CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR
MASTER OF SCIENCE (M.Sc.)

(2 Year Postgraduate Degree Programme) IN

CHEMISTRY

[w. e. f. 2025 onwards]

FACULTY OF SCIENCE & HUMANITIES SRM UNIVERSITY
DELHI-NCR, SONEPAT
Plot No.39, Rajiv Gandhi Education City, P.S. Rai, Sonepat Haryana-131029

Vision

Department of Chemistry is committed to provide intellectual, innovative & motivational surroundings to students and faculty members. Department is focused to contribute for academic, scientific, research and experimental knowledge through excellence and to produce scientist, researchers and bureaucrats. Department wants to strive and achieve reputation of seeking attention of Government of India and use of others to be invited to provide services on the subjects involving Chemistry and allied areas.

Mission

- To improve the problem-solving capability of students through continuous learning to produce quality Chemists, Scientists, Academic intellectuals etc. in the field of Science and Technology.
- To bridge the gap between industry and academia by imparting technical/experimental knowledge along with its application in the practical world.
- To encourage innovation through multidisciplinary research and development activities.
- To inculcate human values and ethics into students to serve the society and nation with utmost devotion.
- To develop the overall personality of students along with the learning process simultaneously.

PROGRAM REQUIREMENT

General Education Requirements: Applied Science and Humanities (ASH)

Basic Science Requirements: Fundamental Sciences (FS) Core Sciences (ES) through regular/online mode

Disciplinary Requirements comprising of:

Department Name: Department of Chemistry-Core courses (through regular/online mode)

Department Name: Department of Chemistry/Mathematics/CSE-Electives (through regular/online mode)

Department Name; Department of Chemistry-Open Electives (through regular/online mode)

Practical and Research component:

1. Regular Practical and Research
2. Summer Internships
3. Specialized courses through the Study Abroad program
4. Minor and Major Project
5. Industry internship through the semester.

CHEMISTRY POST GRADUATE EMPLOYABILITY ATTRIBUTES

- Sound Knowledge and Understanding of the Domain Area.
- Analytical & Critical Thinking and Problem-Solving Skills.
- Scientific Temperament Towards Research & Innovation for the Betterment of Society.
- Efficient Communication & Presentation Skills.
- Dependability, Reliability, Responsibility and Independent Leadership Abilities.
- Awareness about Recent and Modern Applications and Techniques.

PROGRAM EDUCATIONAL OBJECTIVES

Degree is awarded to candidates who have completed the course and who have met the assessment criteria for all written, major/minor projects and practical examination/assignments. The overall assessment aims for each topic are that candidates should be able to:

- Grasp the concepts while teaching in classes.
- Interpret and analyze the questions.
- Bridge the multiple concepts of various topics via numerical and Practicals/Projects.
- Extract critical knowledge from the comprehensive topics.
- Ability to write & review of scientific articles.

PROGRAM LEARNING OUTCOMES

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On successful completion of this program, students will:

- Have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- Think critically and analyze chemical problems.
- Present scientific and technical information resulting from laboratory.
- Should broaden their professional foundations through activities such as teaching, internships, and fellowships.
- Use technologies/instrumentation to gather and analyze data.
- Should be able to communicate scientific results in writing and in oral presentation.
- Should acquire the basic tools needed to carry out independent chemical research. Students should become proficient in their specialized area of chemistry and successfully complete an advanced research project.
- Will be able to describe the common methods of spectroscopic and chromatographic analysis, and discuss how they can be applied to pharmaceuticals.

MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES AND PROGRAM LEARNING OUTCOMES

Program Educational Objectives (PEOs)	Program Learning Outcomes (PLOs)							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
PEO1	■	■		■				
PEO2		■						
PEO3		■	■		■			■
PEO4	■				■		■	
PEO5			■	■		■		■

PROGRAM STRUCTURE

Category of Course	**Abbreviations**	**No. of Courses**	**Credits**
Core Courses	CC	22	74
Discipline Specific Elective (DSE)	DSE	2	8
Open Elective (OE)	OE	2	8
Total Courses Offered		**26 (T+P)**	**90**

Program Credit Structure

Category/Semester	I	II	III	IV	No. of Courses	Credits	%
Core course (CC)	18	18	20	18	22	74	82.22
Open Elective (OE)	4	4	–	–	2	8	8.88
Discipline Specific Elective	-	-	4	4	2	8	8.88
Total	22	22	24	22	26	90	100

SEMESTER-I

Code	Category	Course	L	T	P	C
Theory						
25CYMS101	CORE	Inorganic Chemistry-I (Co-ordination and Rare Earth Metals)	**4**	**0**	**0**	**4**
25CYMS102	CORE	Organic Chemistry-I (GOC and Stereochemistry)	**4**	**0**	**0**	**4**
25CYMS103	CORE	Physical Chemistry-I (Quantum Chemistry and Chemical Kinetics)	**4**	**0**	**0**	**4**
25GECY101/ 25GECY102	GE	GE-I	**4**	**0**	**0**	**4**
Practical						
25CYMS151	CORE	Inorganic Chemistry Practical –I	**0**	**0**	**4**	**2**
25CYMS152	CORE	Organic Chemistry Practical -I	**0**	**0**	**4**	**2**
25CYMS153	CORE	Physical Chemistry Practical –I	**0**	**0**	**4**	**2**
Total			**16**	**0**	**12**	**22**
Total Contact Hours			**330**			

SEMESTER-II

Code	Category	Course	L	T	P	C
Theory						
25CYMS201	CORE	Inorganic Chemistry-II (Organometallic Chemistry)	**4**	**0**	**0**	**4**
25CYMS202	CORE	Organic Chemistry-II (Advanced Organic Spectroscopy)	**4**	**0**	**0**	**4**
25CYMS203	CORE	Physical Chemistry-II (Statistical Thermodynamics & Electrochemistry)	**4**	**0**	**0**	**4**
25GECY201/ 25GECY202	GE	GE -II	**4**	**0**	**0**	**4**
Practical						
25CYMS251	CORE	Inorganic Chemistry Practical-II	**0**	**0**	**4**	**2**
25CYMS252	CORE	Organic Chemistry Practical -II	**0**	**0**	**4**	**2**
25CYMS253	CORE	Physical Chemistry Practical -II	**0**	**0**	**4**	**2**
Total			**16**	**0**	**12**	**22**

SEMESTER-III

Code	Category	Course	L	T	P	C
Theory						
25CYMS301	CORE	Organic Reaction Mechanism & Reagents	**4**	**0**	**0**	**4**
25CYMS302	CORE	Inorganic and Physical Spectroscopy	**4**	**0**	**0**	**4**
25CYMS303	CORE	Bio-Inorganic and Bio-Organic Chemistry	**4**	**0**	**0**	**4**
25CYMS304	CORE	Photochemistry and Pericyclic Reactions	**4**	**0**	**0**	**4**
25CYMS305/ 306/307	DSE	DSE-I	**4**	**0**	**0**	**4**
Practical						
25CYMS351	CORE	Chemistry Practical III	**0**	**0**	**4**	**2**
25CYMS352	CORE	Chemistry Practical IV	**0**	**0**	**4**	**2**
Total			**20**	**0**	**8**	**24**

SEMESTER-IV

Code	Category	Course	L	T	P	C
Theory						
25CYMS401	CORE	Application of Group Theory in Chemistry	**4**	**0**	**0**	**4**
25CYMS402	CORE	Natural Products &	**4**	**0**	**0**	**4**
25CYMS403	CORE	Retrosynthesis and Disconnection Approach	**4**	**0**	**0**	**4**
25CYMS404/ 405	DSE	DSE-II	**4**	**0**	**0**	**4**
Project						
25CYMS471	CORE	Project	**6**	**0**	**0**	**6**
		Total	**22**	**0**	**0**	**22**

LIST OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Code	Category	Course	L	T	P	C
Discipline Specific Elective-I						
25CYMS305	DSE	Green Chemistry	**4**	**0**	**0**	**4**
25CYMS306	DSE	Analytical Chemistry	**4**	**0**	**0**	**4**
25CYMS307	DSE	Pharmaceutical Chemistry	**4**	**0**	**0**	**4**
Discipline Specific Elective-II						
25CYMS404	DSE	Medicinal Chemistry	**4**	**0**	**0**	**4**
25CYMS405	DSE	Nuclear Chemistry & Solid State	**4**	**0**	**0**	**4**
25CYMS406	DSE	Chemistry in Industry and Environment	**4**	**0**	**0**	**4**

LIST OF GENERIC ELECTIVE COURSES

Code	Category	Course	L	T	P	C
Generic Elective-I						
25GECY101	GE	Mathematics for Chemists	**4**	**0**	**0**	**4**
25GECY102	GE	Biology for Chemists	**4**	**0**	**0**	**4**
Generic Elective-II						
25GECY201	GE	Computers for Chemists	**4**	**0**	**0**	**4**
25GECY202	GE	Intellectual Property Rights	**4**	**0**	**0**	**4**

SEMESTER – I

Inorganic Chemistry-I (Coordination Compounds and Rare Earth Metals)	
Course Code: 25CYMS101	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To discuss the bonding involving various theories in coordination compounds.
- To explain the electronic spectra pattern of Transition Metal Complexes
- To describe the various mechanisms & stability operative in inorganic complexes during substitution and electron transfer reactions.
- To demonstrate the extraction of lanthanides & various applications of lanthanides & actinides.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Apply various theories of coordination compounds to explain their properties.
- Describe the electronic spectra of various transition metal complexes.
- Explain the various reaction mechanisms for synthetic inorganic chemistry.
- Correlate between properties of inorganic compounds containing f-block elements of the periodic table as the central metal ion and their properties.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I

Theories of Bonding in Co-ordination Complexes **20 Hrs**

Valence bond theory and limitations, Crystal field theory, splitting of d-orbitals in cubic, octahedral, tetragonal, tetrahedral and square planar ligand environments. Structural consequences of splitting of d- orbitals, Jahn-Teller theorem, trends in ionic radii, lattice energy. Structure of spinel. MOT with σ and π bonding.

Unit-II **15 Hrs**

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for 1st series of transition metals, Orgel diagrams for transition metal complexes (d^1– d^9 states) calculation of Dq, B and ß parameters, charge transfer spectra of complexes (metal to ligand and ligand to metal).

Unit-III

Reaction Mechanism of Transition Metal Complexes – I **15 Hrs**

Reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid & base hydrolysis, factors affecting acid & base hydrolysis.

Reaction Mechanism of Transition Metal Complexes -II

Substitution reaction in square planar complexes, the trans-effect, mechanism of the substitution reactions. Redox reactions, electron transfer reactions, outer sphere type reactions, inner sphere type reactions.

Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand.

Unit-IV Lanthanides **10 Hrs**

Extraction & applications, color and spectra, magnetic properties, Binary & Ternary compounds, lanthanide contraction, Use of lanthanide compounds as shift reagents.

Actinides

General properties, oxidation states, applications, color and spectra and magnetic properties.

TEXT BOOKS

1. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 6th Edition, John Wiley & Sons, 1999.
2. J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry, 4th Edition, HarperCollins College Publishers, 1993.

FURTHER SUGGESTED READINGS

1. N.N. Greenwood and A. Earnshaw, Pergamon. Chemistry of the Elements, 2nd Edition, 1997.
2. B.N. Figgis, Introduction to ligand fields, John Wiley & Sons Ltd., London and New York, 1966.
3. J.D.Lee, Concise Inorganic Chemistry, 5th Edition, Wiley, 2016

Organic Chemistry-I (GOC and Stereochemistry)	
Course Code: 25CYMS102	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To impart advanced knowledge of various types of reactive intermediates and their stability.
- To understand the fundamentals of stereochemistry.
- To be familiar with the Conformational analysis of cyclohexanone, nitrogen containing ring systems and dynamic stereochemistry.
- To highlight various types of reaction mechanisms, effect of substrates structure and reagents on reactivity of a chemical reaction.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain the formation, reactivity and stability of reactive intermediates.
- Illustrate the basic concept of symmetry and chirality in the molecules their spatial arrangement, properties and reactivity of stereoisomers, importance of the configuration of chiral organic compounds.
- Describe the stereochemistry of N-heterocyclic system and dynamic stereochemistry.
- Demonstrate the knowledge on reaction mechanism & structure and reactivity involved in organic molecules.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Organic intermediates

Electrophiles and nucleophiles; nucleophilicity and basicity; types, shape and their relative stability of carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne. classical and non-classical carbocation, stability and reactivity of bridged-head carbocations.

