SRI VENKATESWARA UNIVERSITY:: TIRUPATI

SVU COLLEGE OF SCIENCES

DEPARTMENT OF CHEMISTRY

Syllabus for M.Sc. CHEMISTRY

Choice Based Credit System (CBCS)

(w.e.f. the Academic Year 2020-2021)

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.

S.V. UNIVERSITY, TIRUPATI
SVU COLLEGE OF SCIENCES
M.Sc., CHEMISTRY
CBCS Pattern (With effect from 2020-21)
The course of Study and Scheme of Examinations

SEMESTER-I

Sl. No.	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-101	Core-Theory	Inorganic Chemistry- I	4	20	80	100
2	CHE-102	Core-Theory	Organic Chemistry I	4	20	80	100
3	CHE-103	Core-Theory	Physical Chemistry- I	4	20	80	100
4	CHE-104	Core-Practical	Inorganic Practical- I	2	-	-	50
5	CHE-105	Core-Practical	Organic Practical-I	2	-	-	50
6	CHE-106	Core-Practical	Physical Practical I	2	-	-	50
7	CHE-107	Compulsory Foundation	General Chemistry-I	2	10	40	50
6	CHE-108	Elective Foundation	han Values and Professional Ethics – I	4	20	80	100
		Total		**24**			**600**

SEMESTER-II

Sl. No.	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-201	Core-Theory	Inorganic Chemistry- II	4	20	80	100
2	CHE-202	Core-Theory	Organic Chemistry -II	4	20	80	100
3	CHE-203	Core-Theory	Physical Chemistry- II	4	20	80	100
4	CHE-204	Core-Practical	Inorganic Practical- II	2	-	-	50
5	CHE-205	Core-Practical	Organic Practical-II	2	-	-	50
6	CHE-206	Core-Practical	Physical Practical -II	2	-	-	50
7	CHE-207	Compulsory Foundation	General Chemistry-II	2	10	40	50
6	CHE-208	Elective Foundation	han Values and Professional Ethics – II	4	20	80	100
		Total		**24**			**600**

M Sc., (ANALYTICAL CHEMISTRY)
SEMESTER-III

	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-AC-301	Core-Theory	Inorganic Spectroscopy & Thermal Methods of Analysis	4	20	80	100
2	CHE-AC - 302	Core-Theory	Organic Spectroscopy	4	20	80	100
3	CHE-AC-303	Core-Practical	Classical Methods of Analysis	4	-	-	100
4	CHE-AC-304	Core-Practical	Instrumental Methods of Analysis-I	4	-	-	100
5	CHE-305	Generic Elective* **(Related to subject)**	(a) Organic Chemistry III	4	20	80	100
			(b)Physical Chemistry III	4	20	80	100
			(c)Green Chemistry				
6	CHE-306	Open Elective **(For other departments)**	(a) Spectral Techniques or (b) Chromatographic Techniques	4	20	80	100
		Total		**24**			**600**

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

SEMESTER-IV

	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-AC-401	Core-Theory	Quality control and General principles	4	20	80	100
2	CHE-AC-402	Core-Theory	Instrumental Methods of Analysis	4	20	80	100
3	CHE-AC-403	Core-Practical	Instrumental Methods of Analysis-II	4	-	-	100
4	CHE-AC-404	Core-Practical/ Project work	Project work	4	-	-	100
5	CHE-405	Generic Elective* **(Related to subject)**	(a) Applied and Environmental aspects	4	20	80	100
			(b) Bioinorganic, Bioorganic & Biophysical Chemistry	4	20	80	100
			(c) Chemistry of Nanomaterials & Functional meterials				
6	CHE-406	Open Elective* **(For other departments)**	(a)Drug Chemistry or (b) Electroanalytical Techniques	4	20	80	100
		Total		**24**			**600**

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

M Sc., (ENVIRONMENTAL CHEMISTRY)

SEMESTER-III

	Course	Components of		No. of	IA	End	Total

	Code	Study	Title of the Course	Credits	Marks	SEM Exam Marks	
1	CHE-EC-301	Core-Theory	Physical Chemistry III	4	20	80	100
2	CHE-EC-302	Core-Theory	Spectroscopy Applications	4	20	80	100
3	CHE-EC-303	Core-Practical	Water Analysis	4	-	-	100
4	CHE-EC-304	Core-Practical	Instrumental Methods of Analysis-I	4	-	-	100
5	CHE-305	Generic Elective* **(Related to subject)**	(a) Organic Chemistry III	4	20	80	100
			Inorganic Spectroscopy & Thermal Methods of Analysis	4	20	80	100
			(c) Green Chemistry				
6	CHE-306	Open Elective **(For other departments)**	(a) Spectral Techniques or (b) Chromatographic Techniques	4	20	80	100
		Total		**24**			**600**

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

SEMESTER-IV

	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-EC-401	Core-Theory	Water pollution Monitoring and Environment laws	4	20	80	100
2	CHE-EC-402	Core-Theory	Air pollution, control Methods-Noise and Thermal pollution	4	20	80	100
3	CHE-EC-403	Core-Practical	Instrumental Methods of analysis-II	4	-	-	100
4	CHE-EC-404	Core-Practical/ Project work	Project work	4	-	-	100
5	CHE-405	Generic Elective* **(Related to subject)**	(a) Energy, Environment and Soils	4	20	80	100
			(b) Bioinorganic, Bioorganic & Biophysical	4	20	80	100
			(c) Chemistry of Nanomaterials & Functional meterials				
6	CHE-406	Open Elective* **(For other departments)**	(a)Drug Chemistry or (b) Electroanalytical Techniques	4	20	80	100
		Total		**24**			**600**

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

M Sc., (INORGANIC CHEMISTRY)

SEMESTER-III

	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam	Total

						Marks	
1	CHE-IC-301	Core-Theory	Inorganic Spectroscopy & Thermal Methods of Analysis	4	20	80	100
2	CHE-IC-302	Core-Theory	Organic Spectroscopy	4	20	80	100
3	CHE-IC-303	Core-Practical	Preparation of Inorganic complexes and characterization	4	-	-	100
4	CHE-IC-304	Core-Practical	Instrumental Methods of Analysis-I	4	-	-	100
5	CHE-305	Generic Elective* **(Related to subject)**	(a) Organic Chemistry III	4	20	80	100
			(b)Physical Chemistry III	4	20	80	100
			(c)Green Chemistry				
6	CHE-306	Open Elective **(For other departments)**	(a) Spectral Techniques or (b) Chromatographic Techniques	4	20	80	100
		Total		**24**			**600**

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

SEMESTER-IV

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	End SEM Exam Marks	**Total**
1	CHE-IC-401	Core-Theory	Coordination compounds, Organo metallic chemistry & Chemistry of non-transition elements	4	20	80	100
2	CHE-IC-402	Core-Theory	Instrumental Methods of Analysis	4	20	80	100
3	CHE-IC-403	Core-Practical	Instrumental Methods of Analysis-II	4	-	-	100
4	CHE-IC-404	Core-Practical/ Project work	Project work	4	-	-	100
5	CHE-405	Generic Elective* **(Related to subject)**	(a) Solid state and Photo Chemistry	4 4	20 20	80 80	100 100
			(b) Bioinorganic, Bioorganic & Biophysical				
			(c) Chemistry of Nanomaterials & Functional meterials				
6	CHE-406	Open Elective* **(For other departments)**	(a)Drug Chemistry or (b) Electroanalytical Techniques	4	20	80	100
		Total		**24**			**600**

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

M Sc., (ORGANIC CHEMISTRY)

SEMESTER-III

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	**End SEM Exam Marks**	**Total**

1	CHE-OC-301	Core-Theory	Organic Chemistry III	4	20	80	100
2	CHE-OC-302	Core-Theory	Organic Spectroscopy & Applications	4	20	80	100
3	CHE-OC-303	Core-Practical	Organic Estimations	4	-	-	100
4	CHE-OC-304	Core-Practical	Multistep preparations	4	-	-	100
5	CHE-305	Generic Elective* **(Related to subject)**	(a) Inorganic Spectroscopy & Thermal Methods of Analysis	4	20	80	100
			(b)Physical Chemistry III	4	20	80	100
			(c)Green Chemistry				
6	CHE-306	Open Elective **(For other departments)**	(a) Spectral Techniques or (b) Chromatographic Techniques	4	20	80	100
		Total		**24**			**600**

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

SEMESTER-IV

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	**End SEM Exam Marks**	**Total**
1	CHE-OC-401	Core-Theory	Organic synthesis -I	4	20	80	100
2	CHE-OC-402	Core-Theory	Organic Synthesis- II	4	20	80	100
3	CHE-OC-403	Core-Practical	Spectral Identification of organic compounds	4	-	-	100
4	CHE-OC-404	Core-Practical/ Project work	Project work	4	-	-	100
5	CHE-405	Generic Elective* **(Related to subject)**	Heterocycles & Natural products	4	20	80	100
			(b) Bioinorganic, Bioorganic & Biophysical Chemistry	4	20	80	100
			(c) Chemistry of Nanomaterials & Functional meterials				
6	CHE-406	Open Elective* **(For other departments)**	(a)Drug Chemistry or (b) Electro analytical Techniques	4	20	80	100
		Total		**24**			**600**

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

M Sc., (PHYSICAL CHEMISTRY)

SEMESTER-III

	Course Code	**Components of Study**	**Title of the Course**	**No. of Credits**	**IA Marks**	End SEM Exam Marks	**Total**
1	CHE-PC-	Core-Theory	Physical Chemistry III	4	20	80	100

	301						
2	CHE-PC-302	Core-Theory	Organic Spectroscopy	4	20	80	100
3	CHE-PC-303	Core-Practical	Practical-III	4	-	-	100
4	CHE-PC-304	Core-Practical	Practical- III	4	-	-	100
5	CHE-305	Generic Elective* **(Related to subject)**	(a) Organic Chemistry III	4	20	80	100
			(b) Inorganic Spectroscopy & Thermal Methods of Analysis	4	20	80	100
			(c)Green Chemistry				
6	CHE-306	Open Elective **(For other departments)**	(a) Spectral Techniques or (b) Chromatographic Techniques	4	20	80	100
		Total		**24**			**600**

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

SEMESTER-IV

	Course Code	Components of Study	Title of the Course	No. of Credits	IA Marks	End SEM Exam Marks	Total
1	CHE-PC-401	Core-Theory	Electrochemistry	4	20	80	100
2	CHE-PC-402	Core-Theory	Thermodynamics, Polymers and Solid state Chemistry	4	20	80	100
3	CHE-PC-403	Core-Practical	PRACTICAL-I	4	-	-	100
4	CHE-PC-404	Core-Practical/ Project work	Project work	4	-	-	100
5	CHE-405	Generic Elective* (Related to subject)	CHEMICAL KINETICS	4	20	80	100
			(b) Bioinorganic, Bioorganic & Biophysical	4	20	80	100
			(c) Chemistry of Nanomaterials & Functional meterials				
6	CHE-406	Open Elective* (For other departments)	(a)Drug Chemistry or (b) Electro analytical Techniques	4	20	80	100
		Total		24			600

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

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	-	3	-	2	1	1	-	2	-	1
CO2	3	1	2	3	-	2	-	2	1	1-	-	1
CO3	3	2	-	3	2		1		2	1	1	1
CO4	3	1	1	3	1	1	-	2	1	-	2	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.

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 stereochemical 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	1	-	1	2	1	-	2	-
CO2	3	2	2	3		1	-	1	2	1	1	2
CO3	3	1	2	3	1	1	1	2		1	-	-
CO4	3	2	2	3	2	2	-	2	-	1	-	2

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.

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	2	1	3	2	1	-	2	1	2	1	1
CO2	3	1	2	3	1	1	1	-	2	1	-	1
CO3	3	2	1	3	2			3		1	2	2
CO4	3	2	2	3	-	1	1	-	1	2	-	2

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).

CHE 104	**Core practical I: Inorganic Chemistry**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Inorganic Chemistry practical.			

SEMI MICRO QUALITATIVE ANALYSIS • Basic laboratory techniques of titration and analysis. • Quantitative estimation of inorganic compounds through volumetric techniques.	
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	
CO4	

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	2	-
CO2	3	2	2	3	1	1	-	1	2	1	1	2
CO3												
CO4												

CHE 104: Core practical I: Inorganic Chemistry

Semi Micro Qualitative Analysis

I. 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).

CHE 105	**Core practical I: Organic CheImistry**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Organic Chemistry practical.			

Course Objectives: • Identification of single organic component by systematic qualitative analysis • Single step preparations												
Course Outcomes: At the end of the course, the student will be able												
CO1	To familiarize the systematic procedures of analysis of organic components, conformational tests for various functional groups.											
CO2	To understand the mechanisms and familiarize with methodologies to prepare biologically important molecules.											
CO3												
CO4												
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	1	2	-	2	-
CO2	3	2	2	3	2	2	-	1	1	2	-	2
CO3												
CO4												

CHE : 105 : PRACTICAL – II : ORGANIC CHEMISTRY

a) Identification of single organic component by systematic qualitative analysis.
Aromatic acids

Phenols

Neutral compounds

Esters

Carbonyl compounds etc.

b) Single step preparations.

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

CHE 106	**Core practical I: Physical CheImistry**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Physical Chemistry practical.			

Course Objectives:

- Determination of critical solution temperature, eutectic composition and temperature of binary system.

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

CO1	To study the determination of critical solution temperature, eutectic composition, distribution coefficient, adsorption of different
CO2	To calibrate the statistical data
CO3	
CO4	

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	1
CO2	3	2	2	2	1	2	-	1	1	2	-	2
CO3												
CO4												

CHE : 106 : PRACTICAL – III : Physical Chemistry

Syllabus

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

CHE-107	**General Chemistry I**	**L-5,T-1,P-0**	**2 Credits**
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 .

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	
CO4	

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	-	1	1	2
CO2	3	2	2	3	1	-	2	1	-	2	-	2
CO3												
CO4												

CHE107: 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.

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 108	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	1	2	3	-	1	2
CO2	3	-	2	3	1	2	--	2	3	2	-	2
CO3	3	1		3	2		1				1	3
CO4	3	1	2	3		2	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.

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	-	2	-	1
CO2	3	1	1	3	1	2	-	2	-	1	-	1
CO3	3	-	2	3	-	2	1	-	2	1	1	-
CO4	3	1	1	3	1	2	-	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.

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 E_2, E_1, E_{1CB}.
- 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	3	2	2	3	-	2	1	1	2	-	1
CO2	3	3	2	2	3	2	2	-	1	-	1	1
CO3	3	3	2	2	3	2	2	1	1	1	2	
CO4	3	3	2	2	3	-	2	-	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.

CHE -203	Physical chemistry II	L-5,T-1,P-6	4 Credits
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	-	3	-	2	1	1	-	1	1	1
CO2	3	2	2	3	2	2	2	-	2	-	2	-
CO3	3	2	2	3	-	-	1	1	-	1	1	1
CO4	3	2	-	2	2	1	1	-	2	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.

