SRI VENKATESWARA UNIVERSITY: TIRUPATI

S.V.U COLLEGE OF SCIENCES

DEPARTMENT OF CHEMISTRY

Course

M.Sc. ENVIRONMENTAL CHEMISTRY

Choice Based Credit System (CBCS)

Academic Year 2017 – 18

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.

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	an 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	an Values and Professional Ethics – II	4	20	80	100
		Total		**24**			**600**

SEMESTER-III

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

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.**

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 (3rd 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_8reactions.

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-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 (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-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-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).