Aromaticity

Benzenoid and nonbenzenoid compounds, Hückel's rule, energy level of molecular orbitals, annulenes, anti-aromaticity and homo-aromaticity.

Unit-II

Conformational Analysis **12 Hrs**

Basics of conformational analysis. effect of conformation on reactivity of acyclic and cyclic compounds. Fischer projection, Newmann and Sawhorse projection formulae and their interconversions; conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars.

Unit-III

Stereochemistry **18 Hrs**

Introduction of stereochemistry, Classification of isomers, Optical activity, Chirality, Elements of symmetry, Nomenclature systems D & L, R & S and E & Z, CIP rules, *threo* and *erythro* isomers. Molecules with more than one chiral center, asymmetric synthesis (basic principle). Methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes); stereochemistry of the compounds containing nitrogen and phosphorus.

Unit-IV

Reaction Mechanism: Structure and Reactivity **15 Hrs**

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acid and bases; Effect of structure on reactivity – resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants, Cram's rule for nucleophilic addition reactions of carbonyl compounds.

TEXT BOOKS

1. F.A. Carey and R.J. Sundburg, Advanced Organic Chemistry, ,5th Edition, Springer US. 2005
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th Edition, Prentice-Hall, 1992.
3. D. Nasipuri, Stereochemistry of Organic Compounds, 3rd Edition New Age International, 1994.
4. P.S. Kalsi, Stereochemistry of Organic Compounds, 10th Edition, New Age International, 2019.

FURTHER SUGGESTED READINGS

1. C.K. Ingold, Structure and Mechanism in Organic Chemistry, 2nd Edition, CBC Publisher &
2. Distributors, 1995.
3. Jerry March, Advanced Organic Chemistry-Reactions, Mechanism and Structure, 7th Edition, John Wiley, 2015.
4. E. L. Eliel and S. H. Wilen, Stereochemistry of Organic Compounds, Wiley Interscience, 2008.
5. S Sengupta, Basic stereochemistry of organic molecules, 2nd Edition, Oxford University Press, 2018.
6. Reinhard Bruckner, Advanced Organic Chemistry: Reaction Mechanism, Academic Press, 2001.

Physical Chemistry-I (Quantum Chemistry and Chemical Kinetics)	
Course Code: 25CYMS103	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (COs):

- To discuss the limitations of classical mechanics and the need of quantum chemistry.
- To make students familiar with postulates of quantum chemistry and apply the same to derive equations for various models and hydrogen atoms.
- To illustrate different theories of chemical kinetics.
- To discuss various theories of chemical kinetics to different types of chemical and biochemical reactions.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the postulates of quantum chemistry and apply to obtain the expression for uncertainty principles and other quantum mechanical system.
- Apply the concept of quantum chemistry to get the wave functions, probability and energy of various models and systems.
- Demonstrate different theories of chemical kinetics.
- Illustrate the use of theories of chemical kinetics to different types of chemical and biochemical reactions.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I 20 Hrs

Quantum Mechanics I

Introduction to quantum mechanics, postulates of quantum mechanics, Max-Born interpretation and the Heisenberg's uncertainty principle, Quantum mechanical operators and their commutation relation, Hermitian operators, (elementary ideas, quantum mechanical operator for linear momentum and angular momentum as Hermitian operator). The average value of the square of Hermitian operators; commuting operators and uncertainty principle(x & p; E & t), formulation of Schrodinger wave equation; Schrodinger wave equation for a particle in one and three dimensional box, evaluation of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, pictorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, lowest energy of the particle.

Unit-II **13 Hrs**

Quantum Mechanics II

Schrodinger wave equation for a particle in a three-dimensional box and the concept of degeneracy of energy levels. Schrodinger wave equation for linear harmonic oscillator, solution by polynomial method, zero-point energy and its consequence. Schrodinger wave equation for two- and three-dimensional rigid rotor, energy of a rigid rotor, selection rule, space quantization, Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution. Principle, azimuthal and magnetic quantum numbers and the magnitude of their values, probability distribution function, radial distribution function and shapes of atomic orbitals (*s*, *p* & *d*).

Unit-III **12 Hrs**

Chemical Kinetics I

Effect of temperature on reaction rates, rate law for opposing reactions of 1^{st} order and 2^{nd} order, rate law for consecutive 1^{st} order reactions, collision theory of reaction rates and its limitations, steric factor, activated complex theory. Ionic reactions: influence of solvent (single and double sphere models) and salt effect, comparison of collision and activated complex theory.

Unit-IV **15 Hrs**

Chemical Kinetics II

Chain reactions: Hydrogen – Bromine reaction, pyrolysis of acetaldehyde and decomposition of ethane. Photochemical reactions (hydrogen-bromine & hydrogen-chlorine reactions), ortho-para hydrogen conversion, apparent activation energy of chain reactions, chain length, Rice-Herzfeld mechanism of organic molecules, decomposition (acetaldehyde) kinetics of polymerization reaction, kinetics of (one intermediate) enzymatic reaction: Michaelis–Menton treatment, evaluation of Michaelis's constant for enzyme-substrate binding by Lineweaver– Burk plot, Dixon and Eadie-Hofstae methods. Competitive, non-competitive inhibition and mixed inhibition.

TEXT BOOKS

1. P.W. Atkins, Physical Chemistry, 11^{th} Edition Oxford University, New York 2017.
2. G.W. Castellan, Physical Chemistry, 3^{rd} Edition Narosa. Publishers, New Delhi, 2004.
3. B. R Puri, L.R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 47^{th} edition, Vishal Publishing Co. 2020.
4. Gurtu, J. N.; Gurtu, A. Advanced Physical Chemistry, 2019, Pragati Prakashan.

FURTHER SUGGESTED READINGS

1. C. Kalidas, Chemical Kinetics Methods, New Age International, 2017
2. K.J. Laidler, Chemical Kinetics, 2^{nd} Edition, McGraw Hill, 1993.
3. A.K. Chandra, Introductory Quantum Chemistry, 4^{th} Edition, Tata McGraw Hill, 2017.
4. I.M. Levine, Quantum Chemistry, 7^{th} Edition Prentice Hall, 2016.

Inorganic Chemistry Practical – I	
Course Code: 25CYMS151	Continuous Evaluation: 60 Marks
Credits: 2	End Semester Practical Examination: 40 Marks
L T P : 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (COs):

- To apply theoretical knowledge to design and perform experiments, analyze data, and draw conclusions related to the principles behind water analysis.
- To make understand the fundamental principles governing the separation of inorganic metal ions by gravimetric methods.
- To make students familiar with preparation & properties of inorganic complex compounds.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Apply concepts of inorganic chemistry to perform the water analysis.
- Comprehend the principle, mechanism and will receive hands-on training to separate mixture of metal ions by gravimetric analysis.
- Synthesize, isolate, and characterize inorganic compounds.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**		
	CLO 1	**CLO 2**	**CLO 3**
CO 1			
CO 2			
CO 3			

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform a minimum 6 of experiments)

A. Water Analysis

a. To determine dissolved oxygen in a given water sample.
b. To find out the amount of bleaching powder required to disinfect a water sample by Horrock's test.
c. To evaluate the biochemical oxygen demand of a waste water sample.
d. To determine the total, permanent and temporary hardness of water by EDTA method.

B. Quantitative Analysis

a) To separate and determine two metal ions such as Ag-Cu, Cu- Ni, Cu-Zn, Ni- Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

C. Preparations & properties

To prepare and analyse the following metal complexes:

a. $[Cu(NH_3)_4]^{2+}$
b. $Mn(acac)_3$
c. Prussian Blue/Turnbull's Blue

FURTHER SUGGESTED READINGS

1. J. Bassett, R. C. Denney, G.H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Analysis, revised, ELBS, 5th Edition, John Wiley & Sons Inc, 1989.
2. G. Svehla, Longman. Vogel's Textbook of Macro and Semi-micro Qualitative Inorganic Analysis, revised, 5th Edition, the Chaucer Press, Great Britain, 1979.
3. Marr and Rocket. Practical Inorganic Chemistry, Van Nostrand Reinhold Inc., U.S., 1972.
4. O.P. Virmani and A.K. Narula, Applied Chemistry, 2nd Edition, New Age International 2017.

Organic Chemistry Practical – I	
Course Code: 25CYMS152	Continuous Evaluation: 60 Marks
Credits: 2	End Semester Practical Examination: 40 Marks
L T P : 0 0 4	**Course Type: Core Course**
Prerequisite:	

COURSE OBJECTIVES (COs):

- To illustrate the safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents.
- To create competency of experimental skills of various separation, purification techniques and structural elucidation.
- To discuss the mono & bi-functional groups in organic compounds.
- To impart knowledge in the synthesis of organic compounds.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Demonstrate safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents.
- Perform synthetic procedures, starting materials, functional groups, mechanism, and typical reaction conditions.
- Replicate the mono & bi-functional groups in organic compounds.
- Execute characterization by physical and spectroscopic techniques.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum **7** experiments)

1. Safety Practices in the Chemistry Laboratory.
2. **Qualitative Analysis:** Identification of organic compounds having mono or bi-functional groups.
3. **Organic Synthesis:** Two step preparations

TEXT BOOKS

1. H. Clark, Adward Arnold, Handbook of Organic Analysis-Qualitative and Quantitative Hodder Arnold H& S, 1975.
2. A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, John Wiley, 1989.
3. Jagdamba Singh, L.D.S. Yadav and M. Shrivastava, Advanced Practical Chemistry, 9th Edition Pragati Prakasan, 2019.
4. J.N. Gurtu and R. Kapoor, Advanced Organic Practical Chemistry, S. Chand, 1987.

FURTHER SUGGESTED READINGS

1. N.K. Vishnoi, Advanced practical organic chemistry, 3rd Edition, Vikas Publishing House, 2009
2. Pasto, C. Johnson and M. Miller Experiments and Techniques in Organic Chemistry, 1st Edition, Prentice Hall, 1991.
3. K.L. Williamson, D.C. Heath Macroscale and Microscale Organic Experiments, 1989.
4. Middleton, Adward Arnold, Systematic Qualitative Organic Analysis, 1939.

Physical Chemistry Practical – I	
Course Code: 25CYMS153	Continuous Evaluation: 60 Marks
Credits: 2	End Semester Practical Examination: 40 Marks
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (COs):

- To make students familiar with the kinetics of various reactions.
- To develop students' understanding about distribution law.
- To make students familiar with phase equilibria & preparation of phase diagram.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Perform the kinetics of various reactions by different methods.
- Apply distribution law in various systems.
- Describe the concept of phase equilibria & prepare phase diagram.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	
CO 1				
CO 2				
CO 3				

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum of 7 experiments)

A. Chemical Kinetics

(i) To study kinetics of hydrolysis of an ester in the presence of acid.
(ii) To determine the order for the saponification of ester by initial rate method.
(iii) Neutral salt effect - Kinetics of reaction between iodide and Persulphate - Effect of ionic strength on rate constant.
(iv) Kinetics of iodination of acetone.

B. Distribution Law

(i) Determination of partition coefficient of benzoic acid between benzene and water.
(ii) Determination of partition coefficient of iodine between carbon tetrachloride & water.
(iii) Determination of equilibrium constant for $I_2 + I = I_3$

C. Phase Equilibria

i) Phase diagram of naphthalene - m-dinitrobenzene system or other system (Simple eutectic system).
ii) Phase diagram of two-component system forming a compound.

