CO2	Interpretation of results while adhering to DC Polarography.		
CO3	Analysing and compiling the data and results in polarography.		

CO4	Familiarize Types of ion sensitive electrodes.											
Mapping of course outcomes with the program outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	2	-	-	2	3
CO2	3	3	3	3	-	2	-	2	-	2	-	3
CO3	3	3	-	3	-	3	-	2	-	3	-	3
CO4	3	-	3	-	3	2	-	-	-	2	-	3

CHE : OC : 406(B): (OPEN ELECTIVE) : ELECTRO ANALYTICAL TECHNIQUES

Unit I: Types and Classification of Electro analytical Methods.
i) Potentiometry- Types of electrodes, Hydrogen gas, Calomel, Quin hydrone and glasselectrodes. Determination of pH. Potentiometric titrations.
ii) Conductometry – Definition of terms – conductivity, specific conductivity, cell constant. Mobility of ions, Conductometric titrations.

Unit II: D.C Polarography: Dropping mercury electrode- Instrumentation-polarogram. Types of Currents : Residual, Migration, Limiting. Two and Three electrode assemblies. Ilkovic equation (derivation not necessary) and its consequences. Types of limiting Currents: Adsorption, Diffusion, Kinetic. Applications of polarography in qualitative and quantitative analysis. Analysis of mixtures. Application to inorganic and organic compounds. Determination of stability constants of complexes.

Unit III: (i) A.C. polarography (ii) Square-wave polarography (iii) Pulse polarography (iv) Differential pulse polarography(V) Cyclic Voltammetry: Principle, instrumentation, reversible and irreversible cyclic voltammograms.

Unit IV: Ion selective electrodes: Ion-sensitive electrodes –types of ion sensitive electrodes –metal based cation and anion sensitive electrodes, solid membrane electrodes. Liquid ion-exchange electrodes, gas sensing membrane electrodes.

Books Suggested

1. H.W. Willard, LL. Merrit and J.A. Dean: Instrumental Methods of Analysis. Affiliated East-West).
2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denny. Vogel's Text Book of Quantitative Chemical Analysis (ELBS).
3. D.A. Skoog and D.M. West: Principles of Instrumental Analysis (Holt, Rinehart and Wilson).
4. J.G. Dick : Analytical Chemistry (Mc Graw Hill).