CHE 204	**Core practical I: Inorganic Chemistry**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Inorganic Chemistry practical.			
SEMI MICRO QUALITATIVE ANALYSIS • Separation and determination of the two component mixtures. • Preparation of metal complexes			

Course Outcomes: At the end of the course, the student will be able	
CO1	CO 1: To separate and determine the two component mixtures.
CO2	CO 2: To acquire knowledge in the preparation of metal complexes
CO3	
CO4	

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	-	3	3	1
CO2	3	2	2	3	-	1	2	-	2	3	3	1
CO3												
CO4												

CHE 204: Core practical I: Inorganic 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. 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 106	**Core practical II: Organic CheImistry**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Organic Chemistry practical.			

Course Objectives:
- Familiarize with two component mixture separation and identification.
- preparation of derivatives and purification by different methods

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

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

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	1
CO2	3	2	2	3	-	2	-	1	2	1	-	2
CO3												
CO4												

CHE : 205 : PRACTICAL – II : ORGANIC CHEMISTRY

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

Binary mixture of

Acid + Neutral
Phenol + Neutral
Base + Neutral
Acid + Ether insoluble component
Phenol + Ether insoluble component
Base + Ether insoluble component

CHE 206	**Core practical II: Physical CheImistry**	**L-5,T-1,P-0**	**2 Credits**

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

Course Objectives:
- 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 study the determination of cell constant and verification of Onsagar equation, strength of strong
CO2	To get knowledge on the applications of conductometry, potentiometry, coulometry and pH metry.
CO3	
CO4	

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**	**1**	**2**	**-**	**1**	**1**	**1**
CO2	**3**	**2**	**2**	**3**	**2**	**1**	**1**	**-**	**2**	**1**	**-**	**2**
CO3												
CO4												

CHE : 106 : PRACTICAL – III : Physical Chemistry

Syllabus

1. Conductometry:
   - (a) Getermination 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. pH metry: Strong acid, Strong base titrations.

CHE-207	**General Chemistry II**	**L-5,T-1,P-0**	**2 Credits**
Pre-requisite: Understanding of graduate level Chemistry			
Course Objectives: • Gain knowledge on the principles of different electro analytical methods. • Familiarize with chromatographic techniques.			
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		
CO2	To learn general principles and classifications of chromatographic separations and applications of		

	TLC, GLC
CO3	
CO4	

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	-	2	3	1	2	1	2	-	2	1	1
CO3												
CO4												

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.

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).

CHE 208	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	1	-	3	1	1	1
CO2	3	1	1	3	-	2	-	3	3	1	1	1
CO3	3	2	2	3	2	2	2	2	2	3	-	1
CO4	3	1	1	3	1	2	-	-	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-AC- 301	**Inorganic Spectroscopy and Thermal Methods of Analysis**	**L-5,T-1,P-0**	**4 Credits**

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 about TG and DTA and applications of different scanning calorimetry.											
CO2	To gain knowledge on Doppler shift and chemical shift, basic principles and applications of NQR spectroscopy.											
CO3	To learn zero field splitting and Kramer's degeneracy, relaxation processes, instrumentation and applications of ESR.											
CO4	To know about photoelectric effect and Koopmans theorem and impart the applications of X-ray and UV photoelectron spectroscopy.											
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	-	2	2	1
CO2	3	2	2	3	2	2	-	2	1	2	2	-
CO3	3	2	2	3	2	2	1	2		2		1
CO4	3	2	2	3	2	-	-1		2	-	2	1

CHE-AC- 301: 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 $CuSO_4 5H_2O$, $CaC_2O_4\ 2H_2O$. 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-AC 302	**Organic Spectroscopy and Applications**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite: Understanding of Organic Spectroscopy and Applications			

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 be able to

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 molecule based on the data provided
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	1
CO2	3	2	2	3	2	2	-	2	-	2	2	-
CO3	3	2	2	3	2	2	1		2	2	2	2
CO4	3	2	2	3	2	2	1	2	-	2	2	-

CHE 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

CHE AC 303 & 304	Core-Practical: Classical Methods of Analysis	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Analytical Chemistry- Practical.

Course Objectives:

- Gain knowledge on synthesis of inorganic complexes.
- Analysis of ores, alloys and water.
- Acquire knowledge on working principle of colorimetry.
- Estimation of metal ions by complex metric and colorimetric method.

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	3		2	3	2	1	-	1	-
CO2	3	2	2	3	2	2	3	2		1	1	2
CO3	3	2		3	-	2	-	2	1	2	-	-
CO4	3	2	2	3	2	-	1	2	2	1	1	2

CHE -AC -303: Core-Practical Classical Methods of Analysis PRACTICAL –I

1. Analysis of ores and alloys:

a) Brass/Bronze
b) Cement
c) Illmenite/Chalcopyrite
d) Dolamite
e) Copper and Nickel alloy

II. Water Analysis:

a) Determination of dissolved Oxygen
b) Determination of BOD of Waste water
c) Determination of COD of Waste water
d) Hardness of Water
e) Chloride, sulphates, carbonates and bicarbonates.

CHE AC 304 Core-Practical PRACTICAL –II –Instrumental methods of analysis

1. Colorimetric Determinations:
   a) Determination of manganese
   b) Determination of nickel
   c) Determination of iron by 1,10 Pheren-thiroline
   d) Determination of chromium
   e) Determination of Phosphate
   f) Determination of Pesticides
   g) Determination of Nitrite.

CHE-AC-305A	Organic Chemistry III	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Organic Chemistry

Course Objectives: Course Objectives:

- Familiarize with the applications of different reagents in organic synthesis, Mechanisms and stereochemistry.
- Study the methods of preparation and applications of organometallic reagents.
- Understand topocity, prochirality, auxillary and reagent-controlled methods in asymmetric synthesis.
- Applications of different oxidizing and reducing agents in organic synthesis with region and stereo controlled products.

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

CO1	To familiarize with the specific functions of the reagents particularly diazomethane, N-bromosuccinimide, Ziegler Natta catalyst, 1,3-dithianes and Merrifield resin in the synthesis of a variety of complex molecules.
CO2	To gain knowledge in the synthesis of different organometallic reagents and also stereo and regio specificity and selectivity of reactions with organometallic reagents
CO3	To understand diastereoselectivity, stereoselectivity and substrate controlled auxillary controlled reactions
CO4	To acquire knowledge about the reagents which causes oxidation in various compounds and also the reagents that causes selective and complete reductions to synthesize various compounds.

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	2	1
CO2	3	2	2	3	2	2	1	2	1	-	2	1
CO3	3	2	2	3	2	2	-	-	1	1	2	-
CO4	3	2	2	3	2	2	1	2	-	2	2	1

CHE-AC-303A Core-Theory Organic Chemistry III

UNIT I: REAGENTS IN ORGANIC SYNTHESIS 15 Hrs

Use of the following reagents in organic synthesis: Anhydrous $AlCl_3$, Boran trifluoride, N-Bromosuccinimide, Diazomethane, Dicyclohexylcarbodiimide, Lead tetraacetate, Zieglar-Natta catalysts, DDQ, Dithianes, Merrifield resin.

UNIT-II: ORGANOMETALLIC REAGENTS 15 Hrs

Synthesis and applications of Grignard reagents, Organolithium, Zinc, Copper, Mercury, Palladium and Rhodium compounds in Organic Synthesis, Homogeneous catalytic hydrogenation and hydroformylation reactions

UNIT III: ASYMMETRIC SYNTHESIS 15 Hrs

Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantioselectivity-Substrate controlled methods-use of chiral substrates - examples

Auxiliary controlled methods-Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines – Stereoselective Diels-Alder reaction

Reagent controlled methods-Use of chiral reagents-Asymmetric oxidation-Sharpless epoxidation-Asymmetric reduction-Use of lithium aluminium hydride and borate reagents.

UNIT IV: METHODS OF ORGANIC SYNTHESIS 15 Hrs

i). ***Oxidations:*** **(a)** Alcohols to carbonyls-Chromium (iv) oxidants-Dimethylsulfoxide oxidation,

periodate xidation, Oppenauer oxidation, oxidation with manganese dioxide, oxidation with silver carbonate **(b)** Alkenes to epoxides-peroxide induced epoxidations. **(c)** Alkenes to diols-oxidation with potassium permanaganate, osmium tetraoxide, Prevost reaction **(d)** Ketones to esters-Bayer-Villiger oxidation **(e)** Oxidative bond cleavage-cleavage of alkenes by transition metals. **(f)** Oxidation of alkyl or alkenyl fragments-selenium dioxide and chromium trioxide oxidations.

ii). ***Reductions*** **:** Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bis-methoxy ethoxy aluminium hydride, Boran aluminium hydride and derivatives-catalytic,hydrogenation-dissolving metal reductions, Non-Metallic reducing agents including enzymatic and microbial reductions.

Suggested Books

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. Name reactions and reagents in organic synthesis, B.P. Muway and M.G Ellord, John Wiley.
6. Principles of Organic Synthesis, R.O.C Norman and J.M Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Principles of organometallic chemistry, P. Powell, ELBS.
9. Organo transition metal chemistry-Applications to organic synthesis, S.G. Davis, Pergmon.
10. Stereochemistry to Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry, P.S. Kalsi, Wiley Eastern.

CHE-AC-305B	Physical Chemistry III	L-5,T-1,P-0	4Credits

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	1
CO2	3	2	2	3	2	2	2	1	-	2	-	2
CO3	3	2	2	3	2	2	1	-	2	-	2	2
CO4	3	2	2	3	-	2	--	2	-	2	-	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 Coordinate 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 Frenkel defects, 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 AC 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	-	1	2
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2	-	2		1		1	1
CO4	3	2	2	3	-	2	-	1	-	1	--	2

CHE : AC : 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 AC 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	-	2	3	-	2	3	2	1	1	1	1
CO2	3	2	2	3	2	2	3	2	1	1	-	2
CO3	3	2	1	2	2	-	2		2	-	1	1
CO4	3	2	2	3	1	2	-	1	-	1	-	2

CHE AC 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).

CHE-EC-301	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	-	2	2
CO2	3	2	2	3	2	2		1	2	2	1	1
CO3	3	2	2	3	2	2	2	1	1	-	-	2
CO4	3	2	2	3	-	2	-	-	2	2	2	2

CHE-EC-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 Co-ordinates. 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-EC 302	Organic Spectroscopy and Applications	L-5,T-1,P-0	4Credits
Pre-requisite: Understanding of Organic Spectroscopy and Applications			

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 be able to

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 molecule based on the data provided
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	1
CO2	3	2	2	3	2	2	-	2	1	2	2	1
CO3	3	2	2	3	2	2	2	-	1	2	2	2
CO4	3	2	2	3	2	2	-	2	-	2	2	2

CHE-EC 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.

CHE EC 303 & 304	**Core practical I: Environmental Chemistry - Practical**	**L-5,T-1,P-0**	**4 Credits**
Pre-requisite: Understanding of Environmental Chemistry- Practical.			
Course Objectives: • Familiarize with water analysis • Study of soil analysis. • Know about instrumentation and analysis of mixtures by potentiometry			

- Identification of cations by flame photometry

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

CO1	To get an idea about water analysis.
CO2	To understand the basic principles of soil analysis.
CO3	To familiarize with instrumentation of potentiometric techniques.
CO4	To gain knowledge on flame photometry and its applications.

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	2	-	2
CO2	3	2	2	3	3	2	3	2	-	2	2	2
CO3	3	2	3	2	3	-	-	2	-	1	-	2
CO4	3	2	2	3	3	2	2	-	2	2	2	2

CHE- EC-303: Core-Practical PRACTICAL-I

WATER & SOIL ANALYSIS

Water Analysis

a. Alkalinity
b. Acidity
c. Temporary, Permanent and total hardness
d. Sulphate
e. Phosphorus
f. Nitrites
g. Cholorides
h. D.O, BOD and COD
i. Insecticides

Soil Analysis:

Determination Of:

a) pH
b) Conductivity
c) Ca
d) Mg
e) Heavy metals like Cr, Pb, Cd, Zn.

CHE EC-304: Core-Practical PRACTICAL-II – INSTRUMENTAL METHODS OF ANALYSIS

1) Potentiometry:
   a)Mixture of Acids
   b)Mixture of Halides
2) Flame Photometry: Determination of Na, K, and Li.

CHE-EC-305A	Organic Chemistry III	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Organic Chemistry

Course Objectives: Course Objectives:

- Familiarize with the applications of different reagents in organic synthesis, Mechanisms and stereochemistry.
- Study the methods of preparation and applications of organometallic reagents.

• Understand topocity, prochirality, auxillary and reagent-controlled methods in asymmetric synthesis. • Applications of different oxidizing and reducing agents in organic synthesis with region and stereo controlled products.												
Course Outcomes: At the end of the course, the student will be able to												
CO1	To familiarize with the specific functions of the reagents particularly diazomethane, N-bromosuccinimide, Ziegler Natta catalyst, 1,3-dithianes and Merrifield resin in the synthesis of a variety of complex molecules.											
CO2	To gain knowledge in the synthesis of different organometallic reagents and also stereo and regio specificity and selectivity of reactions with organometallic reagents											
CO3	To understand diastereoselectivity, stereoselectivity and substrate controlled auxillary controlled reactions											
CO4	To acquire knowledge about the reagents which causes oxidation in various compounds and also the reagents that causes selective and complete reductions to synthesize various compounds.											
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	2	-
CO2	3	2	2	3	2	2	-	2	1	1	2	1
CO3	3	2	2	3	2	2	2	-	2	-	1	1
CO4	3	2	2	3	2	2	2	2	-	2	2	-

CHE-EC-305A Core-Theory Organic Chemistry III

UNIT I: REAGENTS IN ORGANIC SYNTHESIS 15 Hrs

Use of the following reagents in organic synthesis: Anhydrous $AlCl_3$, Boran trifluoride, N-Bromosuccinimide, Diazomethane, Dicyclohexylcarbodiimide, Lead tetraacetate, Zieglar-Natta catalysts, DDQ, Dithianes, Merrifield resin.

UNIT-II: ORGANOMETALLIC REAGENTS 15 Hrs

Synthesis and applications of Grignard reagents, Organolithium, Zinc, Copper, Mercury, Palladium and Rhodium compounds in Organic Synthesis, Homogeneous catalytic hydrogenation and hydroformylation reactions

UNIT III: ASYMMETRIC SYNTHESIS 15 Hrs

Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantioselectivity-Substrate controlled methods-use of chiral substrates - examples

Auxiliary controlled methods-Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines – Stereoselective Diels-Alder reaction

Reagent controlled methods-Use of chiral reagents-Asymmetric oxidation-Sharpless epoxidation-Asymmetric reduction-Use of lithium aluminium hydride and borate reagents.