REFERENCE BOOKS

1. A.M. James and F.E. Pricherd, Practical Chemistry, Prentice Hall Press, 1974.
2. B. Levitt and Findley's, Practical Physical Chemistry, Longman, 1973.
3. S. R. Palit and S.K. De, Practical Physical Chemistry, 3rd Edition, Calcutta: Science Book Agency, 1974.

FURTHER SUGGESTED READINGS

1. R.C. Das and B. Behra, Experimental Physical Chemistry, McGraw Hill, 1983.
2. Shoemaker and Garland Experiments in Physical Chemistry, McGraw Hill, 1967.
3. B. D. Khosla, Senior Practical Physical Chemistry, R Chand & co, 2018.
4. J. B. Yadav, Advanced Practical Physical Chemistry, Krishna Prakashan Media, 2016.

SEMESTER II

Inorganic Chemistry-II (Organometallic Chemistry)	
Course Code: 25CYMS201	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To discuss the basics of Organometallic Chemistry.
- To explain the bonding, properties & reactions of metal carbene, metal carbyne & fluxional organometallic compounds.
- To describe the principles of catalysis reactions.
- To illustrate the low & high nuclear metal clusters.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the fundamental understanding of organometallic compounds.
- Demonstrate bonding, properties & reactions of metal carbene, metal carbyne & fluxional organometallic compounds.
- Replicate various catalytic reactions by using transition metal catalyst.
- Explain the structure & bonding of low & high nuclear metal cluster.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Organometallic Chemistry

Electron count, application of 18-electron rule. Preparation and properties (Bonding modes, IR Spectra) of transition metal carbonyls and nitrosyls.

Transition Metal π–Complexes

Transition metal π–complexes with unsaturated molecules, alkenes, alkynes, allyl, &arenes and Cp (metallocene) complexes: preparation, properties and nature of bonding (MO picture) and structural features, important reactions related to nucleophile and electrophilic attack on ligands and to organic synthesis.

Unit-II **15 Hrs**

Compounds of Transition Metal-Carbon Multiple Bonds

Transition metal- carbene complexes: Fischer type and Schrock type carbene complexes: synthesis, reactions and structures& bonding; Transition metal-carbyne complexes: synthesis, reactions and structural features.

Fluxional Organometallic Compounds

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes, s-bonded and p–bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

Unit-III **15 Hrs**

Catalysis Reactions

Oxidative addition, reductive elimination and insertion reactions. Zeigler-Natta polymerization; homogeneous catalytic hydrogenation; alkene hydrogenation- Wilkinson Catalyst; Oxidation of olefins- Wacker's process; hydroformylation of olefins the oxo process; Monsanto process. Fischer-Tropsch Reaction, The water- Gas Shift Reaction, Hydrocyanation, activation of C-H bond.

Unit-IV **15 Hrs**

Metal Clusters

Chemistry of inorganic rings, cages and metal cluster compounds and their bonding, Chemistry of polyphosphonitriles and Borazine, polyhedral boranes, carboranes, metalloboranes and metallocarboranes, isoelectronic and isolobal analogy of metal carbonyl compounds and boranes.

TEXT BOOKS

1. J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, Principles and Application of Organo-transition Metal Chemistry, University Science Books.
2. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley.
3. R.C. Mehrotra and A. Singh, Organometallic Chemistry, New Age International.
4. A. Salzer, Ch. Elschenbrioch, Organometallics, VCH Publications.

FURTHER SUGGESTED READINGS

1. B. D. Gupta and A. J. Elias, Basic Organometallic Chemistry: Concepts, Synthesis and Applications of Transition Metals; University Press.
2. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, John Wiley.
3. J.E. Huheey, Inorganic Chemistry, Harper Collins.
4. N.N. Greenwood and A. Earnshaw, Chemistry of the Elements, Pergamon.
5. B.N. Figgis, Introduction to ligand fields, II-Edition, Wiley Eastern.

Organic Chemistry-II (Organic Spectra and Reagents)	
Course Code: 25CYMS202	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (COs):

- To explain the basic principles of IR spectroscopy and its applications in structure determination.
- To discuss the basic principles of UV spectroscopy and its applications in structure determination.
- To study the basic principles of 1D and 2D NMR spectroscopy and its applications in structure determination. To understand the role of oxidizing and reducing reagents in reactions.
- To illustrate the oxidizing and reducing agent and their mechanism of action.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Demonstrate the principles of IR spectroscopy for the structure determination of organic compounds.
- Apply the principles of UV spectroscopy and Mass spectrometry for the structure determination of organic compounds.
- Apply the basic principles of NMR spectroscopy such as chemical shift, coupling constant, and anisotropy in the characterization of compounds.
- Illustrate various reducing and oxidizing agents and their applications in organic synthesis.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I Ultraviolet spectroscopy — 17 Hrs

Introduction, absorption laws, measurement of the spectrum, chromophores, auxochrome, bathochromic shift and hypochromic shift, standard works of reference, definitions, Intensity of max: Hyperchromic and hypsochromic shift, Applications of UV spectroscopy to conjugated dienes, trienes, unsaturated carbonyl compounds and aromatic compounds. Factors affecting λ^{max}, solvent effect.

Infrared spectroscopy

Frequency, wave length and wave number, molecular vibrations, factors influencing vibrational frequencies, the IR spectrometer, sampling techniques, and characteristics frequencies of organic molecules and interpretation of spectra.

Unit-II — 20 Hrs

Nuclear Magnetic Resonance Spectroscopy (Proton and Carbon-NMR)

The measurement of spectra, the chemical shift: the intensity of NMR signals and integration, factors affecting chemical shifts: spin-spin coupling to ^{13}C-^{1}H, ^{1}H-^{1}H first order coupling: some simple ^{1}H-^{1}H splitting patterns: the magnitude of ^{1}H-^{1}H coupling constants: Techniques for simplification of complex spectra: solvent effects, Lanthanide shift reagents, spin decoupling (double resonance)

Nuclear Overhauser effect (NOE). Effect of sensitivity of ^{13}C NMR compared to ^{1}H NMR,

elementary discussion on natural abundance, chemical shifts and splitting in Carbon, nitrogen, fluorine and phosphorous NMR. Simplification of ^{13}C spectra by process of decoupling,
off resonance decoupling. Introduction to 2D NMR-DEPT, HSQC, HMBC etc.

Unit-III **8 Hrs**

Mass spectrometry

Basic Principles; instrumentation; mass spectrometer, isotope abundances; the molecular ion, metastable ions. Fragmentation: fission, Mclafferty rearrangement, Nitrogen Rule.

Unit-IV **15 Hrs**

Oxidation
Oxidations of hydrocarbons, alkenes, alcohols, aldehydes and ketones, oxidative coupling reactions. Use of $Pb(OAc)_4$, CrO_3, SeO_2, MnO_2, $AgCO_3$, $KMnO_4$, OsO_4, -m-cpba, H_2O_2, Ozone, DDQ, Swern oxidation, Jones oxidation, IBX, Fenton's reagent

Reduction
Catalytic hydrogenation (homogeneous and heterogeneous), reduction by dissolving metals, Birch reduction, Wilkinson hydrogenation. Reduction by hydride transfer -reagents ($LiAlH_4$, $NaBH_4$, $NaBH_3CN$), Zn dust, DIBAL, 9-BBN, $LiBH_4$, BH_3, selectivity in reduction of nitroso and nitro compounds, reductive cleavage, n-Butyllithium.

TEXT BOOKS

1. R.M. Silverstein, G.C. Bassler and T.C. Morrill, Spectrometric Identification of Organic Compounds, John Wiley.
2. R.J. Abraham, J. Fisher and P. Loftus, Introduction to NMR Spectroscopy, Wiley.
3. J.R. Dyer, Application of Spectroscopy of Organic Compounds, Prentice Hall.
4. D.H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, Tata McGraw- Hill.
5. William Kemp, Organic Chemistry, John Wiley.
6. Jag Mohan, Organic Spectroscopy, Narosa Publishers, New Delhi

FURTHER SUGGESTED READINGS

1. Donald L. Pavia, Introduction to spectroscopy, 4th edition, Brooks cole.
2. Fieser and Fieser, Reagents in Organic Synthesis, Wiley.
3. Sanyal, Reactions, Rearrangements & Reagents, Bharti Bhawan.
4. O. P. Agarwal, Reaction & Rearrangements, Krishna Prakashan Media (P) Ltd, 1975.
5. V. K. Ahluwalia, Rakesh Kumar Parashar, Organic reaction mechanism, 3rd Edition, alpha science.

Physical Chemistry - II (Statistical Thermodynamics and Electrochemistry)	
Course Code: 25CYMS203	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To discuss the concept of statistical thermodynamics and its classifications
- To highlight applications of statistical thermodynamics in the determination of partition function & thermodynamic properties.
- To illustrate the ion-ion interactions and its application in electrochemistry.
- To make students familiar with ion transport in solution under different environment.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain concept of statistical thermodynamics and various types of systems.
- Demonstrate the applications of statistical thermodynamics in determination of partition function.
- Analyze the ion-ion interactions and its limitations in electrochemistry.
- Describe the ion transport in solution under different environment.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I 15 Hrs

Statistical Thermodynamics-I

Fundamentals: Concepts and distribution. Thermodynamic Probability and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its Types of statistics: Maxwell-Boltzmann, Bose-Einstein Statistics and Fermi-Dirac Statistics. Idea of microstates and macrostates. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers. Stirling's approximation, Molecular partition function and its importance. Assembly partition function.

Unit-II 15 Hrs

Statistical Thermodynamics-II

Application of ideal gases: The molecular partition function and its factorization. Evaluation of translational, rotational and vibrational partition functions for monoatomic, diatomic and polyatomic gases. The electronic and nuclear partition functions. Calculation of thermodynamics properties of ideal gases in terms of partition function. Statistical definition of entropy. Ortho and Para-hydrogen, statistical weights of ortho and para states, symmetry number. Calculation of equilibrium constants of gaseous solutions in terms of partition function.

Perfect gas mixtures. Einstein theory and Debye theory of heat capacities of monoatomic solids. Third law of thermodynamics. Residual Entropy.

Unit-III **15 Hrs**

Electrochemistry I

Ion-Ion Interactions -The Debye-Huckel theory of ion-ion interactions: potential and excess charge density as a function of distance from the central ion, Debye-Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye-Huckel limiting law of activity coefficients and its limitations, ion-size effect on potential, ion-size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite-sized ions. Debye-Huckel-Onsager treatment for aqueous solutions and its limitations. Debye-Huckel-Onsager theory for non-aqueous solutions, the solvent effect on the mobility at infinite dilution, equivalent conductivity vs. concentration $c^{1/2}$ as a function of the solvent, effect of ion association upon conductivity (Debye-Huckel-Bjerrum equation).

Unit-IV **15 Hrs**

Electrochemistry II

Ion Transport in solutions – Ionic movement under the influence of an electric field , mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation , the Nernst -Einstein equation, Walden's rule, the rate-process approach to ionic migration , the rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst-Planck Flux equation, ionic drift and diffusion potential , the Onsager phenomenological equations. The basic equation for the diffusion, Planck-Henderson equation for the diffusion potential.

REFERENCE BOOKS

1. S. Glasstone, An Introduction to Electrochemistry, Franklin Classics Trade Press
2. J. O. M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol.I and Vol II, Plenum.
3. Puri, Sharma & Pathania, Principles of Physical Chemistry, Vishal Pub.
4. Gurtu & Gurtu, Advanced Physical Chemistry,Vol 1, Edition V, Pragati Prakashan.

FURTHER SUGGESTED READINGS

1. P.W. Atkins, Physical Chemistry, Oxford University Press.
2. G.W. Castellan, Physical Chemistry, Narosa Publishers, New Delhi
3. Puri, Sharma & Pathania, Principles of Physical Chemistry, Vishal Pub.
4. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press.
5. I.M. Klotz and R.M. Rosenberg, Chemical Thermodynamics, Benzamin.
6. R.P. Rastogi and R.R. Misra, An Introduction to Chemical Thermodynamics, Vikas Pub.

Inorganic Chemistry Practical – II	
Course Code: 25CYMS251	Continuous Evaluation: 60 Marks
Credits: 2	End Semester Practical Examination: 40 Marks
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To impart knowledge about the qualitative analysis of various anions present in inorganic salts.
- To illustrate qualitative analysis of various cations present in inorganic salts.

COURSE LEARNING OUTCOMES (CLO);

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Comprehend the underlying principle how to identify various anions present in inorganic salt mixture qualitatively.
- Apply different strategies to evaluate various cations present in inorganic salt mixture qualitatively.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**	
	CLO 1	**CLO 2**
CO 1		
CO 2		

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum of 4 experiments)

Qualitative Analysis

a) To determine anion and cation present in a given mixture.
b) To qualitatively analyse rare metal ions- Tl, Se, Te, Mo, W, Ti, Zr, & V.
c) To perform the qualitative analysis of insoluble- Oxides (WO_3, Silica, Alumina); Sulphates (Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate); Halides (Calcium fluoride and silver halides) (2 rare metal ions and 1 insoluble to be given)

FURTHER SUGGESTED READINGS

1. J. Bassett, R. C. Denney, G.H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Analysis, revised, ELBS.
2. G. Svehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, Longman.
3. Marr and Rocket, Practical Inorganic Chemistry, Van Nostrand Reinhold Inc., U.S.

Organic Chemistry Practical – II	
Course Code: 25CYMS252	Continuous Evaluation: 40
Credits: 2	End Semester Practical Examination: 60
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To illustrate the separation methods of organic mixtures.
- To discuss the synthesis of organic compounds.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Demonstrate the separation and identification of compounds.
- Execute synthesis of organic compounds and related steps such as aqueous workup, distillation, reflux, separation, isolation, and crystallization.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**	
	CLO 1	**CLO 2**
CO 1		
CO 2		

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum of 4 experiments)

A. Qualitative Analysis

Separation and identification of compounds of binary mixture using water/$NaHCO_3$ and HCl / NaOH and checking purity of individual component using TLC. IR spectra to be used for functional group identification.

B. Organic synthesis: Two Step Preparations

TEXT BOOKS

1. F. Lousis, O. C. Fieser, Heath Experiments in Organic Chemistry, Company Boston, 1955.
2. D. Pasto, C. Johnson and M. Miller, Experiments and Techniques in Organic Chemistry, Prentice Hall.
3. K.L. Williamson, Macroscale and Microscale Organic Experiments, D.C. Heath Publishers.
4. H. Middleton, Systematic Qualitative Organic Analysis, Adward Arnold.
5. H. Clark, Handbook of Organic Analysis-Qualitative and Quantitative, Adward Arnold.
6. A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, John Wiley.

FURTHER SUGGESTED READINGS

1. Jagdamba Yadav and Jaya Shrivastava, L. D. S. Yadav, Advanced practical chemistry, Pragati Prakasan.
2. J. N. Gurtu and R. Kappor, Advanced organic practical chemistry, S. Chand.
3. N.K. Vishnoi, Advanced practical organic chemistry, Vikas Publishing House.

Physical Chemistry Practical – II	
Course Code: 25CYMS253	Continuous Evaluation: 40
Credits: 2	End Semester Practical Examination: 60
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To discuss the potentiometric and conductometric titrations.
- To impart knowledge about the Thermochemistry.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Replicate potentiometric and conductometric titration of acid and base to study the details of rates of chemical reactions.
- Apply the principles of Thermochemistry in the determination of heat of reaction.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**	
	CLO 1	**CLO 2**
CO 1		
CO 2		

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum of **6** experiments)

Conductometric

(i) To study the precipitation reaction.
(ii) To study the neutralization reaction of mixture of acids with strong base.
(iii) To study the neutralization reaction of dibasic acids with strong base.
(iv) To study the redox reaction.

Potentiometry

(i) To determine the strength of strong acid by titrating against strong base.
(ii) To study the precipitation reaction.
(iii) To study the redox reaction.

Thermochemistry

(i) Determination of heat of neutralization.
(ii) To determine the strength of strong acid by titrating against strong base.
(iii) To determine the strength of weak acid by titrating against strong base.

REFEFRENCE BOOKS

1. A.M. James and F.E. Pricherd, Practical Chemistry, Longman.
2. B. Levitt and Findley's, Practical Physical Chemistry, Longman.
3. S.R. Palit and S.K. De, Practical Physical Chemistry, Science Book Agency.
4. R.C. Das and B. Behra, Experimental Physical Chemistry, McGraw Hill.

FURTHER SUGGESTED READINGS

1. Experiments in Physical Chemistry, Shoemaker and Garland McGraw Hill.
2. Senior Practical Physical Chemistry, B.D. Khosla
3. Advanced Practical Physical Chemistry, J. B. Yadav

SEMESTER III

Structure & Mechanism in Organic Chemistry	
Course Code: 25CYMS301	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To learn aliphatic/aromatic electrophilic &nucleophilic substitution reactions and factors affecting the rate of these reactions.
- To explain the arenium ion mechanism and effects of substituents on the reactivity and orientation of aromatic rings.
- To gain knowledge about the chemistry of free radicals.
- To study the mechanism of addition of carbon-carbon multiple and carbon hetero bonds and chemistry of various name reactions.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe various nucleophiles and electrophiles and their reactions. Will also get to know about the various factors which affects the rate and outcomes of electrophilic &nucleophilic substitution reactions.
- Explain the various types of reactions involving arenium ion as in intermediate.
- Explain the role of free radicals in organic chemistry and in reaction mechanism.
- Apply the knowledge about the mechanistic and stereochemical aspects of addition reactions of C=C and C=X.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Aliphatic Nucleophilic Substitution

The S_N2, S_N1, S_Ni, mixed S_N1 and S_N2 and SET Mechanisms; neighboring group participation by and bonds; Classical and non-classical carbocations, phenonium ions, norbornyl system, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambident-nuleophile, regioselectivity.

Aromatic Nucleophilic Substitution

The S_N^{Ar}, S_N1, benzyne and S_{RN}^1 mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, Steven's rearrangement, and Smile's rearrangements.

Unit-II **15 Hrs**

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, ipso attack, orientation in other ring systems. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction, Stephen's reaction. **Elimination Reactions:** Type of elimination reactions, E1, E2 and E1cb Mechanisms. Saytzeff vs Hofmann elimination, Hofmann exhausted methylation xanthate elimination, Chugaev elimination, Peterson elimination, Julia olefination and stereochemistry of elimination reactions having two chiral centers.

Unit-III **15 Hrs**

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Role of AIBN, Bu_3SnCl etc. in free radical chemistry.

Unit-IV **15 Hrs**

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation and hydroxylation.

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of carbonyl compounds, acids and esters. Wittig reaction. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions, Baylish-Hilmann reaction, Stark enamine reaction, Shapiro reaction, Favorski and quasi-favorski reaction.

TEXT BOOKS

1. Jerry March, Advanced Organic Chemistry-Reactions, Mechanism and Structure, 7th Edition, John Wiley, 2015.
2. F.A. Carey and R.J. Sundburg, Advanced Organic Chemistry, Plenum, 5th Edition, 2007.
3. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition, Pearson.
4. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th Edition, Prentice-Hall, 2010.
5. S.M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 2007.

FURTHER SUGGESTED READINGS

1. V K Ahluwalia and R K Prasher, Organic reaction Mechanism, Narosa Publishing House, 2006.
2. P S Kalsi, Organic reactions and their mechanisms New Age International Publishers., 2020.
3. Bradford P. Mundy, Michael G. Ellerd and Frank G. Favaloro Jr. Name Reactions and Reagents in Organic Synthesis 2nd Edition, Wiley, 2005.
4. Jie Jack Li, Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications Springer, 2021.

Inorganic and Physical Spectroscopy	
Course Code: 25CYMS302	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To explain the basic principle involved in Vibrational Spectroscopy.
- To discuss the theories of Raman Spectroscopy.
- To lay out the underlying theory behind spin resonance and electronic spectroscopy.
- To describe the concept of Mossbauer and AAS in the characterization of molecules.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the concepts of vibrational spectroscopy and IR spectra of molecules.
- Apply the concepts of Raman spectroscopic techniques to characterize different molecules and crystals.
- Demonstrate the electronic and spin resonance spectroscopy in molecular characterization.
- Explain the characterization of materials using Mossbauer and Atomic Absorption Spectroscopy.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

UNIT-I **15 Hrs**

Vibrational Spectroscopy

Recapitulation of Principle of IR spectroscopy; Harmonic and Anharmonic Oscillator, Fundamental, Overtone and Hot Bands, Applications of vibrational spectroscopy in investigating (i) symmetry and shapes of simple AB_2, AB_3, AB_4, AB_5 and AB_6 molecules on the basis of spectral data, (ii) mode of bonding of ambidentate ligands (thiocyanate, nitrate, etc.) ethylenediamine and diketonate complexes,

UNIT-II **15 Hrs**

Raman Spectroscopy

Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications. Principle and application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins.

UNIT-III **15 Hrs**

Spin Resonance Spectroscopy

Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field, Larmor precession, population of energy levels. Difference between NMR and ESR Spectroscopy.

Electronic Spectroscopy

UV-visible molecular absorption spectrometry (principle, instrumentation and applications), Born

Oppenheimer approximation, Molecular Quantum Yield, Jablonski diagram, Frank-Condon Principle, Molecular luminescence spectroscopy (fluorescence, phosphorescence, chemi-luminescence).

UNIT-IV **15 Hrs**

Mossbauer Spectroscopy

The theory of Moss-Bauer spectroscopy, the chemical shift, quadrupole effects, the effect of magnetic field, application of Moss-Bauer spectroscopy.

Photo Electron Spectroscopy (PES)

Principle, Experimental Methods, Ionization Processes and Koopman's Theorem, photoelectron spectra and their interpretation; Introduction to Auger electron and X-ray fluorescence spectroscopy.

REFERENCE BOOKS

1. J.M. Hollas, Modern Spectroscopy, 2nd Edition, John Wiley, 1998.
2. F.A. Cotton, Chemical Applications of Group Theory, 3rd Edition, Wiley, 2008.
3. G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, 1962.
4. G.M. Barrow, Basic Principles of Spectroscopy, McGraw Hill, 1992.
5. C. N. Banwell, Fundamentals of molecular spectroscopy, Tata Macgraw Hill, 1996.
6. J.M. Hollas, Modern Spectroscopy, 4th Edition John Wiley, 2003.

FURTHER SUGGESTED READINGS

1. P.K. Ghosh, Introduction to Photoelectron Spectroscopy, John Wiley, 1984.
2. Skoog and West, Fundamental of Instrumental Analysis, 6tjh Edition, Cengage Learning,
3. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edn, Blackwell Scientific Publications, Oxford, London 1987.
4. L.S.Dent, Glasser, Application of X-ray crystallography, 1st Edition, ELBS, 1987.

Bio-Inorganic and Bio-Organic Chemistry	
Course Code: 25CYMS303	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To explain about various alkali and alkaline earth metals in biological systems & their role as biological carriers
- To study the function & mechanism of various metalloenzymes
- To gain knowledge about various classes of carbohydrates, their roles, synthesis & stereochemistry.
- To gain knowledge about various biomolecules such as nucleic acids, amino acids & proteins, their roles, synthesis & properties.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the function of alkali and alkaline earth metals in biological system & their role as biological carriers
- Analyze the importance, function & mechanism of various metalloenzymes
- Explain various classes of carbohydrates, their roles, synthesis & stereochemistry.
- Identify various biomolecules such as nucleic acids, amino acids & proteins, their roles, synthesis & properties.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Alkali and alkaline earth metals in biological systems

Ionophores, active transport of cations across membranes, sodium-potassium pump, Calcium carriers, role of carriers in muscle contraction.

Oxygen carriers

Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems.

Nitrogen fixation

Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll.

Metal transport and storage

Transferrin, Ferritin, Siderophores (without synthesis).

Porphyrins: Structure of chlorophyll and Haemoglobin (without synthesis).