UNIT IV: METHODS OF ORGANIC SYNTHESIS 15 Hrs

i). ***Oxidations:*** **(a)** Alcohols to carbonyls-Chromium (iv) oxidants-Dimethylsulfoxide oxidation, periodate xidation, Oppenauer oxidation, oxidation with manganese dioxide, oxidation with silver carbonate **(b)** Alkenes to epoxides-peroxide induced epoxidations. **(c)** Alkenes to diols-oxidation with potassium permanaganate, osmium tetraoxide, Prevost reaction **(d)** Ketones to esters-Bayer-Villiger oxidation **(e)** Oxidative bond cleavage-cleavage of alkenes by transition metals. **(f)** Oxidation of alkyl or alkenyl fragments-selenium dioxide and chromium trioxide oxidations.

ii). ***Reductions*** **:** Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bis-methoxy ethoxy aluminium hydride, Boran aluminium hydride and derivatives-catalytic,hydrogenation-dissolving metal reductions, Non-Metallic reducing agents including enzymatic and microbial reductions.

Suggested Books

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. Name reactions and reagents in organic synthesis, B.P. Muway and M.G Ellord, John Wiley.
6. Principles of Organic Synthesis, R.O.C Norman and J.M Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Principles of organometallic chemistry, P. Powell, ELBS.
9. Organo transition metal chemistry-Applications to organic synthesis, S.G. Davis, Pergmon.
10. Stereochemistry to Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry, P.S. Kalsi, Wiley Eastern.

CHE-EC- 305B	**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 about TG and DTA and applications of different scanning calorimetry.
CO2	To gain knowledge on Doppler shift and chemical shift, basic principles and applications of NQR spectroscopy.
CO3	To learn zero field splitting and Kramer's degeneracy, relaxation processes, instrumentation and applications of ESR.
CO4	To know about photoelectric effect and Koopmans theorem and impart the applications of X-ray and UV photoelectron spectroscopy.

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	2	2	1
CO2	3	2	2	3	2	2	-	2	-	2	2	-
CO3	3	2	2	3	2	2	1	1	2	2	1	-
CO4	3	2	2	3	2	-	-	1	1	-	2	1

CHE-EC- 301: 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 (4th Ed.) (Addison-Wesley)
3. Gary Wulfsberg: Inorganic Chemistry (5th 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-EC- 306 A	**Spectral Techniques**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite: Understanding of Basic 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 be 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	1	3	-	2	3	2	1	-	1	1
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2	-	2	--	1		1	-
CO4	3	2	2	3	-	2	1	1	-	1	-	2

CHE : EC : 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 EC 306 B	Chromatographic Techniques	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of 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 be able

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	-	1	3	-	2	3	2	1	-	1	1
CO2	3	2	2	3	2	2	3	2		1	-	2
CO3	3	2	-	2	2	1	2	-	2	-	1	1
CO4	3	2	2	3	-	2	1	2	-	1	-	2

CHE : EC : 306(B): (OPEN ELECTIVE) 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,McGrraw Hill,New Delhi, (1973).

CHE-IC- 301	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 about TG and DTA and applications of different scanning calorimetry.
CO2	To gain knowledge on Doppler shift and chemical shift, basic principles and applications of NQR spectroscopy.
CO3	To learn zero field splitting and Kramer's degeneracy, relaxation processes, instrumentation and applications of ESR.
CO4	To know about photoelectric effect and Koopmans theorem and impart the applications of X-ray and UV photoelectron spectroscopy.

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	2
CO2	3	2	2	3	2	2	1	2	2	2	2	-
CO3	3	2	2	3	2	2	-	1	-	2	-	2
CO4	3	2	2	3	2	-	2	-	1	-	2	2

CHE-IC- 301: 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 $CuSO_4 5H_2O$, $CaC_2O_4\ 2H_2O$. 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

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

CHE-IC 302	Organic Spectroscopy and Applications	L-5,T-1,P-0	4Credits
Pre-requisite: Understanding of Organic Spectroscopy and Applications			

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 be able to

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 molecule based on the data provided
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	2	1
CO3	3	2	2	3	2	2	2		2	2	2	2
CO4	3	2	2	3	2	2	2	1	-	2	2	-

CHE-IC 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:

6. Organic spectroscopy, W. Kemp 5th Ed, ELBS
7. Spectroscopy of organic compounds, RM Silversteen and others, 5th Ed,John Wiley
8. Spectroscopy of organic compounds, P.S. Kalsi, Wiley, 1993.
9. NMR in chemistry-A multi nuclear introduction, William Kemp, Mc Millan, 1986.
10. Spectroscopic methods in Organic chemistry, DH Williams & I Flemm.

CHE IC 33 & 304	Core practical I & II Inorganic Chemistry	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Inorganic Chemistry - Practical.

Course Objectives:

- Gain knowledge on synthesis of inorganic complexes
- Estimation of metal ions by complex metric and colorimetric method.

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 familiarize with the analysis of organometallic complex salts.
CO3	To Understand the complexity, theory and working principle of colourimetry.
CO4	To gain knowledge on analysis of organic components

Mapping of course outcomes with the program outcomes

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

CHE- IC -303: Core-Practical **PRACTICAL-I**

Preparation of Inorganic complexes and characterization:

a) Tris thiourea Zinc (II) Sulphate
b) Tris thiourea Copper(I) Sulphate
c) Hexamine nickel (II) Chloride
d) Chloropentamanine cobalt (III) Chloride
e) Cis potassium diaquodioxalato chromate (III)
f) Tris (acetylacetonato) manganese (III)
g) Mercury tetrakristhiocyanato cobaltate (II)
h) Sodium trioxalato ferrate (III)
i) Tetrammine Copper (II) Sulphate
j) Potassium hexathiocyanato chromate (III) tetrahydrate

CHE -IC -304 Core-Practical- **PRACTICAL –II –Instrumental methods of analysis**

Colorimetric determinations:

k) Determination of manganese
l) Determination of nickel
m) Determination of iron by 1,10 Pheren-thiroline
n) Determination of chromium
o) Determination of Phosphate
p) Determination of Pesticides
q) Determination of Nitrite.

CHE-IC-305A	Organic Chemistry III	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Organic Chemistry												
Course Objectives: Course Objectives: • Familiarize with the applications of different reagents in organic synthesis, Mechanisms and stereochemistry. • Study the methods of preparation and applications of organometallic reagents. • Understand topocity, prochirality, auxillary and reagent-controlled methods in asymmetric synthesis. • Applications of different oxidizing and reducing agents in organic synthesis with region and stereo controlled products.												
Course Outcomes: At the end of the course, the student will be able to												
CO1	To familiarize with the specific functions of the reagents particularly diazomethane, N-bromosuccinimide, Ziegler Natta catalyst, 1,3-dithianes and Merrifield resin in the synthesis of a variety of complex molecules.											
CO2	To gain knowledge in the synthesis of different organometallic reagents and also stereo and regio specificity and selectivity of reactions with organometallic reagents											
CO3	To understand diastereoselectivity, stereoselectivity and substrate controlled auxillary controlled reactions											
CO4	To acquire knowledge about the reagents which causes oxidation in various compounds and also the reagents that causes selective and complete reductions to synthesize various compounds.											
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	-	2	2	1
CO2	3	2	2	3	2	2	-	2	2	-	2	2
CO3	3	2	2	3	2	2	1	-	2	2	-	1
CO4	3	2	2	3	2	2	-	2	-	2	2	2

CHE-IC-303A Core-Theory Organic Chemistry III

UNIT I: REAGENTS IN ORGANIC SYNTHESIS **15 Hrs**

Use of the following reagents in organic synthesis: Anhydrous $AlCl_3$, Boran trifluoride, N-Bromosuccinimide, Diazomethane, Dicyclohexylcarbodiimide, Lead tetraacetate, Zieglar-Natta catalysts, DDQ, Dithianes, Merrifield resin.

UNIT-II: ORGANOMETALLIC REAGENTS **15 Hrs**

Synthesis and applications of Grignard reagents, Organolithium, Zinc, Copper, Mercury, Palladium and Rhodium compounds in Organic Synthesis, Homogeneous catalytic hydrogenation and hydroformylation reactions

UNIT III: ASYMMETRIC SYNTHESIS **15 Hrs**

Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantioselectivity-Substrate controlled methods-use of chiral substrates - examples

Auxiliary controlled methods-Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines – Stereoselective Diels-Alder reaction

Reagent controlled methods-Use of chiral reagents-Asymmetric oxidation-Sharpless epoxidation-Asymmetric reduction-Use of lithium aluminium hydride and borate reagents.

UNIT IV: METHODS OF ORGANIC SYNTHESIS **15 Hrs**

i). ***Oxidations:*** **(a)** Alcohols to carbonyls-Chromium (iv) oxidants-Dimethylsulfoxide oxidation,

periodate xidation, Oppenauer oxidation, oxidation with manganese dioxide, oxidation with silver carbonate **(b)** Alkenes to epoxides-peroxide induced epoxidations. **(c)** Alkenes to diols-oxidation with potassium permanaganate, osmium tetraoxide, Prevost reaction **(d)** Ketones to esters-Bayer-Villiger oxidation **(e)** Oxidative bond cleavage-cleavage of alkenes by transition metals. **(f)** Oxidation of alkyl or alkenyl fragments-selenium dioxide and chromium trioxide oxidations.

ii). ***Reductions*** **:** Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bis-methoxy ethoxy aluminium hydride, Boran aluminium hydride and derivatives-catalytic,hydrogenation-dissolving metal reductions, Non-Metallic reducing agents including enzymatic and microbial reductions.

Suggested Books

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. Name reactions and reagents in organic synthesis, B.P. Muway and M.G Ellord, John Wiley.
6. Principles of Organic Synthesis, R.O.C Norman and J.M Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Principles of organometallic chemistry, P. Powell, ELBS.
9. Organo transition metal chemistry-Applications to organic synthesis, S.G. Davis, Pergmon.
10. Stereochemistry to Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry, P.S. Kalsi, Wiley Eastern.

CHE-IC-305B	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	2	-	1	-	2	-
CO2	3	2	2	3	2	2	1	2	2	2	1	-
CO3	3	2	2	3	2	2	1	1	-	2	-	2
CO4	3	2	2	3	-	2	1	-	2	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 IC 306 A	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	1	3	1	2	3	2	1	-	1	-
CO2	3	2	2	3	2	2	3	2	-	1	2	2
CO3	3	2	1	2	2	1	2	-	2	-	1	-
CO4	3	2	2	3	1	2	-	1	-	1	-	2

CHE : IC : 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:

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

CHE IC 306 B	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	1	1	3	1	2	3	2	2	-	1	1
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2	-	2	-	2	-	1	-
CO4	3	2	2	3	1	2	-	2	-	1	2	2

CHE IC 306 (B) : 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:

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

CHE-OC-301	Organic Chemistry III	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Organic Chemistry

Course Objectives: Course Objectives:

- Familiarize with the applications of different reagents in organic synthesis, Mechanisms and stereochemistry.
- Study the methods of preparation and applications of organometallic reagents.
- Understand topocity, prochirality, auxillary and reagent-controlled methods in asymmetric synthesis.
- Applications of different oxidizing and reducing agents in organic synthesis with region and stereo controlled products.

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

CO1	To familiarize with the specific functions of the reagents particularly diazomethane, N-bromosuccinimide, Ziegler Natta catalyst, 1,3-dithianes and Merrifield resin in the synthesis of a variety of complex molecules.
CO2	To gain knowledge in the synthesis of different organometallic reagents and also stereo and regio specificity and selectivity of reactions with organometallic reagents
CO3	To understand diastereoselectivity, stereoselectivity and substrate controlled auxillary controlled reactions
CO4	To acquire knowledge about the reagents which causes oxidation in various compounds and also the reagents that causes selective and complete reductions to synthesize various compounds.

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	1
CO2	3	2	2	3	2	2	1	2	1	1	2	2
CO3	3	2	2	3	2	2	1	-	2	-	-	2
CO4	3	2	2	3	2	2	-	2	1	2	2	2

CHE-OC-301Core-Theory Organic Chemistry III

UNIT I: REAGENTS IN ORGANIC SYNTHESIS 15 Hrs

Use of the following reagents in organic synthesis: Anhydrous $AlCl_3$, Boran trifluoride, N-Bromosuccinimide, Diazomethane, Dicyclohexylcarbodiimide, Lead tetraacetate, Zieglar-Natta catalysts, DDQ, Dithianes, Merrifield resin.

UNIT-II: ORGANOMETALLIC REAGENTS 15 Hrs

Synthesis and applications of Grignard reagents, Organolithium, Zinc, Copper, Mercury, Palladium and Rhodium compounds in Organic Synthesis, Homogeneous catalytic hydrogenation and hydroformylation reactions

UNIT III: ASYMMETRIC SYNTHESIS 15 Hrs

Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantioselectivity-Substrate controlled methods-use of chiral substrates - examples

Auxiliary controlled methods-Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines – Stereoselective Diels-Alder reaction

Reagent controlled methods-Use of chiral reagents-Asymmetric oxidation-Sharpless epoxidation-Asymmetric reduction-Use of lithium aluminium hydride and borate reagents.

UNIT IV: METHODS OF ORGANIC SYNTHESIS **15 Hrs**

i). ***Oxidations:*** **(a)** Alcohols to carbonyls-Chromium (iv) oxidants-Dimethylsulfoxide oxidation, periodate xidation, Oppenauer oxidation, oxidation with manganese dioxide, oxidation with silver carbonate **(b)** Alkenes to epoxides-peroxide induced epoxidations. **(c)** Alkenes to diols-oxidation with potassium permanaganate, osmium tetraoxide, Prevost reaction **(d)** Ketones to esters-Bayer-Villiger oxidation **(e)** Oxidative bond cleavage-cleavage of alkenes by transition metals. **(f)** Oxidation of alkyl or alkenyl fragments-selenium dioxide and chromium trioxide oxidations.

ii). ***Reductions*** **:** Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bis-methoxy ethoxy aluminium hydride, Boran aluminium hydride and derivatives-catalytic, hydrogenation-dissolving metal reductions, Non-Metallic reducing agents including enzymatic and microbial reductions.

Suggested Books

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. Name reactions and reagents in organic synthesis, B.P. Muway and M.G Ellord, John Wiley.
6. Principles of Organic Synthesis, R.O.C Norman and J.M Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Principles of organometallic chemistry, P. Powell, ELBS.
9. Organo transition metal chemistry-Applications to organic synthesis, S.G. Davis, Pergmon.
10. Stereochemistry to Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry, P.S. Kalsi, Wiley Eastern.

CHE-OC 302	**Organic Spectroscopy and Applications**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite: Understanding of Organic Spectroscopy and Applications			

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 be able to

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 molecule based on the data provided
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	1	-	1	2	2	1
CO2	3	2	2	3	2	2	1	2	1	2	2	-
CO3	3	2	2	3	2	2	1	2	-	2	2	2
CO4	3	2	2	3	2	2	-	2	1	2	2	1

CHE-IC 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:

11. Organic spectroscopy, W. Kemp 5th Ed, ELBS
12. Spectroscopy of organic compounds, RM Silversteen and others, 5th Ed,John Wiley
13. Spectroscopy of organic compounds, P.S. Kalsi, Wiley, 1993.
14. NMR in chemistry-A multi nuclear introduction, William Kemp, Mc Millan, 1986.
15. Spectroscopic methods in Organic chemistry, DH Williams & I Flemm.