Organoselenium Compounds

Unit-II **15 Hrs**

Metalloenzymes- I (function and mechanism)
Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase.
Copper Enzymes – Superoxide dismutase, blue copper- proteins.
Nickel Enzyme - Urease
Metalloenzymes- II (only function)
Iron Enzymes– Catalase, peroxidase, Cytochromes (cytochrome c, cytochrome c oxidase and cytochrome P-450, non-heme iron-containing protein.

Unit-III **15 Hrs**

Carbohydrates
Occurrence, classification and their biological importance.

Monosaccharides
Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani - Fischer synthesis and Ruff degradation; Wohl degradation.

Disaccharides - Structure elucidation of sucrose.

Polysaccharides -Elementary treatment of starch, cellulose and glycogen.

Unit-IV **15 Hrs**

Nucleic Acids
Components of nucleic acids, Nucleosides and nucleotides. Structure of polynucleotides (DNA and RNA). Replication of DNA, transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA, modified nucleic acids like LNA, PNA, antisense technology, size exclusion chromatography.

Amino Acids, Peptides and Proteins
Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis.

Study of peptides
Determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups, Solid-phase synthesis.

Proteins
Primary, secondary, tertiary and quaternary structures of proteins, Protein Denaturation.

REFERENCE BOOKS

1. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentne, Bioinorganic Chemistry, University Science Books, 1994.
2. Lippard, S. J. & Berg, J. M. Principles of Bioinorganic Chemistry Univ. Science Books 1994.
3. Lippard, S. J. Progress in Inorganic Chemistry Vols. 18 and 38, Wiley-Interscience 1991.
4. I.L. Finar, Volume 2,

FURTHER SUGGESTED READINGS

1. Enzo Alessio (Ed.), Bioinorganic Medicinal Chemistry, Wiley-VCH Verlag 2011.
2. A.L. Lehninger, Principles of Biochemistry, 6th Edition W. H. Freeman, 2013.
3. R. Norman and J. M. Coxon, Blakie Principles of Organic Synthesis, 3rd Edition,Springer, 1993.
4. B.G. Davis and Fairbanks, Basics in Carbohydrate Chemistry, Oxford University Press

Photochemistry & Pericyclic Chemistry	
Course Code: 25CYMS304	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To learn about concept of photochemistry of organic compounds and photochemistry of carbonyl compounds.
- To explain photochemistry of alkene and rearrangement due to photochemistry.
- To understand the basic principles of pericyclic reactions and chemistry of electrocyclic reactions.
- To study cycloaddition and sigmatropic reactions and their applications in organic synthesis.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe concept of photochemistry and their applications in carbonyl compounds.
- Illustrate the intermolecular rearrangement in olefinic and carbonyl compounds.
- Apply the molecular orbital symmetry and possibility of thermal and photo-chemical pericyclic reactions of electro-cyclic reactions
- Explain cycloaddition reaction and sigmatropic reactions such as Diels alder reactions, Claisen rearrangement, ene reactions etc.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

UNIT-I **15 Hrs**

Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, quantum yield, transfer of excitation energy.

Photochemistry of Carbonyl Compounds

Intermolecular reactions of carbonyl compounds, saturated, cyclic, acyclic, and β, γ-unsaturated compounds.

UNIT-II **15 Hr**

Intermolecular cycloaddition reactions – dimerizations and oxetane formation.

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5-dienes. Di-pimethane, oxa di-pi, aza di-pi rearrangement, Photosensitizer and its chemistry, Energy transfer reactions.

Miscellaneous Photochemical Reactions

Photo-Fries rearrangement. Barton reaction.

UNIT-III

Pericyclic Chemistry: Electrocyclic reactions **15 Hrs**

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams.
FMO and PMO approach. Electrocyclic reactions -conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Ring closing and ring opening through electocyclization reactions

UNIT-IV

Cycloadditions **15 Hrs**

Antarafacial and suprafacial additions, 4n and 4n+2 systems, Diels Alder reaction, Intra, Retro and factor affecting DA reactions.

Sigmatropic rearrangements

Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 2,3-, 3,3-and 5,5-, 9,9- sigmatropic rearrangements. Claisen, Sommelet Hauser and Cope rearrangements.
Ene Reaction

REFERENCE BOOKS

1. K.K. Rohtagi Mukherjee, Fundamental of Photochemistry, Wiley Eastern, 1978.
2. Burger, Medicinal chemistry, 4th Edition, Wiley Interscience. 1981.
3. F.A. Carey, & R. J. Sundberg, Advanced Organic Chemistry, Parts A & B, Plenum: U.S. 2004.
4. W. M. Horspool, Aspects of Organic Photochemistry Academic Press 1976.
5. Lowry, T. H. & Richardson, K. S. Mechanism and Theory in Organic Chemistry, Addison Wesley Educational Publishers, Inc. 1981.

FURTHER SUGGESTED READINGS

1. J. March, Advanced Organic Chemistry John Wiley & Sons 1992.
2. P. Marchand, & R. E. Lehr, Pericyclic Reactions Academic Press 1977.
3. M G Arora, Organic Photochemistry and Pericyclic Reactions, Anmol Publishers, New Delhi, 2004.
4. S.M. Mukherji, Pericyclic Reaction Macmillan, India, 1979.

Chemistry Practical – III	
Course Code: 25CYMS351	Continuous Evaluation: 40 Marks
Credits: 2	End Semester Practical Examination: 60 Marks
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To understand the preparation and characterization methods of inorganic compounds.
- To be familiar with isolation techniques used for isolating organic compounds from natural sources.
- To learn the preparation and characterization of nanoparticles.
- To impart the knowledge about conductometry

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Synthesize, and characterize inorganic compounds.
- Describe various techniques used in isolation of organic compounds from natural sources.
- Demonstrate the synthesis and characterization of nanoparticles
- Analyze the effect on conductance as the number of ions increases or decreases.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

LIST OF EXPERIMENTS

1. To Prepare Inorganic compounds/complexes and their characterization using techniques/methods such as elemental analysis, conductance measurement, molecular weight determination, magnetic susceptibility measurements, infrared, UV, visible, etc. Handling of air and moisture sensitive compounds.

a. $[Ni(dmg)_2]$
b. $[Ni(NH_3)_6]Cl$
c. $K_3[Fe(C_2O_4)_3]$

2. Isolation of Organic Compounds from Natural Sources

(i) Piperine from black pepper
(ii) Lactose and casein from milk
(iii) Caffeine from tea leaves

3. Synthesis of Gold & Silver nanoparticles using conventional and green methods

4. Conductometry

(i) Determination of solubility and solubility product of sparingly soluble salt (AgCl, $PbSO_4$).

(ii) Determination of degree of hydrolysis and hydrolysis constant of aniline hydrochloride in aqueous solution.

FURTHER SUGGESTED READINGS:

1. Synthesis and Characterization of Inorganic Compounds. W.L. Jolly, Prentice Hall , 1970
2. A.I. Vogel, A Textbook of Quantitative Analysis. ELBS, London, 1939

Chemistry Practical – IV	
Course Code: 25CYMS352	Continuous Evaluation: 40 Marks
Credits: 2	End Semester Practical Examination: 60 Marks
L T P: 0 0 4	Course Type: Core Course

COURSE OBJECTIVES (CO):

- To understand the multi-step synthesis and isolation of organic compounds from natural resources.
- To impart knowledge about the applications of Polarimetry.
- To learn the synthesis of polymers.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Perform the multi-step synthesis of organic compounds.
- Preparation of polymers
- Apply polarimetry to study the progress of chemical reactions.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**		
	CLO 1	**CLO 2**	**CLO 3**
CO 1			
CO 2			
CO 3			

LIST OF EXPERIMENTS

1. Multi-step Synthesis of Organic Compounds

2. Preparation of Urea-formaldehyde resin

3. Preparation of Nylon 6,6

4. Polarimetry

(i) Determination of specific rotation for optically active substance

(ii) Estimation of concentration of optical active substance in the given solution

REFERENCE BOOKS

1. B. Levitt and Findley's, Practical Physical Chemistry, Longman, 1973.
2. S.R. Palit and S.K. De, Practical Physical Chemistry, Science Book Agency, 1974.
3. R.C. Das and B. Behra, Experimental Physical Chemistry, McGraw Hill, 1983.
4. Shoemaker and Garland, Experiments in Physical Chemistry, McGraw Hill, 1998.
5. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co, 2018.

FURTHER SUGGESTED READINGS

1. H. Clark, Adward Arnold, Handbook of Organic Analysis-Qualitative and Quantitative, Hodder Arnold H& S, 1975.
2. A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edition, John Wiley, 1989.
3. Jagdamba, Yadav and Shrivastava, Advanced practical chemistry, 1st Edition, Pragati Prakasan, 2010

SEMESTER-IV

Subject Name: Applications of Group Theory in Chemistry	
Course Code: 25CYMS401	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To impart the knowledge of symmetry elements and classifying molecules on the basis of symmetry.
- To be familiar with the symmetry transformation using different basis sets.
- To obtain normal modes of vibrations and the spectroscopic transition for various molecular point group.
- To understand the concepts symmetry of hybrid orbitals for sigma and pi bonding and for the symmetry adapted linear combination of atomic orbitals.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Work out the symmetry point groups of molecules.
- Derive the character table and obtain the Mulliken symbol and irreducible representation for various point group molecules.
- Obtain normal modes of vibrations and the spectroscopic transition for various molecular point group.
- Apply the concepts of symmetry of hybrid orbitals for sigma and pi bonding and for the symmetry adapted linear combination of atomic orbitals.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Symmetry and Group Theory in Chemistry

Symmetry elements & symmetry operation in molecules, Group and its properties, Schonflies symbol, point groups, reduction formula, Multiplication table, application of point group assignment to molecules, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly)

Unit-II **15 Hrs**

Molecular Symmetry

Matrix representation of symmetry operation, The Great orthogonality theorem (without proof) & its importance, Derivation of character tables (non-degenerate such as C_{2v}, C_{2h}), Mulliken symbols, character tables and their use in spectroscopy, reducible & irreducible representation of groups. Construction of representation using vectors and atomic orbital as basis- symmetry transformation by Cartesian coordinates positioned on the atoms of a molecule.

Unit-III **20 Hrs**

Molecular Vibration

The symmetry of normal vibrations, determining the symmetry types of the normal modes, cartesian coordinate and internal coordinate methods, selection rules for fundamental vibrational transitions (IR and Raman); mutual exclusion principle, illustrative examples.

Unit-IV **10 Hrs**

Construction of hybrid orbitals (H_2O, BF_3, CH_4, $PC1_5$ etc.), and bonding, transformation properties of atomic orbitals, Symmetry species of hybrid orbitals, projection operator and its application in SALCs, Illustrative examples from different geometries, Inorganic/organic reactions: symmetry considerations

REFERENCE BOOKS

1. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edition, John Wiley & Sons, New York, 1999.
2. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi, 1999.
3. A. Vincent, Molecular Symmetry and Group Theory, John Wiley & Sons, 1977.
4. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 2nd Edition, Prentice Hall International Inc., London, 1999.
5. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry , University Press.

Natural Products and Protecting Agents	
Course Code: 25CYMS402	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P: 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To explain about the natural products such as terpenoids, alkaloids and steroids.
- To describe biomolecules including proteins, enzymes, carbohydrates and natural pigments.
- To explain the chemistry of heterocyclic compounds.
- To discuss the applications of protecting groups and their role in organic synthesis.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain natural products, their types and synthesis.
- Describe the chemistry of proteins, enzymes or carbohydrates and their structure determination methods.
- Demonstrate heterocyclic compounds with respect to their structure, synthesis and reactions.
- Lay out the different types of protecting groups used in organic synthesis and their purpose.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **16 Hrs**

Terpenoids: Classification, general method of structure elucidation, chemistry of menthol, camphor, and abietic acid. Biosynthesis of terpenoids-acetate hypothesis, isoprene rule, mevalonic acid and non-mevalonic acid pathways.
Alkaloids: Classification of alkaloids, structure elucidation of morphine, nicotine, and quinine.
Steroids: General introduction on their biosynthesis, structure determination of progesterone, cortisone, and cholesterol.

Unit-II **14 Hrs**

Proteins and enzymes: Structure, conformation and properties of proteins, protein sequence determination methods. Enzyme classification, their kinetics and inhibition mechanism.

Carbohydrates: General introduction and classification, general methods of structure and ring size elucidation, structure determination of maltose, lactose and sucrose.
Natural Pigments: General discussion of carotenoids and flavonoids, structure elucidation and synthesis of flavone, flavonol, chromone, xanthone and porphyrins (chlorophyll).

Unit-III **15Hrs**

Heterocyclic Compounds: General behavior, Classification & Nomenclature, Criteria of aromaticity.
Five membered Heterocycles: Synthesis and reactions of 1, 3-Azoles: Imidazole, Thiazole and Oxazole
Six membered Heterocycles with two heteroatoms: Detailed study of Pyrimidines and Purines. Structural elucidation of uric acid and caffeine.

Unit-IV **15 Hrs**

Ylides: General methods of formation, General study of reactions with their mechanisms of Nitrogen (Ammonium, Immonium, Diazonium), Phosphorous and Sulphurylides and their applications.

Protecting Group Chemistry: Role of Protective groups in organic synthesis, Protection of Hydroxy group (1, 2 and 1,3 diols), Phenols (Esters & ethers), Protection of amino group (carbamates) and Protection of carbonyl group (acetal and ketal).

FURTHER SUGGESTED READINGS

1. R.F. Boerge, Ed. Wilson and Gisvelds, J.B., Text Book of organic medicinal and pharmaceutical chemistry, 12th Edition, Lippincott Co., 2010.
2. J. Mann, R. S. Davidson, Natural Products, their chemistry and biological significance, Prentice Hall, 1994.
3. J. B. Hobbs, D. V. Banthrope and J. B. Harborne, Longmann, Essex, Medicinal Biochemistry, N. V. Bhagavan, Academic Press, Elsevier, 1994.
4. Leland J. Cseke, Ara Kirakosyan, Peter B. Kaufman, Sara Warber, James A. Duke, Harry L. Brielmann, Natural Products from Plants 2nd Edition, CRC Press 2006.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Parts A & B, 5th Edition Springer U.S. 2005.
6. W. Carruthers, Modern Methods of Organic Synthesis, 4th Edition, Cambridge University Press, 2005.
7. Acheson, R. M. Introduction to the Chemistry of Heterocyclic Compounds John Wiley & Sons (1976).
8. I. L. Finar and A. L. Finar, Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, Pearson Education India, 2002.
9. O P Aggarwal, Chemistry of natural products Vol 1 and 2, Krishna Prakashan Media (P) Ltd, 2015.
10. Radha R. Gupta, Mahendra Kumar, V. Gupta, Heterocyclic Chemistry Vol. 1, 2, & 3, Springer, 1998.

Retrosynthesis and Disconnection Approach in Organic Synthesis	
Course Code: 25CYMS403	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Core Course**

COURSE OBJECTIVES:

1. To understand about the basic term in retro analysis.
2. To discuss the strategies involved in disconnection approach for one C-X and two C-X group disconnection.
3. To understand the disconnection approach to develop synthetic approach for synthesizing the organic moiety having alcohol and carbonyl group.
4. To illustrate the disconnection approach in process chemistry.

COURSE OUTCOMES: The syllabus has been prepared in accordance with UGC regulation. After completion of course, students would be able to:

1. Describe the basic term in retro analysis.
2. Explain the strategies involved in disconnection approach for one C-X and two C-X group disconnection.
3. Design a synthetic scheme for synthesis of organic molecules.
4. Apply the concept of retrosynthetic in organic and process chemistry.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**CLO 1**	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENT

Unit I Basic Principles in disconnection approach **15 Hrs**

Basic principle of designing of molecule in synthesis, technical terms in disconnection approach: target molecule (*TM*), synthon, Basic Principles: Synthons and reagents, retrosynthetic analysis of aromatic electrophilic and nucleophilic reaction on the basis of target molecules.

Unit II Strategies involved in disconnection approach I **15 Hrs**

Strategy I: The Order of Events, One-Group C-X Dìsconnections, Strategy II: Chemoselectivity, Two-Group C-X Dìsconnections, Strategy III: Reversal of polarity, cyclisation reactions, Amine synthesis.

Unit III Strategies involved in disconnection approach II **15 Hrs**

Strategy IV: Protecting group, One Group C-C Disconnections I: Alcohols, stereoselectivity, One, Group C-C Disconnections II: Carbonyl compound, regioselectivity, alkene synthesis, Rearrangement in synthesis, photochemistry in synthesis.

Unit IV **15 Hrs**

Two Group disconnection I: Diels Alder Reaction, introduction to carbonyl condensation, Two group disconnection II: 1,3-di functionalized compounds and α, β- unsaturated carbonyl compound, 1,5-difunctionalised compound: Michael addition and Robinson annulation, use of aliphatic nitro compound in synthesis, radical reaction in synthesis, FGA and its reverse, application of disconnection approach in organic process and chemistry.

TEXT BOOKS:

1. M.B. Smith & Jerry March, 2001, March's Advanced Organic Chemistry, 5th Edition, John Wiley & Sons, New York.
2. Stuart Warren, Paul Wyatt, Organic Synthesis the Disconnection Approach 2nd Edition, A John Wiley and Sons, Ltd., Publication, New York.
3. Nina Hall (Editor-in-chief), 2000, The New Chemistry, Cambridge university Press.

FURTHER SUGGESTED READINGS

1. Robert M. Silverstein, Francis X. Webster, Spectrometric Identification of Organic Compounds 6th Edition, Jhon and willey sons, Inc., New York Chichester Weinhein Brisbane Singapore Toronto.
2. D.G. Peters, J.M. Hayes and C.M. Hieftj, 1974, Chemical Separation and Measurements, 2nd Edition, Saunders Holt, London.
3. Mike Lancaster, 2002, Green Chemistry: An Introductory Text, Royal Society of Chemistry.

Chemistry Practical – V	
Course Code: 25CYMS451	Continuous Evaluation: 40
Credits: 2	End Semester Practical Examination:60
L T P : 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To be familiar with the effect on conductance as number of ions increases or decreases.
- To get aware about the optically active compounds.

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Demonstrate the effect on conductance as number of ions increases or decreases.
- Describe light interaction with matter through study of optically active substances.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**	
	CLO 1	**CLO 2**
CO 1		
CO 2		

List of Experiments:

1. To determine saponification value of various oils.
2. To estimate the iodine number.

3. Conductometry

(i) Determination of concentration of salicylic acid by

(a) Salt line method (b) Double alkali method

(ii) Determination of solubility and solubility product of sparingly soluble salt (AgCl, $PbSO_4$)

(iii) Determination of degree of hydrolysis and hydrolysis constant of aniline hydrochloride in aqueous solution.

4. Polarimetry

(i) Determination of percentage composition of optical substances in the given binary mixture (Glucose + Fructose or Tartaric acid)

(ii) Determination of rate constant for hydrolysis/inversion of sugar

REFERENCE BOOKS

1. A.M. James and F.E. Pricherd, Practical Physical Chemistry, 3rd Edition, Longman, 1974.
2. Findlay, B. P. Levitt, Practical Physical Chemistry, Prentice Hall Press, 1973.
3. Viswanathan, P. S. Raghavan, Practical Physical Chemistry, Viva Books, 2015.
4. R.C. Das and B. Behra, Experimental Physical Chemistry, New Delhi Tata McGraw-Hill 1983.
5. J. B. Yadav, Advanced Practical Physical Chemistry, Krishna Prakashan Media (P) Ltd, 2015.

Chemistry Practical – VI	
Course Code: 25CYMS452	Continuous Evaluation: 40
Credits: 2	End Semester Practical Examination: 60
L T P: 0 0 4	**Course Type: Core Course**

COURSE OBJECTIVES (CO):

- To synthesis of nanoparticles via conventional as well as greener method.
- To learn isolation technique for extraction of some important moiety from plant sources.
- To perform multistep synthesis.

COURSE LEARNING OUTCOMES (CLO):

- . The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:
- Demonstrate preparation and characterization of nanoparticles.
- Isolate some important moiety from plant sources.

Synthesize particular compound using multi-step approach.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**		
	CLO 1	**CLO 2**	**CLO 3**
CO 1			
CO 2			
CO 3			

List of Experiments:

1. Bio-Diesel synthesis.
2. Determination of pH of Soil
3. Synthesis of Gold & Silver nanoparticles
4. Greener synthesis of Gold & Silver nanoparticles using tea leaves
5. 1. Isolation
   2. (i) Caffeine from tea leaves
   (ii) Cysteine from human
6. Multi-step synthesis-II (Name of experiments)

REFERENCE BOOKS

1. Lousis F. Fieser, Experiments in Organic Chemistry, 3rd Ed., D.C. Heath, Boston, 1957.
2. D. Pasto, C. Johnson and M. J. Miller, Experiments and Techniques in Organic Chemistry, Pearson. 1991.
3. H. Middleton, Systematic Qualitative Organic Analysis, Edward Arnold, 1939.
4. H. T. Clark, Bernard Haynes, Handbook of Organic Analysis-Qualitative and Quantitative, Hodder Arnold H&S, 1975.

FURTHER SUGGESTED READINGS

1. A.M. James and F.E. Pricherd, Practical Physical Chemistry, 3rd Edition, Longman, 1974.
2. A. Findlay, B. P. Levitt, Practical Physical Chemistry, Prentice Hall Press, 1973.
3. R.C. Das and B. Behra, Experimental Physical Chemistry, New Delhi Tata McGraw-Hill 1983.
4. J. B. Yadav, Advanced Practical Physical Chemistry, Krishna Prakashan Media (P) Ltd, 2015.

GENERIC ELECTIVE COURSE (GE-I & II)

Mathematics for Chemists	
Course Code: 25GECY101	Continuous Evaluation: 40
Credits: 4	End Semester Examination: 60
L T P : 4 0 0	**Course Type: Generic**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To get basic understanding of Vector analysis
- To understand the concept of differential calculus used in chemistry.
- To solve problems related to matrices & determinants in chemistry.
- To be familiar with the concept of integral calculus used in chemistry.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain the basic concepts of Vector analysis
- Apply the concept of differential calculus used in chemistry.
- Solve problems related to matrices & determinants in chemistry.
- Apply the concept of integral calculus used in chemistry.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **10 Hrs**

Vector: Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors.

Unit-II **15 Hrs**

Differential Calculus: Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation. Examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution. Exact and inexact differential with their application to thermodynamic principles.

Unit-III **20 Hrs**

Matrices and Determinants: Definition of matrix, types of matrices, viz. row matrix, column matrix, null & square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication.

Unit-IV

Integral Calculus

Integral theory, basic rules of integration, integration by parts, partial fraction, and substitution.

REFERENCE BOOKS

1. Richard Bronson, Differential equation, Schaum series, 3rd Edition, Tata McGraw Hill, 2010
2. Erwin Kreyszig, Advanced Engg. Mathematics, 10th Edition, John Wiley & sons, 2010
3. Dominic Jordan and Peter Smith, Mathematical Techniques, 3rd Edition, Oxford University Press, 2002.
4. Peter Tebbutt, Basic Mathematics for Chemists, 2nd edition, Wiley, 1978.

Computer for Chemists	
Course Code: 25GECY102	Continuous Evaluation: 40
Credits: 4	End Semester Examination: 60
L T P : 4 0 0	**Course Type: Generic**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To study the basic concepts of Python programming along with its installation
- To make students familiar with text files and data processing.
- To use software for drawing various reaction mechanisms &perform theoretical calculations.
- To use software for performing molecular docking.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain the basic knowledge of Python like data types &implementing conditional loops with the help of few examples.
- Apply basic operators on the text file using python fundamentals and implementing few Machine learning algorithms.
- Illustrate reaction mechanism along with theoretical calculations.
- Perform molecular docking.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **15 Hrs**

Hardware & Software, Classification of Computer Systems, Number systems, Operating System, Algorithms, Types of Algorithms, Introduction to Python, Python Installation and Working of it, concept of data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages. Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while).