CHE OC 303 & 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, glucose, primary amine and ketone
- Estimation and percentage purity of aspirin and paracetamol.
- 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 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 multi step preparation of biologically important
CO4	To gain experience in the proposal of synthetic routes to functionalized derivatives.

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	1	2	2	2
CO3	3	2	2	3	2	-	1	2	-	-	-	2
CO4	3	2	2	3	2	1	-	2	1	2	-	2

CHE-OC-303 Core-Practical Organic Estimations PRACTICAL –I

1) Estimation of phenol
2) Estimation of glucose
3) Estimation of primary amine
4) Estimation of ketone
5) Estimation of percentage purity of aspirin
6) Estimation of percentage purity of paracetamol.

CHE-OC-304 Core-Practical Multistep preparations PRACTICAL –II

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

CHE-OC-305 A	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	-	3	2	2	3	2	1	-	1	-
CO2	3	2	2	3	2	2	3	2	2	1	1	2
CO3	3	1	3	3	2	2	-	2	-	2	1	-
CO4	3	2	2	3	2	1	1	2	1	1	-	2

CHE-OC- 305 A: 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 $CuSO_4 5H_2O$, $CaC_2O_4\ 2H_2O$. 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- 305B	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	1	1	-	2	1
CO2	3	2	2	3	2	2	1	-	2	2	1	-
CO3	3	2	2	3	2	2	2	2		2	-	2
CO4	3	2	2	3	-	2	1	1	1	2	2	2

CHE-OC-305B 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 306 (A)	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	1	3	-	2	3	2	-	1	1	1
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2	2	2	-	2	-	1	-
CO4	3	2	2	3	-	2	1	2	1	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 (B)	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	1	-	3	1	2	3	2	2	1	1	-
CO2	3	2	2	3	2	2	3	2	2	1	-	2
CO3	3	2	-	2	2	-	2	-	2	-	1	-
CO4	3	2	2	3	2	2	-	1	-	1	1	2

CHE OC 306 (B) : 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).

CHE-PC-301	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	2	1	1	-	2	2
CO2	3	2	2	3	2	2	1	2	2	2	-	1
CO3	3	2	2	3	2	2	-	2	-	1	2	2
CO4	3	2	2	3	-	2	2	-	2	2	-	2

CHE-PC-301 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

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

CHE-PC 302	**Organic Spectroscopy and Applications**	**L-5,T-1,P-0**	**4Credits**

Pre-requisite: Understanding of Organic Spectroscopy and Applications

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 be able to

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 molecule based on the data provided
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	-	-	2	2	-
CO2	3	2	2	3	2	2	-	2	2	2	2	2
CO3	3	2	2	3	2	2	2	1	-	2	2	2
CO4	3	2	2	3	2	2	-	2	-	2	2	2

CHE-PC 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

CHE PC 303 & 304	Core practical I: Physical Chemistry-practicals I & II	L-5,T-1,P-0	4 Credits
Pre-requisite: Understanding of Inorganic Chemistry - Practical.			

Course Objectives:

- Study on chemical kinetics of different reactions
- Flame photometry to determine different cations
- Familiarize with conductometric titrations of mixtures
- Colorometric estimation of different molecules.

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

CO1	To study chemical kinetics of homogeneous solutions
CO2	To gain knowledge on the determination of different cations by flame photometry
CO3	To understand the principle and working aspects of conductometric titrations
CO4	To acquire knowledge on the implementation of colorometric estimations.

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	-	2
CO2	3	2	2	3	3	2	-	2	-	2	2	2
CO3	3	3	3	2	-	2	1	-	2	-	2	2
CO4	3	2	2	3	3	2	1	2	-	2	2	2

CHE-PC-303: Core-Practical PRACTICAL-I

1. Chemical Kinetics:

a) Study of the kinetics of halogenations of acetone.
b) Determination of activation energy of reaction between iodide and Persulphate
c) Determination rate constant of oxidation of iodide ion by persulphate ion and study the effect of neutral salt (KCl) on this reaction.

2. Flame Photometry:

a) Determination of Na
b) Determination of K
c) Determination of Cu

CHE- PC-304: Core-Practical PRACTICAL-II

1. Conductometry:

a) Titration of mixture of halides
b) Titration of mixture of HCl+HOAC
c) Saponification of an ester

2. Colorimetry:

a) Estimation of Manganese
b) Estimation of Iron
c) Estimation of Phosphate
d) Titration of copper Vs EDTA

(Mandatory Core)

CHE PC 305 A	**Organic Chemistry III**	**L-3,T-1,P-2**	**4Credits**
Pre-requisite: Understanding of Organic Chemistry			

Course Objectives: Course Objectives:

- Familiarize with the applications of different reagents in organic synthesis, Mechanisms and stereochemistry.
- Study the methods of preparation and applications of organometallic reagents.
- Understand topocity, prochirality, auxillary and reagent-controlled methods in asymmetric synthesis.
- Applications of different oxidizing and reducing agents in organic synthesis with region and stereo controlled products.

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

CO1	To familiarize with the specific functions of the reagents particularly diazomethane, N-bromosuccinimide, Ziegler Natta catalyst, 1,3-dithianes and Merrifield resin in the synthesis of a variety of complex molecules.
CO2	To gain knowledge in the synthesis of different organometallic reagents and also stereo and regio specificity and selectivity of reactions with organometallic reagents
CO3	To understand diastereoselectivity, stereoselectivity and substrate controlled auxillary controlled reactions
CO4	To acquire knowledge about the reagents which causes oxidation in various compounds and also the reagents that causes selective and complete reductions to synthesize various compounds.

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	-	2	2	2
CO2	3	2	2	3	2	2	-	2	2	2	2	2
CO3	3	2	2	3	2	2	1	1	2	-	2	-
CO4	3	2	2	3	2	2	-	2	-	2	2	1

CHE-PC-305A Core-Theory Organic Chemistry III

UNIT I: REAGENTS IN ORGANIC SYNTHESIS 15 Hrs

Use of the following reagents in organic synthesis: Anhydrous $AlCl_3$, Boran trifluoride, N-Bromosuccinimide, Diazomethane, Dicyclohexylcarbodiimide, Lead tetraacetate, Zieglar-Natta catalysts, DDQ, Dithianes, Merrifield resin.

UNIT-II: ORGANOMETALLIC REAGENTS 15 Hrs

Synthesis and applications of Grignard reagents, Organolithium, Zinc, Copper, Mercury, Palladium and Rhodium compounds in Organic Synthesis, Homogeneous catalytic hydrogenation and hydroformylation reactions

UNIT III: ASYMMETRIC SYNTHESIS 15 Hrs

Topocity - Prochirality- Substrate selectivity - Diastereoselectivity and enantioselectivity-Substrate controlled methods-use of chiral substrates - examples

Auxiliary controlled methods-Use of chiral auxiliaries-Chiral enolates-alkylation of chiral imines – Stereoselective Diels-Alder reaction

Reagent controlled methods-Use of chiral reagents-Asymmetric oxidation-Sharpless epoxidation-Asymmetric reduction-Use of lithium aluminium hydride and borate reagents.

UNIT IV: METHODS OF ORGANIC SYNTHESIS 15 Hrs

i). ***Oxidations:*** **(a)** Alcohols to carbonyls-Chromium (iv) oxidants-Dimethylsulfoxide oxidation, periodate xidation, Oppenauer oxidation, oxidation with manganese dioxide, oxidation with silver carbonate **(b)** Alkenes to epoxides-peroxide induced epoxidations. **(c)** Alkenes to diols-oxidation

with potassium permanaganate, osmium tetraoxide, Prevost reaction **(d)** Ketones to esters-Bayer-Villiger oxidation **(e)** Oxidative bond cleavage-cleavage of alkenes by transition metals. **(f)** Oxidation of alkyl or alkenyl fragments-selenium dioxide and chromium trioxide oxidations.

ii). ***Reductions*** **:** Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bis-methoxy ethoxy aluminium hydride, Boran aluminium hydride and derivatives-catalytic,hydrogenation-dissolving metal reductions, Non-Metallic reducing agents including enzymatic and microbial reductions.

Suggested Books

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. Name reactions and reagents in organic synthesis, B.P. Muway and M.G Ellord, John Wiley.
6. Principles of Organic Synthesis, R.O.C Norman and J.M Coxon, Blackie Academic & Professional.
7. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New Age International.
8. Principles of organometallic chemistry, P. Powell, ELBS.
9. Organo transition metal chemistry-Applications to organic synthesis, S.G. Davis, Pergmon.
10. Stereochemistry to Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry, P.S. Kalsi, Wiley Eastern.

CHE-PC- 305 B	**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 about TG and DTA and applications of different scanning calorimetry.											
CO2	To gain knowledge on Doppler shift and chemical shift, basic principles and applications of NQR spectroscopy.											
CO3	To learn zero field splitting and Kramer's degeneracy, relaxation processes, instrumentation and applications of ESR.											
CO4	To know about photoelectric effect and Koopmans theorem and impart the applications of X-ray and UV photoelectron.											
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	2	1
CO2	3	2	2	3	2	2	2	2	1	2	2	-
CO3	3	2	2	3	2	2	-	2	1	2	-	1
CO4	3	2	2	3	2	1	1	-	2	-	2	1

CHE-PC- 304: 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 $CuSO_4 5H_2O$, $CaC_2O_4\ 2H_2O$. 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 PC 306 A	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	1	3	-	2	3	2	1	-	1	1
CO2	3	2	2	3	2	2	3	2	2	1	-	2
CO3	3	2	-	2	2	-	2	2		2	1	-
CO4	3	2	2	3	1	2	1	-	2	1	-	2

CHE : PC : 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:

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

CHE PC 306 B	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	-	2	3	-	2	3	2	2	-	1	1
CO2	3	2	2	3	2	2	3	2	-	1	-	2
CO3	3	2	-	2	2	-	2	-	2	-	1	-
CO4	3	2	2	3	1	2	-	2	-	1	-	2

CHE PC 306 B : 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).

CHE-AC- 401	Quality Control and General Principles	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Quality Control and General Principles

Course Objectives:

- Study on quality assurance and management
- Obtain practice on the applications of different organic reagents in analysis of inorganic compounds.
- Understand standard reduction potential, mechanism of complex formation reactions. Enzyme characteristics and applications
- Study on Equilibrium constants of oxidation and reduction reactions and the complexometric titration with EDTA.

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

CO1	To diagnose problems in the quality improvement process and Explain each total quality implementation phase
CO2	To know about theoretical basis for the use of organic reagents in inorganic analysis.
CO3	To understand different types of kinetic methods and their evaluation and to determine the kinetics of enzyme
CO4	To understand the oxidation reactions with Ce (IV) sulphate solutions and applications of complexometric titrations.

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		2	2	-
CO2	3	2	2	3	1	2	1	2	2	2	-	2
CO3	3	3	3	3	2	2	2	-	2	1	1	1
CO4	3	3	3	3	1	-	1	-	2	1	-	1

CHE AC 401: CORE THEORY: QUALITY CONTROL AND GENERAL PRINCIPLES

UNIT-I: QUALITY CONTROL IN ANALYTICAL CHEMISTRY 15 Hrs

Definition of analytical terms: Accuracy, precision, limit of detection, sensitivity, selectivity and specificity, ruggedness, principles of Ruggedness test, validating the Method as a Standard Method.

Quality assurance and management systems: Elements of quality assurance, Quality and quantity management system ISO 9000 and ISO 14000 series.

Good laboratory practices (GLP): Elements of Good Laboratory Practice, Laboratory accreditation, GLP status in India.

UNIT-II: ORGANIC REAGENTS IN INORGANIC ANALYSIS 15 Hrs

Theoretical basis for the use of organic reagents in inorganic analysis**:** Application of the following reagents in inorganic analysis: dimethylglyoxime, salicylaldehyde, cupferron, d-benzoin, 1,10 phenanthroline, 8-hydroxy quinoline, nitron, tannin, pyridine, 8-hydroxyquinoldine, dithizone, Acetylacetone, theonyl, trifluoroacetone, 8-hydroxy quinoline, tri-M-octylphosphine oxide.

UNIT – III: KINETIC METHODS OF TRACE ANALYASIS 15 Hrs

Rate laws, Analytical use of reaction rates, First and second order reactions, relative rate of reactions. Determination of reaction rates. Analytical utility of first and pseudo first order reactions. Types of kinetic methods, differential, integral, logarithmic, extrapolation method. Evaluation of kinetic methods – Scale of Operation, Catalyzed reactions, measurement method for catalyzed reaction. Micro determination of Inorganic species like Iodine and Hg in complex materials. Determination of organic species. Kinetics of enzyme, catalyzed reactions. Michael's constant factors affecting the rate of enzyme, Catalyzed reactions, Enzyme characteristics and applications of Kinetic methods of trace

analysis.

UNIT-IV:REDOX AND COMPLEXOMETRIC TITRATIONS: 15Hrs

Redox Titrations: Standard reduction potential, equilibrium constants of oxidation-reduction reactions, change of electrode potential during the titration of reductant with an oxidant. Formal potential primary standard substance. Standard solutions. Preparation and storage. Oxidations with cerium (IV) sulphate solutions. Theory and use of (i) acid-base, (ii) Oxidation-reduction (iii) Metal ion indicators.; **Complexometric titrations:** Introduction, complexones, stability constants of EDTA complexes, conditional stability constants, titration curves, types of EDTA titration's, titration of mixtures.

Books Suggested

1. Vogel's Text book of Quantitative Chemical Analysis, Basselt, Denmy, Jaffery and Merdhan, ELBS, Orientlong- Manan, 5th Ed.1990.
2. Analytical Chemistry, Gary D. Christian, John Laliley and Senes, New York, 6th Ed., 2007.
3. Fundamentals of ANALYTICAL CHEMISTRY, Skoog, West, Holler; 7th Editin 2001
4. Fundamentals of Analytical Chemistry, D.A. Skoog & D.M. West, Holf-Saunderrs, 5th Ed., 1991.
5. Principles and Methods Chemical Analysis: H.F. Walton, Prentice Hall, New Delhi.
6. Chemical Analysis, H.A. Laitinan, Mc.Graw Hill Book Company.
7. Technical methods of analysis – Griffin, Mc Graw Hill Book Co.
8. K.V.S.G Murali Krishna, An Introduction ISO 9000, ISO 1400 Series,
9. Environmental Management Quality Assurance and Good Laboratory Practices, Prof. Y. Anjaneyulu, In Now Publication, New York.
10. Quality Assurance in Analytical Chemistry – G.Kateman and F.W Pijpers, John Wiley and Sons, New York

CHE-AC 402	: Instrumental Methods of Analysis	L-5,T-1,P-0	4Credits
Pre-requisite: Understanding of Instrumental Methods of Analysis			

Course Objectives:

- Gain sound knowledge in spectroscopic methods of ICP-AES, ICP-MS, x-ray fluorescence, spectroscopic techniques and their applications.
- Chromatographic techniques like High-Performance Liquid Chromatography, Capillary Electrophoresis and Supercritical Fluid Chromatography (SFC).
- Familiarise with instrumentation, resolution and ionization sources of GCMS and LCMS.

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

CO1	To understand the working principles, instrumentation and applications of ICP-AES and ICP-MS, energy dispersive X-ray fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF).
CO2	To understand the basic principles, procedure and components of the High-Performance Liquid Chromatography (HPLC), Gel Permeation Chromatography (GPC): Capillary Electrophoresis (CE), Supercritical Fluid Chromatography (SFC).
CO3	To get knowledge on instrumentation and applications of GCMS in drug analysis and environmental samples analysis.
CO4	To improve the knowledge about coulometric techniques and their analysis of cations (As (III), Fe (II)) and anions (I^- and S^{2-}) by using I_2 liberations and Ce^{4+} liberation in 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	2	-	2	1	-	1
CO2	3	3	3	3	3	2	2	1	-	1	1	1
CO3	3	3	3	3	3	2	1	2	1	1	1	3
CO4	3	3	2	2	-	2	2	-	1	1	1	3

CHE-402: CORE THEORY: INSTRUMENTAL METHODS OF ANALYSIS

UNIT –I SPECTROSCOPIC METHODS 15 Hrs

Emission Spectroscopy:

(i) ICP-AES: Principles, instrumentation, AES detectors, applications in the analysis of trace and toxic metals in water, geological and industrial samples.

(ii) ICP-MS: Principles, instrumentation, quadrupole mass spectrometers, applications

Fluorescence Spectroscopy:

i) Molecular Fluorescence Spectroscopy: Principle, Theory of fluorescence, phosphorescence, relation between intensity of fluorescence and concentration, Correlation of fluorescence with molecular structure, Fluorescence quenching, Instrumentation and applications.

ii) X-ray Fluorescence Spectroscopy: Principle, energy dispersive X-ray fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF), applications.

UNIT – II: CHROMATOGRAPHIC METHODS 15 Hrs

High Performance Liquid Chromatography (HPLC): Principles, Stationary phases, Instrumentation, Solvent delivery system, sample introduction, gradient elution, columns and detectors.Partition Chromatography, adsorption chromatography, Gel permeation chromatography.

Capillary Electrophoresis: Principle, Electroosmotic flow, Instrumentation, Applications to separation of small ions, separation of Molecular Species, DNA sequencing

Supercritical-fluid chromatography: Supercritical-fluids, Instrumentation and Applications

UNIT –III: HYPHENATED TECHNIQUES 15 Hrs

Mass Spectroscopy: Principle, basic instrumentation, resolution, Ionization sources- Electron impact and Chemical ionization, Mass Analyzers- Quadrupole Mass analyzer and Time- of- Flight Analyzer.

Gas Chromatography- Mass spectrometry: Introduction, GC – MS interface, processing of GC – MS

data – ion chromatogram. Quantitative measurement – sample preparation, Selected ion monitoring – Application of GC-MS for Trace constituents. Drugs analysis, Environmental analysis and others.

Liquid chromatography- Mass spectrometry – Introduction – Instrumentation – liquid chromatography – Mass spectrometer Interface – Instrumental details – Processing LC-MS data – ion chromatograms, Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples and others.

UNIT- IV: ELECTRO ANALYTICAL METHODS 15 Hrs

Anodic stripping voltametry: principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltametry.

Coulometric analysis: principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I- and S_2- by using I_2 liberations and Ce^{4+} liberation in solutions

Ion Selective Electrodes: types of ion selective electrodes, basic properties, potentials and construction, calibration of ion selective electrodes, ion selective electrodes with fixed membrane sites, silver, lead, cadmium, sulfide, fluoride, cyanide and glass electrodes, applications in the analysis of air and water pollutants, principles of liquid membrane, gas sensing and enzyme based electrode

Books Suggested

1. Analytical Chemistry, Gary D. Christian, John Laliley and Senes, New York, 6th Ed., 2007.
2. Analytical Chemistry Principles and Techniques, I.G. Harge, Prentice Hall.
3. Principles of Instrumental analysis, D.A. Skoog and J.L. Loacy, W.B. Saunders.
4. Handbook of Instrumental Techniques for Analytical Chemistry, F. Serlie, Prentice Hall.
5. Vogels Text book of Quantitative Chemical Analysis, Basett, Denny Jebbary, 5th Ed. ELBs 1990.
6. Instrumental Methods of Chemical Analysis, Willard Merrit, Dean, Stella Jr 6th Edition.
7. Separation methods, M.N Sastri, Himalaya Publishing Company, Mumbai

CHE AC 403	**Core practical I: Analytical Chemistry- Practical**	**L-5,T-1,P-0**	**4 Credits**
Pre-requisite: Understanding of Analytical Chemistry- Practical.			

Course Objectives: • To learn about the separation methods and flame photometric analysis of pesticide residues • Determination of transition metal ions by polarography • Principle, instrumentation, determination of metal ions By AAS. • Interpretation of NMR chemical shifts and hydrogen bonding.	
Course Outcomes: At the end of the course, the student will be able to	
CO1	Understand the common laboratory techniques including separation techniques
CO2	Polarography, atomic absorption spectroscopy in both emission and absorption mode.
CO3	Gain knowledge on implementation of gas chromatography and HPLC for separation of mixtures.
CO4	Familiarize with interpretation of data to structures by NMR.

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**	**-**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**		**2**	**-**	**3**
CO3	**3**	**3**	**-**	**3**		**3**	**-**	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**-**	**3**	**1**	**3**	**2**	**2**	**-**	**1**	**2**	**-**	**3**

CHE AC 404: CORE PRACTICALS: <u>PRACTICAL – I-</u>

Instrumental methods of analysis- II

1. Flame Photometry**:** Determination of Na and K, Ca and Li in Water and Soil.
2. TLC/Paper chromatographic separation.
3. Determination of Pesticide residues by gas chromatographic method
4. Polarography: a) Determination of E ½ of Zn and Cd; b) Determination of amounts of Zn and Cd
5. Atomic Absorption Spectroscopy: Determination of transition metal ions (Cd, Cr, Cu, Pb, Zn etc.,) by AAS.
6. Separation of Metal ion by Solvent Extraction /Ion exchange.

II <u>DEMONSTRATION EXPERIMENTS</u>

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 AC 404	Project Work	L-5,T-1,P-0	4Credits

Pre-requisite: Project Work

Course Objectives:

- Identification of problem
- Ability to carry out independent chemistry research with competency in research design, data gathering
- Interpretation and communication of research results through scientific publications and presentations.
- Preparation of dissertation

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

CO1	Perform experiments, collection and evaluation of data.
CO2	Interpretation of results while adhering to scientific principles of responsible and ethical behaviour.
CO3	Analysing and compiling the data and results in a chronological order in the form of dissertation.
CO4	Preparation 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	3	2	1	2	1	3
CO2	3	3	3	3	3	2	3	3	-	-	2	3
CO3	3	3	3	3	3	-	3	2	-	3	-	3
CO4	3	3	3	3	3	2		2	1	-	2	3

CHE AC 404: PRACTIAL II/ PROJECT WORK

CHE-AC-405	Applied and Environmental Aspects	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Environmental Aspects

Course Objectives:

- Gain sound knowledge on preparation of sampling, decomposition, separation and pre-concentration
- Experience with fertilizer analysis, pesticide analysis minerals and ores.
- Know about analysis of fuels, alloys and explosives
- Expertise with water quality monitoring

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

CO1	Have an idea about preparation of sampling, decomposition, separation and preconcentration of metal ions etc.
CO2	Gain experience on agrochemicals and fertilizers and their analysis.
CO3	Have an idea on the analysis of fuels, alloys and explosives
CO4	Experience with environmental pollution monitoring techniques.

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	3	3	3	3	2	-	1	1	1	1	1
CO3	3	3	3	3	3	2	1	2	2	1	1	3
CO4	3	3	2	2	1	2	-	2	-	1	1	3

CHE : AC 403(A): (GENERIC ELECTIVE) APPLIED AND ENVIRONMENTAL ASPECTS

UNIT-I: SAMPLING AND SEPARATION METHODS 15 Hrs

Preparing the sample for analysis: Sampling, The effect of sampling uncertainties, Gross sample, determination of the size of the gross sample. Analytical sample. Preparation of laboratory sample from gross sample, Moisture in the sample, Karl-Fisher reagent for the determination of moisture content in samples.

Decomposition and dissolving the sample: Decomposition of sample by fluxes, wet digestion, dry ashing, combustion with oxygen, microwave decomposition.

Separation and pre-concentration: Extractive separation of metal ions as chelates (dithizone, oxine, APDC, NaDDTC), Solid-phase extraction

UNIT-II: ANALYSIS OF AGRO CHEMICALS and MINERALS 15 Hrs

Soil analysis: Soil moisture, pH, total nitrogen, Phosphorus, silica, boron and metals (Cd, Cu, Fe, Mn, and zinc) in soil.

Fertilizer analysis: Analysis of Ammonical fertilizers, Phosphate fertilizers, Nitrate fertilizers

Pesticide Analysis: Analysis of organo chlorine pesticides by gas chromatography, Determination of DDT residue in vegetable and food grains. Analysis of organo phosphorous pesticides (Malathion, parathion) by spectrophotometric and chromatographic methods.

Analysis of Minerals and Ores: Limestone, Ilmenite, Chalcopylites and Beryl. Analysis of Cement, Ceramics and glass.

UNIT-III: ANALYSIS OF COMPLEX MATERIALS 15 Hrs

Analysis of Fuels: Coal, proximate and ultimate analysis, heating valves and grading of coal.

Liquid Fuels: Flash point, aniline point, octane number and carbon residue.

Analysis of Gaseous Fuels: Producer gas, Water gas, Calorific values

Analysis of alloys: German Silver, Brass, bronze, Solder, Steels containing elements such as Mo, Co,

V, Cr, Si and Ni.

Aanalysis of Explosives: Introduction, Classification, Deflagrating or low explosives, Characteristics of explosives, Nitrocellulose, PETN or PENTHRIT, Di-nitrobenzene (DNB), Trinitrobenzene (TNB), Trinitrotoluene (TNT),

UNIT – IV: ENVIRONMENTAL POLLUTION MONITORING: 15 Hrs

Water Quality monitoring: Methods of **w**ater sample collection, Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand(COD)

Analytical methods for the determination of the following ions in water:

Anions: F^-, PO_4^{3-}, NO_3^-, NO_2^- Cations: Cr^{6+}, As^{5+}, Pb^{2+}, Hg^{2+}, Cd^{2+}

Air Quality Monitoring: Air sampling methods, Chemical analysis of the following Air pollutants**.** i) Gaseous pollutants: Carbon monoxide (CO). sulphur dioxide (SO_2), nitrogen dioxide (NO_2), Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH). (ii) Particulate matter

Books Suggested

1. Analytical Chemistry, Gary D. Christian, John Lalily and Senes, New York, 6th Ed., 2007.
2. Fundamentals of ANALYTICAL CHEMISTRY, Skoog, West, Holler; 7th Editin 2001.
3. Analytical Chemistry Principles and Techniques, I.G. Harge, Prentice Hall.
4. Principles of Instrumental analysis, D.A. Skoog and J.L. Loacy, W.B. Saunders.
5. Fundamentals of Air Pollution by A.C. Strem and others, Academic Press, 1975.
6. Standard methods for the examination of water and waste water published by American public health association, 15th Ed.1981.
7. Methods of Soil Analysis, C.A. Black, Part I and II.
8. Handbook of Analytical Control of Iron and Steel Production, Harrison John Weily 1979
9. Standard methods of Chemical Analysis, Welcher.
10. Technical Methods of Analysis, Griffin, Mc Graw Hill.
11. Environmental Chemistry, Anil Kumar De, Wiley Eastern Ltd.

CHE-AC-406	Bioinorganic, Bioorganic, Biophysical Chemistry	L-5,T-1,P-0	4Credits

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	2	3	1	2	1	2	1	1	1	1
CO2	3	3	3	3	-	2	-	2	2	-	1	3
CO3	3	3	3	2	2	-	2	3	-	1	1	3
CO4	3	2	2	3	2	2	1	-	2	2	-	1

CHE AC-406: (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 AC 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	1	1	2	-	-	2	3
CO2	3	3	3	3	-	2	1	2	2	2	2	3
CO3	3	3	1	3	-	3	-	2		3	-	3
CO4	3	1	3	1	3	2	1	-	1	2	1	3

CHE : AC : 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 AC 406 B	**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	Know how to interpret potentiometry and conductometry
CO2	Know the Interpretation of results while adhering to DC Polarography.
CO3	Know the 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	2	3	3	3	-	1	2	-	1	2	3
CO2	3	3	3	3	1	2	-	2	2	2	-	3
CO3	3	3	1	3	1	3	2	2	-	3	2	3
CO4	3	2	3	1	3	2	-	-	-	2	-	3

CHE : AC : 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 ofCurrents : 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).

CHE-EC- 401	**Energy, Environment and Soil**	**L-5,T-1,P-0**	**4Credits**

Pre-requisite: Understanding of Energy, Environment and Soil	
Course Objectives: • Familiarize with fossil fuels, solar energy, geothermal energy • Hydropower and photo-electrochemistry, hydrological cycle, water pollutants, eutrophication and greenhouse effect. • Detection of composition of soil, biodegradation, goals of green chemistry, biocatalysis • Soil pollution, solid waste management and disposable methods.	
Course Outcomes : At the end of the course, the student will be able to	
CO1	Know about nuclear fission and fusion, uses of solar energy in space heating and water heating, hydropower and water heating, hydropower and production of ethanol from indirect solar energy.
CO2	Learn physical and chemical properties of water and water complexation in natural and waste water and to understand about global warming, ozone depletion, green house effect and acid rains.
CO3	Acquire knowledge on composition of inorganic and organic contaminants in soil, soil corrosion and industrial applications of green chemistry.
CO4	Get knowledge on various methods of solid waste collection and its disposal.

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	1	2	2	2	-	3
CO2	3	3	3	3	3	2	-	2	2	-	2	3
CO3	3	3	3	3	2	2	-	1	2	2	-	3
CO4	3	3	3	3	3	2	1	2	2	-	2	3

CHE EC-401: CORE THEORY: ENERGY, ENVIRONMENT AND SOILS

UNIT-I: Sources of Energy **15 Hrs**

Fossil fuels- Nuclear fission and fusion- Solar energy-use of solar energy in space heating and water heating- production of electricity using solar energy- solar trough collectors- power tower- solar pond- solar energy for driving vehicles- power from indirect solar energy – Hydropower- wind power- Biomass energy- production of ethanol from biomass- production of methane from biomass- photosynthesis- photo electro chemistry- Geothermal energy.