Unit-II **15 Hrs**

Manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab separated), converting strings to numbers, Recursive functions, Classes, objects, attributes and methods; defining classes; design with classes, data modelling; persistent storage of objects, Inheritance, polymorphism, operator overloading; Introduction of Machine Learning algorithms and its implementation using Python.

Unit-III **15 Hrs**

Chem Office: Structure of molecules & chemical reactions (single step, two step & multistep) using Chemdraw/Chemsketch.

Basic idea of molecular modeling using software like Avogadro/Games Software for geometry optimization and potential energy surface (local and global minima).

Unit-IV **15 Hrs**

Molecular Docking: Introduction to Molecular Docking, its importance in drug design, Structure activity relationship, protein preparation, Ligand preparation, protein-ligand interaction by autodock & autodock-vina & result analysis by Discovery Studio.

FURTHER SUGGESTED READINGS

1. Charles R. Severance, Python for everybody: Exploring data using python 3, Amazon digital service, 2016.
2. Paul Barry, Head first Python: A brain friendly guide, 2nd Edition, Shroff/O'Reilly, 2010.
3. A.C. Norris, Computational Chemistry – An Introduction To Numerical Methods, Wiley–Blackwell 1981.

Software: https://colab.research.google.com/notebooks/

Biology for Chemists	
Course Code: 25GECY201	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Generic**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To have the basic knowledge about Cell Structure and Metabolism
- To be familiar with carbohydrates & lipids as well their functioning in biological systems.
- To understand the structures of proteins as well their functioning in biological systems
- To get knowledge about nucleic acids & their role.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain the structure and function of cells and metabolic process inside the body.
- Analyze the structure and function of carbohydrates & lipids.
- Describe the structure of proteins as well their functioning in biological systems.
- Investigate the structure and function of nucleic acids and genetic information.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I

Cell Structure and Metabolism **15 Hrs**

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes – catabolism and anabolism. ATP – the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle.

Unit-II

Carbohydrates **20 Hrs**

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides – cellulose and chitin. Storage polysaccharides – starch and glycogen.

Lipids

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, cholesterol, bile acids, prostaglandins. Lipoproteins – composition and function. Properties of lipid

aggregates-micelles, bilayers, liposomes and their possible biological functions. Lipid metabolism oxidation of fatty acids

Unit-III

Proteins **10 Hrs**

Secondary structure of proteins, forces responsible for holding of secondary structures. A-helix, β-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure.

Unit-IV

Nucleic Acids and Genetic Code **15 Hrs**

Structure of nucleotides, nucleosides, DNA (Watson – Crick Model) RNA structure and conformation, Replication of DNA, transcription, translation of genetic material, genetic code,

Universality of the code, codon, anticodon pairing, RNA, protein biosynthesis (initiation, elongation, termination and processing of the peptide chain)

FURTHER SUGGESTED READINGS

1. David L Nelson, Lehninger Principles of Biochemistry, 7th edition, W H Freeman & Co, 2017.
2. Jeremy Berg, John L. Tymoczko, Lubert Stryer, Biochemistry, 6th edition, W. H. Freeman, 2016.
3. David J. Rawn, Biochemistry, Neil Patterson pub, 1989.
4. Biochemistry, Donald Voet and Judith G. Voet, 4th edition, John Wiley & Sons, Inc., 2010.
5. E. E.Conn and P. K. Stumpf, Outlines of Biochemistry, John Wiley & Sons, Inc., 1976.

Intellectual Property Rights (IPR)	
Course Code: 25GECY202	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: Generic**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To know historical development of IPR, WIPO and their relevancy at the time of globalization.
- To be familiar with various IP's such as trademarks, Industrial Designs, patents & their respective case studies.
- To get to know about various IP's such as copy rights, Geographical Indications, trade secret & their respective case studies.
- To understand the various Different International agreements & the value of various IP's.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the theoretical concepts of evolution of Intellectual Property Laws, and to differentiate between the different kinds of IP.
- Explain the basic knowledge of trademarks, Industrial Designs, patents & know the role of government through case studies.
- Explain the basic knowledge of copy rights, Geographical Indications, trade secret & know the role of government through case studies.
- Describe the various Different International agreements & the value of various IP's.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **10 Hrs**

Introduction to Intellectual Property

Historical Perspective, Different Types of IP, Importance of protecting IP, WIPO.

Unit-II **20 Hrs**

Patents: Historical Perspective, Basic and associated right, how to write &file a patent, PCT system, difference between Indian and US patent, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Industrial Designs: Definition, features, international design registration. Layout design of integrated circuits Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Note: knowledge regarding the role of governments through case studies should be discussed

Unit-III **15 Hrs**

Copyrights: Introduction, How to obtain, Differences from Patents.

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Unit-IV **15 Hrs**

Different International agreements: (a) Word Trade Organization (WTO): (i)General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii)General Agreement on Trade related Services (GATS) (iii)Madrid Protocol (iv)Berne Convention (v)Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IP Infringement issue and enforcement – Role of Judiciary, cyber laws, plagiarism, Role of law enforcement agencies –Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Note: knowledge regarding the role of governments through case studies should be discussed

FURTHER SUGGESTED READINGS

1. N. K. Acharya, Textbook on intellectual property rights, 6th edition, Asia Law House, 2012.
2. Manjula Guru, M.B. Rao. Understanding Trips: Managing Knowledge in Developing Countries. SAGE Publications Pvt. Ltd 2003.
3. Prabuddha Ganguli. Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw Hill, 2001.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)

Green Chemistry	
Course Code: 25CYMS305	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To understand about the impact of research on environment.
- To discuss the latest ways by which we can reduce the pollution in the environment.
- To be familiar with the very recent area of research i.e. Green Chemistry and its role in solving the environmental problems.
- To be familiar with the future trends in green chemistry.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Describe the stoichiometric calculations and relate them to green chemistry metrics. Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources.
- Explain to design safer chemical, products and processes that are less toxic, than current alternatives.
- Describe the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems.
- Illustrate the future trends in green chemistry.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**CLO 1**	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit I

Introduction to Green Chemistry **10 Hrs**

Need for Green Chemistry, Goals of Green Chemistry, Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Unit II **20 Hrs**

Twelve principles of Green Chemistry with their explanations and special emphasis on the following with examples:

Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy**.** Prevention/ minimization of hazardous/ toxic products reducing toxicity risk. Green solvents– super critical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness

of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy, Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

Use of catalytic reagents in green chemistry, comparison of heterogeneous and homogeneous catalysis, bio catalysis, asymmetric catalysis and photo catalysis. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD, greener alternative to Bhopal Gas Tragedy, subdivision of ISD, minimization, simplification, substitution, moderation and limitation.

Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical process.

Unit -III **20 Hrs**

Examples of Green Synthesis/ Reactions and some real-world cases: Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)

Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction

Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.

Right fit pigment: synthetic azo pigments to replace toxic organic and inorganic pigments.

An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils.

Unit –IV **10 Hrs**

Future Trends in Green Chemistry: Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development.

REFERENCES

1. V. K. Ahluwalia, and M. R. Kidwai, New Trends in Green Chemistry, Anamalaya Publishers, 2005.
2. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, 2001
3. M. C. Cann, and M. E. Connely, Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000.
4. M. A. Ryan, and M. Tinnesand, Introduction to Green Chemistry, American Chemical Society Washington, 2002.
5. R. K. Sharma

FURTHER SUGGESTED READINGS

1. M. Lancaster, Green Chemistry an Introductory Text, 2nd Ed., RSC Publishing, 2010.
2. M. Fieser, Reagents in Organic Synthesis, Fieser and Fieser's Reagents for Organic Synthesis, Volume 1, Wiley-Interscience, 1967.
3. O. P. Agarwal, Reaction & Rearrangements, Krishna Prakashan Media (P) Ltd, 1975.

Analytical Chemistry	
Course Code: 25CYMS306	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To be familiar with the sampling procedure and methods for the analysis of data.
- To understand the principle, instrumentations and applications of optical methods of analysis.
- To understand the concepts and instrumentation of thermal and electroanalytical methods.
- To develop the understanding of separation techniques like – solvent extraction and chromatography.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Demonstrate proper sampling procedure and data analysis.
- Apply optical method to analyze the samples.
- Explain and analyze the electroanalytical and thermal analysis.
- Select the proper methods of solvent extraction and chromatography.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**CLO 1**	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **10 Hrs**

Sampling; types, methods and steps, evaluation of analytical data, errors; systematic and random, accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit-II **18 Hrs**

Electron Microscopy: Introduction to Electron microscopy (SEM, TEM, EDX,) – Working principle and electron matter interaction

X-ray diffraction- Generation and characteristics of x-ray, Lattice planes and Bragg's law, Theory of diffraction, determination of particle size and micro/macro strains, reciprocal lattice.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit-III **16 Hrs**

Thermal methods of analysis: Theory of thermogravimetry (TG); types, Basic principle of instrumentation of TGA and DSC. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods: Classification of electro analytical methods, Cyclic Voltammetry: Cathodic and Anodic Processes, Current-Voltage characteristics, Randles-Sevcik equation, Fundamentals of Differential Pulse Voltammetry and Square wave voltammetry, Applications of voltammetry.

Unit-IV **16 Hrs**

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.

REFERENCE BOOKS

1. Arthur I Vogel,: A Text book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman 1978.
2. Hobart H. Willard et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Gary D. Christian,; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Daniel C. Harris,: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. S. M. Khopkar, Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

FURTHER SUGGESTED READINGS

1. R. V. Dilts, Analytical Chemistry – Methods of separation, Van Nostrand 1974.
2. D. A. Skoog, F. J. Holler, and T. A. Nieman, Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore, 1998.

Pharmaceutical Chemistry	
Course Code: 25CYMS307	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To understand the principles of drug action, its synthesis & application
- To develop various classes of antibiotics & their mode of action
- To understand the basic knowledge of Prostaglandins, Antipyretic-& analgesics
- To understand the mode of action of antihypertensive & Contraceptive agents.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Illustrate drug design, discovery and mode of action.
- Describe various classes of antibiotics & their mode of action.
- Explain functioning of Prostaglandins, Antipyretic-& analgesics.
- Discuss the mode of action of antihypertensive & Contraceptive agents.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**CLO 1**	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I 15 Hrs

General mode of action, Medicinal Uses and Synthesis of Important Drugs in Following Categories.

Antineoplastic Agents

Metastasis, classification, mode of action of alkylating agents (synthesis of mephalan, thiotepa, busulfan, lomustine) and antimetabolites (synthesis of methotrexate, 5-fluorouracil, 6-mercaptopurine), hormone- based therapies, plant products, radio-therapeutic agents.

Antiviral agents: RNA and DNA viruses, an introduction to AIDS, how HIV infects the system, mode of action of nucleoside reverse transcriptase inhibitors- AZT, DDI, DDC, and non-nucleoside reverse transcriptase inhibitors-NEVIRAPINE, HIV-protease, inhibitors-Ritonavir (RTV).

Antimalarials: Structure and Functions of: Cinchona alkaloids, 4-aminoquinolines, 8-aminoquinolines, Mefloquine, 9-aminoacridines. Synthesis of Metaquine, chloroquine, primaquin.

Unit-II 15Hrs

Antibiotics: Historical backgrounds of antibiotic discovery

β-Lactam antibiotics: Penicillin, Cepholosporins, β- Lactamase inhibitors, Monobactams

Aminoglycosides: Streptomycin, Neomycin, Kanamycin

Tetracyclines: Tetracycline, Oxytetracycline, Chlortetracycline, Minocycline, Doxycycline Macrolides- mode of action, Erythromycin, erythromycin, azithromycin;
Recent advancement in the field of antibiotics

Unit-III 15Hrs

Prostaglandins: General Introduction about Prostaglandins, Non-Steroidal anti-inflammatory agents: Classification, mode of action, COX-2 inhibitors, salol principle. Synthesis of aspirin, phenbutazone, mefanamic acid, indomethacin, piroxicam, diclofenac, Naproxen

Antipyretic-Analgesics: Opoid antagonists and agonists-codeine and heroin, synthesis of meperidine, methadone, dextropropoxyphen.