UNIT-II: Water Resources and Air **15 Hrs**

Hydrological cycle- physical and chemical properties of water-complexation in natural and waste water,-Anomalous properties-water pollutants-Types-Sources- Heavy metals- metalloids- organic – Inorganic –Biological and Radio active-Types of reactions in various water bodies including marine environment- Eutrophication- Ground water- Potable water standards.Treatment for portable water.

Air: Chemical reactions in the atmosphere – Aerosols types- Production and distribution – Aerosols and Radiation – structure and composition of atmosphere- temperature inversion – Global warning- Ozone depletion – Green house effect, “CFC”s- Acid rain.

UNIT-III: Soil and Green Chemistry **15 Hrs**

Soil: Composition of soil- lithosphere- inorganic and organic contaminants in the soil- Biodegradation- Nondegrdable waste and its effect on the environment- Bioremediation –of surface soils- Fate and transport of contaminants on soil system– Bioindicators- Soil parameters- soil destruction- Erosion- Soil conservation – Nitrogen pathways and NPK in soil .

Green Chemistry: Goals of Green chemistry- Significance and basic components of Green chemistry

research - industrial applications of Green chemistry-products from natural materials- Green fuels and E-Green propellants- Zeolites- Biocatalysts.

UNIT IV: Soil pollution: 15 Hrs

Introduction – soil pollution by industrial wastes. soil pollution by urban wastes, Radioactive pollutants and Agricultural waste- chemical and metallic pollutants-Biological agents – mining - Detrimental effects of soil pollutants – Effects of industrial pollutants- Effects of sewage and domestic wastes- Effects of heavy metals- Effects of radioactive pollutants- Effects of modern agro- technology – Diseases caused by soil pollution – solid waste management – sources and classification -public Health Aspects – methods of collection- Disposal methods – potential methods of disposal.

Books Suggested:

1. Daniel D. Chiras (1994), Environmental Science, 4th Ed.
2. Environmental Chemistry by W. Moore and J.Moore
3. Environmental chemistry by J.O.M. Bockariss
4. Environm,ental by BK SHArma
5. Environmental chemistry by SS Dara
6. Environmental chemistry by Mahajan
7. Environmental chemistry by a.K.De

(Mandatory Core)

CHE-EC 402	**Water Pollution Monitoring and Environment Laws**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite: Understanding of Water pollution monitoring and environment laws.			

Course Objectives:

- Basic concepts of different water pollutants
- Different principles of water treatment.
- Biotechnology and its applications in environmental protection
- Environmental management and environmental laws

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

CO1	Acquire knowledge on disease causing agents in water.
CO2	Learn about the removal of suspended and dissolved solids present in waste water.
CO3	Understand different uses of micro-organisms in environmental protection.
CO4	Know different world life acts such as forest conversion act, water control pollution act and air prevention and control act.

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	2	-	-	2	3
CO2	3	3	3	2	2	-	-	2	2	2	-	3
CO3	3	3	3	3	2	2	1	2	2	2	2	3
CO4	3	3	3	3	-	2	-	2	3	-	2	3

CHE EC-402: CORE THEORY: WATER POLLUTION MONITORING AND ENVIRONMENT LAWS

UNIT-I: Water pollution **15 Hrs**

Basic aspects of water-general principles of water (physical and chemical)-criteria of water quality.Types of water pollutants: sewage and domestic wastes-industrial wastes-agriculture discharges- toxic metals-oxygen demanding wastes-disease causing agents-oils- detergents and phosphates. Sampling**:** Basics of Sampling, sampling procedure, statistics, sampling and physical state, crushing and grinding, hazards waste of sampling, pre-concentration methods

UNIT-II: Waste water treatment: **15 Hrs**

Basic process of water treatment- primary treatment pretreatment – sedimentation – Flotation-secondary (Biological) Treatment – Active sludge process – Trickling filters – sludge Treatment and disposal – Advanced waste water Treatment – Removal of suspended solids – Removal of dissolved solids – Nitrogen removal – phosphorous removal – Advanced Biological systems – chemical oxidation .

UNIT III: Biotechnology and its application in Environmental protection **15 Hrs**

Introduction- Bio-informatics- Bio-Technology and pollution control,-Bioremediation- Biological de-odourisation- Biological purification of contaminated air-microorganisms and energy of mankind-use of microorganisms role in petroleum augmentation and recovery.

UNIT IV: Environmental Management and Important Environmental Laws: **15 Hrs**

Environmental Management: Introduction-objectives-components-environmental impact assessment (EIA)-historical background-elements of EIA process-participants in EIA processes-contents of EIS-design of EIA.

Important Environmental Laws: the world life act-the forest conservation act-the water and control pollution act-air prevention& control act—the environment act-environmental quality management standard-ISO 14000 series.

Books Suggested

1. Environmental Chemistry by W. Moore and J.Moore
2. Environmental chemistry by J.O.M. Bokriss
3. Environmental by BK Sharma
4. Environmental chemistry by SS Dara
5. Environmental chemistry by Mahajan
6. Environmental chemistry by a.K.De
7. Lodge (1994) Methods of air sampling and analysis.Publications, Jaipur
8. Kudesia, V.P. (1985) Water Pollution, Pragati Prakashan
9. Elements of biotechnology by PK Gupta and Rastogi

CHE EC 403	Practical I	L-5,T-1,P-0	4 Credits

Pre-requisite: Environmental Chemistry Practical I

Course Objectives:

- Conductometric methods of analysis.
- Colorimetric methods of analysis
- Interpretation of data from IR, HPLC, GC, AAS
- Determination of purity and alkanility by pH metry

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

CO1	To know the basic principles of conductometry and analysis of acids and halides.
CO2	Colorometric estimation of iron and manganese.
CO3	To have an idea about working principles of IR, AAS, Spectrofluorimetry, Gas chromatography and HPLC.
CO4	Tofamiliarize with interpretation of data

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	2	2	2	-	2	1	2
CO2	3	3	3	3	2	3	2	-	2	2	2	3
CO3	3	3	3	3	3	2	-	2	2	2	-	3
CO4	3	3	2	2	3	2	2	2	-	2	1	3

CHE EC-404: PRACTICAL-I- INSREUMENTAL METHODSOF ANALYSIS-II

1) Conductometry:
a) Mixture of Acids
b) Mixture of Halides
2) Colorimetry:
a) Estimation of Iron
b) Manganese
c) Phosphate
d) Titration of copper Vs EDTA

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 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 EC 404	Practical II:Project Work	L-5,T-1,P-0	4 Credits

Pre-requisite: Project Work

Course Objectives:

- Identification of problem by literature survey
- Carry out the problem independently
- Interpretation of data
- Communication of research results through presentations and preparation of dissertation

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

CO1	To identify research problem, propose the hypothesis and to collect literature.
CO2	To perform research designs & experiments
CO3	To tabulate research results
CO4	To conclude research outcomes 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	3	3	3	-	3	2	2	1	2	3
CO2	3	3	3	3	2	3	-	1	2	2	-	3
CO3	3	3	3	3	3	2	3	-	2	-	3	3
CO4	3	3	3	3	2	3	3	2	3	-	2	3

CHE EC- 405: PRACTIAL II/ PROJECT WORK

CHE-EC-405A	Air Pollution, Control Methods-Noise and Thermal Pollution	L-3,T-1,P-2	4 Credits

Pre-requisite: Understanding of Air Pollution, Control Methods-Noise and Thermal Pollution

Course Objectives:

- Study on properties of air pollutants, air pollution sampling measurements and analysis.
- Familiarize with different control methods and adsorption of solids and liquids, gas analysis.
- Know about pollution caused by vehicle emissions and different industries.
- Get an idea on noise and thermal pollutions and their effect on human health.

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

CO1	Acquire knowledge on air pollutants, air pollution sampling measurements and analysis caused due to sulphur dioxide, carbon monoxide, nitrogen dioxide, oxidants, ozone, hydro carbons and particulate matter.
CO2	Learn about different control methods and adsorption of solids and liquids, gas analysis eluents viz., nitrogen oxides, carbon monoxide and hydrocarbons.
CO3	Understand pollution caused by vehicle emission, different industries, cement plants, steel mills and petroleum refineries.
CO4	Know about noise and thermal power project pollutions and their effect on human health.

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	2	-	1	-	3
CO2	3	3	3	2	2	-	2	2	2	1	2	3
CO3	3	3	3	3	2	2	2	2	2	1	-	3
CO4	3	3	3	3	-	2	1	2	3	-	2	3

CHE : EC-405 A: (GENERIC ELECTIVE): AIR POLLUTION, CONTROL METHODS-NOISE AND THERMAL POLLUTION

UNIT-I: Air Pollution 15 Hrs

Classification and properties of air pollutants-emission sources-major emissions from global sources-importance of anthropogenic sources-behavior and fate of air pollutants photochemical smog and its effects on health-vegetation-material damage in India.

Air pollution sampling and measurement-ambient air sampling-collection of gaseous air pollutants-collection of particulate pollutants-stack sampling-analysis of air pollutants-sulphur dioxide-carbon monoxide-nitrogen dioxide-oxidants-ozone-hydro carbons and particulate matter

UNIT- II: Control methods 15 Hrs

Sources-correction methods-particulate emission control-gravitational settling chambers-cyclone separators-fabric filters-electrostatic precipitator-wet scrubbers-control of gaseous emissions by adsorption of solids and liquids-control methods of sulphur dioxide emission, flue gasesanalysis-control method, nitrogen oxides, carbon monoxide and hydrocarbon-mobile sources.

UNIT-III: Vehicular Air Pollution: 15 Hrs

Genesis of vehicular emissions standard- natural pollution-gasification of vehicles-point sources of air pollution – mechanism of air pollution from automobiles -automobile pollution- Indian scenario population and pollution loads of vehicles-automobile air pollution control-exhaust gas controlling treatment devices-thermal reactor-catalytic converter from automobiles-fuel tank carbonator. Air pollution from Portland cement plants-steel mills and petroleum refineries.

UNIT-IV: Noise and Thermal Polution 15 Hrs

Noise pollution: sources-measurement of noise and indices-effect of meteorological parameters on noise propagation-noise exposure levels and standards –measurement of noise-impact of noise on

human health

Thermal pollution: Introduction-definition-sources-harmful effects-toxic compounds in traces-prevention and control of thermal pollution –thermal power projects in India.

Books Suggested:

1. Environmental Chemistry by W. Moore and J.Moore
2. Environmental chemistry by J.O.M. Bockeriss
4. Environmental chemistry by Sharmar and Kaur, Krishna Publishers
6. Environmental chemistry by a.K.De
8. Henry C perkins (1974) Air Pollution, McGraw-Hill
9. Kudesia, V.P. (1985) Water Pollution, Pragati Prakashan.
10. Environmental Engineering by CS Rao
11. Environmental by BK Sharma
12. Environmental chemistry by SS Dara

CHE-EC-405 B	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 EC-405(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 EC 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	-	1	2	-	1	2	3
CO2	2	3	3	3	1	2	-	2	2	2	1	3
CO3	3	3	2	3	-	3	2	2		3	-	3
CO4	3	1	3	1	3	2	2	-	2	2	2	3

CHE : EC : 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 EC 406 B	**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	2	3	3	3	3	-	2	2	1	-	2	3
CO2	3	3	2	3	1	2	-	2	2	2	1	3
CO3	3	3	1	3	2	3	1	2		3	2	3
CO4	3	-	3	1	3	2	1	-	1	2	-	3

CHE : EC : 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).

CHE-IC- 401	Co-ordination Compounds, Organometallic Chemistry & Chemistry of Non-transition Elements	L-5,T-1,P-0	4Credits

Pre-requisite: Understanding of Co-ordination Compounds, Organometallic Chemistry & chemistry of non-transition elements

Course Objectives:

- Study the organometallic chemistry of different complexes and coordinated ligands.
- Understand the mechanistic aspects of several well-known industrial catalytic processes like olefin hydrogenation, olefin oxygenation, Olefin hydroformylation and Fischer –Tropsch synthesis with an aim to gain a good knowledge on synthetic applications of Organo–Lithium, Magnesium and Aluminium compounds.
- Acquire knowledge of metal cluster compounds, various types of reactions of metal cluster compounds, isoelectronic and isolobal relationship and electron counting scheme for HNCC'S.
- Study on synthesis, properties and structures of nontransition elements

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

CO1	To Gain an extensive knowledge about dinitrogen complexes of Ru(II), Os(II),Co(I), Mo(0)and dioxygen complexes of Ir(I) and Rh(I) and on cycloheptatriene and tropylium complexes of oxidative, reductive elimination reactions
CO2	To understand mechanism, stereochemical aspects and regeneration of catalyst in olefin hydrogenation (Wilkinson's catalyst), olefin oxygenation (Wacker process or Smidt reaction), Olefin hydroformylation and Fischer –Tropsch process.
CO3	To study the examples of metal complexes having metal-metal single or multiple bonds and analyse the spectroscopic evidences for the presence of metal-metal bond.
CO4	To understand the synthesis and structures of boranes, carboranes, borazines, silicates carbides, peroxo compounds and inter halogens, pseudo halides.

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	2		2	-	1
CO2	3	2	2	2	-	2	2	-	2	-	1	1
CO3	3	3	3	3	2	2	-	2		1	-	1
CO4	3	3	3	3	2	1	-	1	2	1	1	2

CHE IC 401: CORE THEORY: Co-ordination Compounds, Organometallic Chemistry and Chemistry of Non-transition Elements

UNIT –I: ORGANOMETALLIC CHEMISTRY OF TRANSITION ELEMENTS:

1.Dinitrogen complexes of Ru(II) , Os (II),Co(I) and Mo(0)

2. Dioxygen complexes of Ir (I) and Rh (I)

3. Cycloheptatriene and Tropylium complexes –Oxidative addition and Reductive Elimination.

Insertion and Elimination reaction –Nucleophilic and Electrophilic attack of coordinated ligands.

UNIT –II: APPLICATIONS OF ORGANOMETALLIC COMPOUNDS 15 Hrs

Catalytic applications –Fischer –Tropsch synthesis, Olefin hydrogenation (Wilkinson catalyst).Olefin oxygenation (Wacker process or Smidt reaction) Olefin hydroformylation (Ziegler-NattaCatalysis).

Synthetic applications of Organo–Lithium, –Magnesium and Aluminium compounds.Biological applications of organometallic compounds in medicine, agriculture and horticulture.

UNIT –III: METAL-TO METAL BONDS AND METAL ATOM CLUSTERS 15 Hrs

Introduction, metal carbonyl clusters –low –nuclearity (M and M) clusters, isoelectronic and isolobal relationships, High nuclearity, carbonyl clusters (HNCC'S), Hetero stomes in metal atom clusters, electron counting scheme for HNCC'S, HNCC'S of the Fe, Ru and Os group HNCC'S of the Cu, Rh and Ir group, HNCC'S of the Ni, Pd, and Pt group. Compounds with M-M multiple bonds, Major structural types, quadruple bonds, relation of clusters to multiple bonds and one dimensional solids.

UNIT –IV: 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, peroxo compounds of boron, carbon and sulphur, oxyacids of nitrogen, phosphorus, sulphur and halogens, inter halogens pseudo halides.

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, IV Edition 1993. Harper Collins College Publishers, New York.
3. J.D. Lee, Concise Inorganic chemistry, V Edition 1996, ELBS, Chapman and Hall, London.
4. Concise Inorganic chemistry by J.D. Lee V Edition ELBS, Chapman and Hall, London.
5. Organometallic Chemistry by R.C. Mehrotra and Singh.

CHE-IC 402	Instrumental Methods of Analysis	L-5,T-1,P-0	4Credits
Pre-requisite: Understanding of Organic Spectroscopy and Applications			

Course Objectives:

- Gain sound knowledge in spectroscopic methods of ICP-AES, ICP-MS, x-ray fluorescence, spectroscopic techniques and their applications
- Chromatographic techniques like High-Performance Liquid Chromatography, Capillary Electrophoresis and Supercritical Fluid Chromatography (SFC).
- Familiarise with instrumentation, resolution and ionization sources of GCMS and LCMS.

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

CO1	To understand the working principles, instrumentation and applications of ICP-AES and ICP-MS, energy dispersive X-ray fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF).
CO2	To understand the basic principles, procedure and components of the High-Performance Liquid Chromatography (HPLC), Gel Permeation Chromatography (GPC): Capillary Electrophoresis (CE), Supercritical Fluid Chromatography (SFC).
CO3	To get knowledge on instrumentation and applications of GCMS in drug analysis and environmental samples analysis.
CO4	To improve the knowledge about coulometric techniques and their analysis of cations (As (III), Fe (II)) and anions (I- and S2-)by using I2 liberations and Ce4+ liberation in 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	2	2	-	2	1	-	1
CO2	3	3	3	3	3	2	1	2	-	1	1	1
CO3	3	3	3	3	3	2		2	2	1	1	3
CO4	3	3	2	2	2	2	2	-	-	1	1	3

CHE-IC 402: CORE THEORY: INSTRUMENTAL METHODS OF ANALYSIS

UNIT –I SPECTROSCOPIC METHODS 15 Hrs

Emission Spectroscopy:

(i) ICP-AES: Principles, instrumentation, AES detectors, applications in the analysis of trace and toxic metals in water, geological and industrial samples.

(ii) ICP-MS: Principles, instrumentation, quadrupole mass spectrometers, applications

Fluorescence Spectroscopy:

i) Molecular Fluorescence Spectroscopy: Principle, Theory of fluorescence, phosphorescence, relation between intensity of fluorescence and concentration, Correlation of fluorescence with molecular structure, Fluorescence quenching, Instrumentation and applications.

ii) X-ray Fluorescence Spectroscopy: Principle, energy dispersive X-ray fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF), applications.

UNIT – II: CHROMATOGRAPHIC METHODS 15 Hrs

High Performance Liquid Chromatography (HPLC): Principles, Stationary phases, Instrumentation, Solvent delivery system, sample introduction, gradient elution, columns and detectors.Partition Chromatography, adsorption chromatography, Gel permeation chromatography.

Capillary Electrophoresis: Principle, Electroosmotic flow, Instrumentation, Applications to separation of small ions, separation of Molecular Species, DNA sequencing

Supercritical-fluid chromatography: Supercritical-fluids, Instrumentation and Applications

UNIT –III: HYPHENATED TECHNIQUES 15 Hrs

Mass Spectroscopy: Principle, basic instrumentation, resolution, Ionization sources- Electron impact and Chemical ionization, Mass Analyzers- Quadrupole Mass analyzer and Time- of- Flight Analyzer.

Gas Chromatography- Mass spectrometry: Introduction, GC – MS interface, processing of GC – MS data – ion chromatogram. Quantitative measurement – sample preparation, Selected ion monitoring – Application of GC-MS for Trace constituents. Drugs analysis, Environmental analysis and others.

Liquid chromatography- Mass spectrometry – Introduction – Instrumentation – liquid chromatography – Mass spectrometer Interface – Instrumental details – Processing LC-MS data – ion chromatograms, Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples and others.

UNIT- IV: ELECTRO ANALYTICAL METHODS 15 Hrs

Anodic stripping voltammetry: principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltammetry.

Coulometric analysis: principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I- and S_2- by using I_2 liberations and Ce^{4+} liberation in solutions

Ion Selective Electrodes: types of ion selective electrodes, basic properties, potentials and construction, calibration of ion selective electrodes, ion selective electrodes with fixed membrane sites, silver, lead, cadmium, sulfide, fluoride, cyanide and glass electrodes, applications in the analysis of air and water pollutants, principles of liquid membrane, gas sensing and enzyme based electrode

Books Suggested

1. Analytical Chemistry, Gary D. Christian, John Laliley and Senes, New York, 6th Ed., 2007.
2. Analytical Chemistry Principles and Techniques, I.G. Harge, Prentice Hall.
3. Principles of Instrumental analysis, D.A. Skoog and J.L. Loacy, W.B. Saunders.
4. Handbook of Instrumental Techniques for Analytical Chemistry, F. Serlie, Prentice Hall.
5. Vogels Text book of Quantitative Chemical Analysis, Basett, Denny Jebbary, 5th Ed. ELBs 1990.
6. Instrumental Methods of Chemical Analysis, Willard Merrit, Dean, Stella Jr 6th Edition.
7. Separation methods, M.N Sastri, Himalaya Publishing Company, Mumbai.

CHE IC 403	Core practical I: Inorganic Chemistry - Practical	L-5,T-1,P-0	4 Credits
Pre-requisite: Understanding of Inorganic Chemistry - Practical.			

Course Objectives: • To learn about the separation methods and flame photometric analysis of pesticide residues. • Determination of transition metal ions by polarography. • Principle, instrumentation, determination of metal ions By AAS. • Interpretation of NMR chemical shifts and hydrogen bonding.												
Course Outcomes: At the end of the course, the student will be able												
CO1	To understand the common laboratory techniques including separation techniques.											
CO2	Polarography, atomic absorption spectroscopy in both emission and absorption mode.											
CO3	To gain knowledge on implementation of gas chromatography and HPLC for separation of mixtures.											
CO4	To Familiarize with interpretation of data to structures by NMR.											
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 IC 403: CORE PRACTICALS: PRACTICAL – I-

Instrumental methods of analysis- II

1) Flame Photometry**:** Determination of Na and K, Ca and Li in Water and Soil.
2) TLC/Paper chromatographic separation.
3) Determination of Pesticide residues by gas chromatographic method
4) Polarography:a) Determination of E ½ of Zn and Cd; b) Determination of amounts of Zn and Cd
5) Atomic Absorption Spectroscopy: Determination of transition metal ions (Cd, Cr, Cu, Pb, Zn etc.) by AAS.
6) Separation of Metal ion by Solvent Extraction /Ion exchange.

II 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
6. Polarography and Anode stripping voltametry – behavior of Cd, Zn, Pb in a mixture.
7. Determination of Pb and Cd in samples using Anode stripping voltametr
8. Gas chromatography- Determination of pesticides
9. HPLC- Determination of pesticides
10. NMR
11. (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.
12. TGA, DTA, DSC – Demonstration of TG, DTA and DSC and study of decomposition of calcium oxalate, calcium carbonate, copper sulfate, oxalic acid.
13. pH metry

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

point

CHE IC 404	Project Work	L-5,T-1,P-0	4 Credits
Pre-requisite: Inorganic Chemistry Project Work			
Course Objectives: • Identification of problem • Ability to carry out independent chemistry research with competency in research design, data gathering • Interpretation and communication of research results through scientific publications and			

presentations.

- Preparation of dissertation

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

CO1	Ability to perform experiments, collection and evaluation of data
CO2	Interpretation of results while adhering to scientific principles of responsible and ethical behaviour.
CO3	Analysing and compiling the data and results in a chronological order in the form of dissertation.
CO4	Preparation 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	-	1	1	1
CO2	3	3	3	3	-	2	-	2	-	-	1	3
CO3	3	3	3	2	2	-	-	3	-	1	1	3
CO4	3	2	2	3	2	2	-	-	-	2	-	1

CHE IC 404: PRACTIAL II/ PROJECT WORK

CHE-IC-405A	Instrumental Methods of Analysis	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Instrumental methods of analysis

Course Objectives:

- Gain sound knowledge in spectroscopic methods of ICP-AES, ICP-MS, x-ray fluorescence, spectroscopic techniques and their applications
- Chromatographic techniques like High-Performance Liquid Chromatography, Capillary Electrophoresis, and Supercritical Fluid Chromatography (SFC).
- Familiarise with instrumentation , resolution and ionization sources of GCMS and LCMS
- Basic principles of electro analytical techniques and their applications.

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

CO1	To understand the working principles, instrumentation and applications of ICP-AES and ICP-MS, energy dispersive X-fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF).
CO2	To understand the basic principles, procedure and components of the High-Performance Liquid Chromatography (HPLC), Gel Permeation Chromatography (GPC): Capillary Electrophoresis (CE), Supercritical Fluid Chromatography (SFC).
CO3	To get knowledge on instrumentation and applications of GCMS in drug analysis and environmental samples analysis.
CO4	To improve the knowledge about coulometric techniques and their analysis of cations (As (III), Fe (II)) and anions (I^- and S^{2-})by using I^2 liberations and Ce^{4+} liberation in 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		1
CO2	3	3	3	3	3	2	-	-	-	1	1	1
CO3	3	3	3	3	3	2	-	2	-	1	1	3
CO4	3	3	2	2	-	2	-	-	-	1	1	3

CHE-IC 405A: CORE THEORY: INSTRUMENTAL METHODS OF ANALYSIS

UNIT –I SPECTROSCOPIC METHODS 15 Hrs

Emission Spectroscopy:

(i) ICP-AES: Principles, instrumentation, AES detectors, applications in the analysis of trace and toxic metals in water, geological and industrial samples.

(ii) ICP-MS: Principles, instrumentation, quadrupole mass spectrometers, applications

Fluorescence Spectroscopy:

i) Molecular Fluorescence Spectroscopy: Principle, Theory of fluorescence, phosphorescence, relation between intensity of fluorescence and concentration, Correlation of fluorescence with molecular structure, Fluorescence quenching, Instrumentation and applications.

ii) X-ray Fluorescence Spectroscopy: Principle, energy dispersive X-ray fluorescence (EDXRF), Wavelength dispersive X-ray fluorescence (WDXRF), applications.

UNIT – II: CHROMATOGRAPHIC METHODS 15 Hrs

High Performance Liquid Chromatography (HPLC): Principles, Stationary phases, Instrumentation, Solvent delivery system, sample introduction, gradient elution, columns and detectors.Partition Chromatography, adsorption chromatography, Gel permeation chromatography.

Capillary Electrophoresis: Principle, Electroosmotic flow, Instrumentation, Applications to separation of small ions, separation of Molecular Species, DNA sequencing

Supercritical-fluid chromatography: Supercritical-fluids, Instrumentation and Applications

UNIT –III: HYPHENATED TECHNIQUES 15 Hrs

Mass Spectroscopy: Principle, basic instrumentation, resolution, Ionization sources- Electron impact and Chemical ionization, Mass Analyzers- Quadrupole Mass analyzer and Time- of- Flight Analyzer.

Gas Chromatography- Mass spectrometry: Introduction, GC – MS interface, processing of GC – MS data – ion chromatogram. Quantitative measurement – sample preparation, Selected ion monitoring – Application of GC-MS for Trace constituents. Drugs analysis, Environmental analysis and others.

Liquid chromatography- Mass spectrometry – Introduction – Instrumentation – liquid chromatography – Mass spectrometer Interface – Instrumental details – Processing LC-MS data – ion chromatograms, Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples and others.

UNIT- IV: ELECTRO ANALYTICAL METHODS 15 Hrs

Anodic stripping voltammetry: principle, instrumentation, Hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltammetry.

Coulometric analysis: principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I- and S_2- by using I_2 liberations and Ce^{4+} liberation in solutions

Ion Selective Electrodes: types of ion selective electrodes, basic properties, potentials and construction, calibration of ion selective electrodes, ion selective electrodes with fixed membrane sites, silver, lead, cadmium, sulfide, fluoride, cyanide and glass electrodes, applications in the analysis of air and water pollutants, principles of liquid membrane, gas sensing and enzyme based electrode

Books Suggested

1) Analytical Chemistry, Gary D. Christian, John Laliley and Senes, New York, 6th Ed., 2007.
2) Analytical Chemistry Principles and Techniques, I.G. Harge, Prentice Hall.
3) Principles of Instrumental analysis, D.A. Skoog and J.L. Loacy, W.B. Saunders.
4) Handbook of Instrumental Techniques for Analytical Chemistry, F. Serlie, Prentice Hall.
5) Vogels Text book of Quantitative Chemical Analysis, Basett, Denny Jebbary, 5th Ed. ELBs 1990.
6) Instrumental Methods of Chemical Analysis, Willard Merrit, Dean, Stella Jr 6th Edition.
7) Separation methods, M.N Sastri, Himalaya Publishing Company, Mumbai.

CHE-IC-405B	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	2	3	-	2	-	2	-	1	1	1
CO2	3	3	3	3	-	2	-	2	-	-	1	3
CO3	3	3	3	2	2		-	3	-	1	1	3
CO4	3	2	2	3	2	2	-		-	2	-	1

CHE AC-405(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 IC 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 : AC : 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:

13. Medicinal Chemistry by Ashitosh Kar
14. Medicinal Chemistry by D. Sriram, P. Yogeeswari
15. Medicinal Chemistry by David A. Williams, Thomas L. Lemke
16. Medicinal Chemistry by V**.** Alagarsamy
17. Biochemistry by U. Satyanarayana
18. Natural Products Chemistry and Applications by Sujata V. Bhat, B.A. Nagasampagi, S. Meenakshi
19. Medicinal Chemistry by V.K. Ahluwalia, Madhu Chopra
20. Medicinal Chemistry by Balkishen Razdar
21. Advanced Practical Medicinal Chemistry by Ashutosh Kar
22. Chemistry of Organic Natural Products by O. P. Agarwal, Vols., 1 & 2, Geol Pubs.
23. Chemistry of Natural Products by S. V. Bhat, B.A. Nagasampagi, M. Sivakumar
24. Natural Products Chemistry by K.B.G. Torssell, John Wiley, 1983.

CHE IC 406 B	**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 : IC : 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 ofCurrents : 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).