Unit-IV 15Hrs

Antihypertensive agents: Classification, Hypertension, Renin-Angiotensin system, mode of action, Calcium channel blockers, ACE inhibitors, centrally acting adrenergic drugs, peripherallyacting sympatholytics- Synthesis of atenolol, clonidine, methyldopa, guanabenz, diltiazem, captopril, enalapril.

Contraceptive agents: Ovulation inhibitors and related hormonal contraceptives- norethindrone, norethynodrel, estradiol and mestranol.

REFERENCE BOOKS

1. R.F. Boerge, Ed. Wilson and Gisvelds, J.B., Text Book of organic medicinal and pharmaceutical chemistry, 12th Edition, Lippincott Co., 2010.
2. Donald J. Abraham (Editor), David P. Rotella, Burger's Medicinal Chemistry and Drug Discovery Vol-I, Wiley, 2010.
3. Laurence Brunton (Author), Bjorn Knollmann, Goodman and Gilman's Pharmacological Basis of Therapeutics, 13th Ed, McGraw-Hill, 2017.
4. I. L. Finar and A. L. Finar, Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, Pearson Education India, 2002.

Polymer Science & Medicinal Chemistry	
Course Code: 21CYMS404	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**
Prerequisite:	

COURSE OBJECTIVES (CO):

- To get to know about polymers
- To understand the basic concept of inorganic polymers & their uses.
- To know about the various concepts of medicinal chemistry
- To be familiar with historical development of drugs.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Explain the organic and inorganic polymers and properties and their applications.
- Describe inorganic polymers & their uses.
- Identify basic concept regarding development of drugs and drugs work inside the body.
- Explain about the historical development of drugs.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **12 Hrs**

Terminologies-Functionality, Degree of Polymerization, Glass Transition Temperature, Classification of polymer, Molecular Weight of Polymer (Mw, Mn), Polymerization- Addition (ionic, free-radical), Co- ordination (Ziegler-Natta), Plastics- PE, Polystyrene, PVC, Teflon, PAN, PMMA, PVA, Polyesters- Polyethylene Terephthalate (PET), Epoxy Resins, Polyamide (Nylon-66, Nylon-6), Phenolic Resins (Bakelite), Amino Resins (Urea-Formaldehyde), Elastomer-Synthetic Rubber, Silicon Rubber, Molding of plastics-Compression, Injection, Extrusion.

Unit-II

Inorganic polymers **14 Hrs**

Silicones, conducting polymers- Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Molecular weight of polymers and its determination, effect of temperature and pressure on chain polymerization,

criteria for polymer solubility; polydispersity index, Biopolymers and their applications.

Unit-III

Medicinal Chemistry **18 Hrs**

Concept and definition of Pharmacophore. Pharmacodynamics and Pharmacokinetics. Drug targets: enzymes and receptors. Competitive, non-competitive and allosteric inhibitors, transition-state analogs and suicide substrates. Nucleic

acids as drug targets: reversible DNA binding agents, DNA alkylating agents and DNA strand breakers. ADMET of drugs: Factors affecting Absorption, Distribution, Metabolism, Elimination and Toxicity.

Unit-IV

History of medicinal chemistry **16 Hrs**

Drug discovery, development, design and delivery system. Receptor structure and sites. Gene therapy (antisense & anti-gene strategies) and drug resistance. General introduction to antibiotics. Neurotransmitters, class of neurotransmitters. Anti-histamines, anti-inflammatory, anti-analgesics, anti- cancer and anti-hypertensive drugs.

REFERENCE BOOKS

1. Principles of Polymerisation by George Odian, Willey, 3rd edition.
2. Polymer Characterization, Physical Techniques by D. Campbell and J.R. White, Champman and Hall.
3. Text book of Polymer Science, F.W. Billmeyer, Willey, 3rd edition.
4. Plastic material by J.A. Brydson, Butterworth- Heinemann, 7th edition.
5. Polymer: Polymer Characterization and Analysis by Jaquieline I Kroschwitz. Wiley Interscience.
6. Spectrometric Identification of Organic Compounds by R.M. Silverstein and F.X. Webster, Wiley Interscience.

FURTHER SUGGESTED READINGS

1. Costas G. Gogos, Zehev Tadmor, Principles of Polymer Processing, Wiley-Interscience, 2006.
2. Michael E. Brown, Introduction to Thermal Analysis, 2nd Ed., Springer, 2001.
3. Gringauz, A. Introduction to Medicinal Chemistry: How Drugs Act and Why? John Wiley & Sons, 1997.
4. Patrick, G. L. Introduction to Medicinal Chemistry Oxford University Press 2001.
5. Chiellini, E., Sunamoto, J., Migliaresi, C., Ottenbrite, R.M., Cohn, D., Biomedical Polymers and Polymer Therapeutics, Springer, 2002.

Solid State & Nuclear Chemistry	
Course Code: 25CYMS405	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**

COURSE OBJECTIVES (CO):

- To get to know fundamentals of nuclear chemistry.
- To understand the lattice structures of solids and their properties.
- To understand the different characterization techniques of solids.
- To be familiar with the methods of synthesis of solids.

COURSE LEARNING OUTCOMES (CLO):

. The syllabus has been prepared in accordance with UGC regulations. After completion of course, students would be able to:

- Illustrate the basic concept of Nuclear Chemistry and their applications.
- Explain the internal structures and properties of solid materials.
- Apply X-Ray diffraction techniques in the characterization of materials.
- Demonstrate different methods of synthesis of solid materials.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I

Nuclear Chemistry **16 Hrs**

Fundamentals of radioactivity and decay, Radioactive decay, decay kinetics, parent daughter decay growth relationship, concepts of transient and secular equilibrium, alpha, beta and gamma decay, artificial radioactivity. preparation of radioisotopes for tracers, measurements by gas filled, scintillation detectors and semiconductor reactors.

Unit-II

Applications of Nuclear Chemistry **14 Hrs**

Radiometric titration, neutron activation analysis (NAA), Isotope Dilution Method, Uses of Nuclear Radiations, Typical applications of radioisotopes as tracers (Chemical Investigation, Physiochemical Application, Age Determination, Medical Applications)

Unit-II **16 Hrs**

Solid State: Introduction, Unit cell, Space lattice, Crystal, packing in solids, Crystal structures of representative systems, Structural classification of binary (AX, AX_2, etc.) and ternary (ABX, ABX_2, ABX_3, AB_2X_4, etc.), Defects, Point defects, Line defects,

Electronic properties and Band theory of solids, electronic properties and Band theory of solids. Free electron model, Metals, semiconductors and insulators, doped semiconductors, electronic structure of solids. Electrical conductivity,

mobility, thermal conductivity, and specific heat of solids. Magnetic properties of solids, magnetization and susceptibility.

Unit-III **14 Hrs**

Characterization of Solids: Powder X-ray diffraction – Bragg's peak, absences, indexing of simple systems. Techniques (working knowledge) for X-ray diffraction, Electron microscopy (SEM, TEM, AFM), Thermal techniques (TG, DTA, DSC), Physical property measurement techniques (Magnetic moments- VSM /SQUID, Electrical Resistivity-Two/Four probe methods and thermal conductivity, Optical band gap, XPES, XAS).

REFERENCE BOOKS

1. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (1995), Wiely-Eastern Ltd.,
2. R. West, Solid state chemistry and its applications, John Wiley & Sons, 1989.
3. L. Smart and E. Moore, Solid state chemistry, Chapman and Hall, 1992.
4. K. Cheetham and P. Day, Solid state chemistry compounds, Clarendon Press, Oxford 1992.
5. N. R. Rao and J. Gopalkrishanan, New directions in solid state chemistry, Cambridge Univ. Press 1997.
6. R. E. Newnham, Structure property relations, Springer-Verlag, 1975.
7. P. A. Cox, Electronic structure and chemistry of solids, Oxford Univ. Press 1987.

FURTHER SUGGESTED READINGS

1. Friedlander, G. Kennedy, J. W., Marcus, E. S. & Miller, J. M. Nuclear & Radiochemistry, John Wiley
2. & Sons (1981).
3. Campbell and J. R. White, Polymer characterization: physical techniques, Champman and Hall, 1989
4. Fred W. Billmeyer, Text book of Polymer Science, 3rd edition, Wiley-Interscience, 1984
5. J.A. Brydson, Plastic material, 7th edition, Butterworth- Heinemann, 1999.

Chemistry in Industry & Environment	
Course Code: 25CYMS406	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	**Course Type: DSE**

COURSE OBJECTIVES (CO):

- To understand the fundamentals of Industrial Chemistry.
- To impart the knowledge about the advantages of Green Chemistry.
- To be familiar with various perfume formulations & their synthesis used in perfumery industry.
- To acquire knowledge about processes that are used in milk & alcohol Industry

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Identify toxicity hazards of toxic gases, safe design systems for large scale production of industrial gases, manufacturing processes handling and storage of inorganic chemicals.
- Explain the hazardous effects of the inorganic chemicals on human beings and vegetation &the advantages of Green Chemistry over conventional methods.
- Describe about various perfume formulations & their synthesis used in perfumery industry.
- Demonstrate the processes that are used in milk & alcohol Industry.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Course Objectives (COs)	**Course Learning Outcomes (CLOs)**			
	CLO 1	**CLO 2**	**CLO 3**	**CLO 4**
CO 1				
CO 2				
CO 3				
CO 4				

COURSE CONTENTS

Unit-I **20 Hrs**

Industrial Chemistry

Industrial Gases and its impact in the industry and atmosphere. Petrochemicals and downstream products. Basic concepts of environmental chemistry, current trends in ecology and pollution. Chemical treatment of pollutants including CFC and PCBs. Concept of pH & buffer systems in the light of environmental aspects of chemistry.

Management of carbonate, and hydrogen systems. Ozone layer depletion, global warming, acid rain and greenhouse effect, radiation hazard and noise pollution. Selected topics from current literature. Chemicals used in warfare, biological weapons.

Unit-II
Green Chemistry **20 Hrs**

Principles of Green Chemistry, Concept of atom economy, Tools of Green Chemistry: Alternative feedstocks/starting materials, Reagents, Solvents, Product/target molecules, Catalysis and process analytical chemistry. Evaluation of chemical product or process for its effect on human health and environment, Evaluation of reaction types and methods to design safer chemicals. Evaluating the effects of Chemistry: Toxicity to humans, Toxicity to wildlife, Effects on local environment, Global environmental effects. Planning a green synthesis.

Unit-III **10 Hrs**
Perfumery

Constitution of perfumes, odorous substances, extraction of perfumes and plants, synthesis of important synthetic chemicals used in perfumery industry esters, phenylethyl alcohol, citronellol, linalool, coumarin, vanillin, haliotropin, perfume formulation.

Unit-IV **10 Hrs**
Milk industry

Chemical composition of milk, processing of milk, types of milk, manufacture of cream, butter, ghee, casein, infant milk food, malted milk food, cheese, fermented milk products.

Alcohol industry

Manufacture of absolute alcohol, beer, wine, distilled spirit, butyl alcohol, citric acid, lactic acid, and oxalic acid.

FURTHER SUGGESTED READINGS

1. V. K. Ahluwalia, and M. R. Kidwai, New Trends in Green Chemistry, Anamalaya Publishers, 2005.
2. A. S. Matlack, Introduction to Green Chemistry, Marcel Dekker, 2001.
3. M. C. Cann, and M. E. Connely, Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000.
4. M. A. Ryan, and M. Tinnes and, Introduction to Green Chemistry, American Chemical Society Washington, 2002.
5. M. Lancaster, Green Chemistry an Introductory Text, 2nd Ed., RSC Publishing, 2010.
6. S. Singh, Dairy Technology: Dairy Products and Quality Assurance Volume 2 of Dairy technology, Zaccheus Entertainment, 2014.

For practical courses number and nature of experiments can vary as per the availability of facilities