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

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

CHE OC 403	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 404	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-405A	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-405(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-405B	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-405(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 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:

25. Medicinal Chemistry by Ashitosh Kar
26. Medicinal Chemistry by D. Sriram, P. Yogeeswari
27. Medicinal Chemistry by David A. Williams, Thomas L. Lemke
28. Medicinal Chemistry by V**.** Alagarsamy
29. Biochemistry by U. Satyanarayana
30. Natural Products Chemistry and Applications by Sujata V. Bhat, B.A. Nagasampagi, S. Meenakshi
31. Medicinal Chemistry by V.K. Ahluwalia, Madhu Chopra
32. Medicinal Chemistry by Balkishen Razdar
33. Advanced Practical Medicinal Chemistry by Ashutosh Kar
34. Chemistry of Organic Natural Products by O. P. Agarwal, Vols., 1 & 2, Geol Pubs.
35. Chemistry of Natural Products by S. V. Bhat, B.A. Nagasampagi, M. Sivakumar
36. Natural Products Chemistry by K.B.G. Torssell, John Wiley, 1983.

CHE OC 406B	**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).

CHE-PC- 401	**Electrochemistry**	**L-5,T-1,P-0**	**4Credits**

Pre-requisite: Understanding of Electrochemistry												
Course Objectives: • Study industrial electrochemistry, corrosion and methods of prevention • Learn about electrochemical batteries and cells and their performance • Study on electro kinetics and electro capillary phenomena and electrokinetic effect • Familiarize polarography techniques and chemical passivity												
Course Outcomes : At the end of the course, the student will be able to												
CO1	Know the techniques of deposition of metals, throwing power simultaneous discharge of cations and methods of corrosion protection											
CO2	Learn about electrochemical Batteries, fuel cells and nickel-cadmium batteries.											
CO3	Understand electrical double layer systems, sedimentation potential, null points of metals and zeta potential.											
CO4	Calculate electrochemical parameters; familiarize mixed ligand systems and reversible systems.											
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	2
CO2	3	3	3	3	2	-	-	2	-	2	-	3
CO3	3	3	3	3	3	-	-	2	-	-	-	2
CO4	3	3	3	3	-	2	-	-	-	-	-	3

CHE PC-401: CORE THEORY: **ELECTROCHEMISTRY**

UNIT-I: Industrial Electrochemistry **15 Hrs**

Deposition of metals, Factors influencing physical nature of electrodeposited metals – current density, concentration of electrolyte, temperature, colloidal matter, electrolyte and basis metal. Throwing power, simultaneous discharge of cations. Separation of metals by electrolysis. Electrochemical passivity. Passivity and current density. Chemical passivity. Theories of passivity. Mechanical passivity. The corrosion of metals. Hydrogen evolution type of corrosion, corrosion in presence of depolarizer. Differential oxygenation corrosion. Methods of corrosion protection.

UNIT- II: Electrochemical Devices: **15 Hr**

Batteries- their performance – characteristics – considerations in the selection and applications, Chemistry of primary batteries – Zinc – Carbon, Mercuric oxide, silver oxide and lithium cells – Solid electrolyte cells.

Chemistry of secondary batteries – Lead acid , Nickel cadmium batteries, Water activated batteries, Fuel cells – Their thermodynamics- performance

UNIT-III: Electrokinetic's and Electro capillary phenomena: **15 Hrs**

Electrical double layer, Helmholtz – Perrin, Gouy – Chapman and Stern theories of electrical double layer. Lipmann equation.

Electrokinetic effect: Electro osmosis, Electrophoresis, streaming potential , sedimentation potential and their relation to zeta potential. Determination of zeta potential from electrophoresis measurements. Tiselius apparatus. Electro capillary curves, Null points of metals and their experimental determination.

UNIT-IV: **Advances in Polarography**: **15 Hrs**

(A) Polarography of Metal Complexes

Reversible, Diffusion-controlled systems, Determination of Formulae and Stability, Constants of Complexed Metal Ions, Determination of Stability Constants and Coordination Numbers of metal complexes, Calculation of Individual Complex, Stability Constants, Mixed Ligand Systems- the Method of Schaap and Mcmasters

(B) Polarography of organic compounds

Structural Effects, Nature of Electroactive group, Steric Effects, substituent Effects.

Books suggested:

1. S. Glasstone. An introduction to Electrochemistry. Affiliated East-West Press Pvt. Ltd.
2. P.T.K. Kissinger, W.R. Heinemann. Laboratory Techniques in Electro analytical Chemistry, Marsal Debber, Inc.
3. Willard, Merit. Instrumental methods of analysis, Welowarth Publiching Co.,
4. L. Antropov. Theoretical Electrochemistry. Mir Publications.
5. Silbey, Alberty, Bawendi. Physical chemistry. Jhon-Wiley & sons. 4th edition-2006.
6. V.S. Bagotsky. Fundamental of Electrochemistry. Jhon Wiley & Sons. 2nd editions-2006.
7. Introduction to polarography and allied Technique by Dr.K. Zutshi

CHE-PC 402	Thermodynamics, Polymers and Solid-state Chemistry	L-5,T-1,P-0	4Credits
Pre-requisite: Understanding of Thermodynamics, Polymers and Solid-state Chemistry			

Course Objectives:

- To learn thermodynamic Properties of fluids, phase equilibria and flash calculations.
- Thermodynamic properties of liquids, activity and activity coefficients.
- Polymer structures, morphology and properties.
- To get knowledge on concept of solid state chemistry and super conductance.

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

CO1	Derive Gibbs Duhem equation and to calculate fugacity and chemical potential.
CO2	Calculate excess free energy and entropy, to draw Hildebrand curves and to correlate excess functions and activity coefficients
CO3	Learn morphology, Tm and Tg points and to calculate transition temperatures and to identify cross linking in polymers.
CO4	Identify magnetic properties of solids, magnetic materials, superconductors and BCS theory

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	-	3
CO2	3	3	3	2	2	-	-	-	-	-	1	3
CO3	3	3	2	2	2	-	-	-	-	2	-	2
CO4	3	3	3	2	2	-	-	-	-	2	-	1

CHE PC-402: CORE THEORY: **THERMODYNAMICS, POLYMERS AND SOLID STATE CHEMISTRY**

UNIT-I: Thermodynamic properties of fluids: 15 Hrs

Thermodynamic relationship residual properties – systems of variable composition- ideal and non-ideal behaviour – fugacity-fugacity coefficient in solutions- Phase equilibrium of low to moderate pressures-dew point-bubble point and flash calculations**.**

UNIT – II: Thermodynamic properties of 'Liquid Mixtures 15 Hrs

Activity and activity coefficients-excess free energy-excess enthalpy-excess volume-excess entropy-relation between excess functions and activity coefficients –Application of Gibbs-Deuhem equation-regular solutions –van Laar theory and Scachard-Hildebrand theory.

UNIT-III: Polymers- structure and properties 15 Hrs

Morphology and order in crystalline polymers, configuration of Polymer chains, crystal structures and polymers, Stain induced morphology, morphology of chrystalline polymers, crystallisation and melting-polymer structure and physical properties, crystalline melting point, T_m-melting point of homogeneous series, effect of chain flexibility and other steric factors- entropy and heat of fusion, the glass transition temperature, Tg , relationship between Tm and Tg effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking.

UNIT-IV: Solid State Chemistry 15 Hrs

Magnetic properties of solids- Classification of magnetic materials, Magnetic Susceptibility, Langevin diamagnetism, Weiss theory of para magnetism. Electronic properties of metals, insulators and semiconductors: Electronic Structure of solids, Band theory, band Structure of metals, insulators and semiconductors. Electrons, holes and Excitons. The temperature dependence of conductivity of extrinsic semiconductors. Photo conductivity and photovoltaic effect –P-n-Junctions. Super conductivity: Occurence of superconductivity. Destruction of Superconductivity by magnetic fields-Meisner effect. Types of superconductors. Theories of super conductivity BCS theory.

Books suggested:

1. J.M. Pransnitz. Molecular Thermodynamics of Fluid Phase Equilibrium. Prentice. Hall
2. Kuriocose and Rajram. Thermodynamics
3. Smith and Van Ners. Chemical Thermodynamics.
4. R.C. Srivastava, Subi. K. Saha. Thermodynamics-A care course. Prentice-Hall of India Pvt, Ltd,. 3rd edition-2007.
5. Silbey, Alberty, Bawendi. Physical chemistry. Jhon-Wiley & sons. 4th edition-2006.
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.
8. Solid State chemistry by M.G. Arora.
9. Solid State Chemistry by Wiley.

CHE PC 403	Core practical I: Inorganic Chemistry - Practical	L-5,T-1,P-0	4 Credits

Pre-requisite: Understanding of Inorganic Chemistry - Practical.

Course Objectives:

- Learn potentiometric titrations of mixture of acids
- Determination of electrode potential by polarography
- Gain knowledge on interpretation of data from IR, AAS, HPLC and GC
- Determination of alkanility and purity by pH metry

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

CO1	To perform titration of mixture of halides and to draw potentiometry curves
CO2	To learn ampherometric titrations and mixtures by polarography
CO3	To Correlation of data obtained from IR, AAS, HPLC and GC
CO4	To Determination of alkanility and purity by pH metry

Mapping of course outcomes with the program outcomes

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

CHE PC 403: CORE PRACTICALS: PRACTICAL – I-

1. Potentiometry: a) Titration of mixture of acids
   b) Titration of mixture of halides
   c) Titration of ferrous ammonium sulphate with potassium dichromate
   d) Redox titrations
   e) Solubility of Sparingly soluble salt.
   f) Formula and instability constant of a complex
   g) Dissociation constant of acetic acid

2. Polarography: a) Determination of E1/2 of Zn and Cd
   b) Determination of Zn and Cd in mixture
   c) Amperometric titration.

II 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
6. Polarography and Anode stripping voltametry – behavior of Cd, Zn, Pb in a mixture.
7. Determination of Pb and Cd in samples using Anode stripping voltametr
8. Gas chromatography- Determination of pesticides
9. HPLC- Determination of pesticides
10. NMR
11. (a)Demonstration of NMR spectrometer and study of hydrogen bonding in a given alcohol or phenol.

12. (b)Interpretation of NMR chemical shifts of ethyl benzene, ethyl alcohol.
13. TGA, DTA, DSC – Demonstration of TG, DTA and DSC and study of decomposition of calcium oxalate, calcium carbonate, copper sulfate, oxalic acid.
14. 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 PC 404	Project Work	L-5,T-1,P-0	4 Credits

Pre-requisite: Physical Chemistry Project Work

Course Objectives:

- Identification of problem by literature survey
- Carry out the problem independently
- Interpretation of data
- Communication of research results through presentations and preparation of dissertation

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

CO1	To identify research problems and to collect research literature
CO2	To propose hypothesis of a research problem
CO3	To perform research experiments
CO4	To analyse the data and conclude the research outcomes

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	3	2	-	-	-	3
CO2	3	3	3	3	3	2	3	2	-	-	2	3
CO3	3	3	3	2	2	3	2	3	-	2	-	3
CO4	3	3	3	3	3	3	2	2	-	2	-	3

CHE PC 404: PRACTIAL II/ PROJECT WORK

CHE-PC-405A	Chemical Kinetics	L-3,T-1,P-2	4Credits

Pre-requisite: Understanding of Chemical kinetics

Course Objectives:

- Differentiate homogeneous and heterogeneous catalysis enzyme catalysis and applications
- Learn photo chemistry, chemical excitations and rate of photochemical reactions
- To familiarize electrochemical relaxation methods, photochemical and isotope effects
- Radical photochemical reactions, theory and applications

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

CO1	Draw skrabal pH diagram and to separate unimolecular and bimolecular reactions
CO2	Study laws of photochemistry, to derive stern-volmer equation
CO3	Identify chromo potentiometry points and to investigate kinetic currents and isotopic effects
CO4	Learn photochemical thresholds, chemiluminescence

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	2	1
CO2	3	3	3	3		2	-	-	-	1	-	2
CO3	3	3	3	3	2	2	-	-	-	-	-	2
CO4	3	3	3	3	2	-	-	-	-	-	2	2

CHE PC-405A : (GENERIC ELECTIVE): CHEMICAL KINETICS

UNIT – I: Catalysis 15 Hrs

Homogeneous catalysis: Steady state and equilibrium treatments of acid-base catalysis. Skrabal P^H diagrams, Protolytic and Prototropic mechanism. Acidity functions, Zucker, Hammett, Bunnett and Yates hypothesis in the elucidation of the mechanism. Enzyme catalysis – influence of concentration, P^H and temperature. **Heterogeneous Catalysis:** Mechanism of interface reactions, application of transition state theories to unimolecular and bimolecular surface reactions

UNIT – II: Photochemistry: 15 Hrs

Interaction of electromagnetic radiation with matter, laws of photochemistry, Quantum yield, types of excitations, Fate of excited molecule, transfer of excitation energy, kinetics of unimolecular and bimolecular photophysical process, Stern-Volmer equation, Kinetics of photochemical reaction rate constants and life times of reactive energy states, determination of rate constants of reactions, effect of light intensity on the rate of photochemical reactions.

UNIT-III: Electrochemical relaxation methods, Photochemical methods, Isoptopic effect 15 Hrs

Electrochemical relaxation methods: Introduction , advantages of Electrochemical transient (or) relaxation techniques, application of these methods, various types of perturbation of a system, pulse polarography, chronopotentiametry, investigation of kinetic currents by chronopoptentiometry.

Photochemical methods: Introduction , phenomena of ISC, fluorescence and phosphorescence, experimental arrangement of fluorescence measurements. Example of quenching reactions.

Isotopic Effects: Equilibrium isotope effects, equilibria in solution, primary kinetic isotopic effects semiclassical treatments, Quantum-mechanical Tunneling,Reactions of the Type $H+H_2$,Transfer of H^+,H and H^- reactions of Huonium,Isotope effect with Havier atoms.

Unit-IV: Photo Chemical and Radiation Chemical Reactions 15 Hrs

Photochemical reactions photochemical primary process, reactions of electronically excited states of species, photo chemical thresholds, laws of photochemical equivalence, rotating-sector technique, multi

photon excitation, photosensitization, radiation chemical primary process, chemiluminiscence**.**

Books suggested:

1. K.K. Rohatgi Mukerjee. Fundamentals of Photochemistry.
2. C. Kalidas. Principles of fast reactions techniques and Applications.
3. V. Yegnaramam, C.A. Basha And G. Prabhakar Rao : Applications of Electrochemistry.
4. Keith J.Laidler: Chemical Kinetics.
5. J. Dalton: A New System of Chemical Philosophy.
6. Chemical Kinetics:Keith J.Laider.

(Compulsory Foundation)

CHE-PC-405B	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	2	3	-	2	-	2	-	1	1	1
CO2	3	3	3	3	-	2	-	2	-	-	1	3
CO3	3	3	3	2	2		-	3	-	1	1	3
CO4	3	2	2	3	2	2	-		-	2	-	1

CHE PC-405(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 PC 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 : PC : 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 PC 406 B	**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 : PC : 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 ofCurrents : 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).