Koneru Lakshmaiah Education Foundation
(Category -1, Deemed to be University estd. u/s. 3 of the UGC Act, 1956)
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DEPARTMENT OF CHEMISTRY

M. Sc SYLLABUS

M. Sc CHEMISTRY

2025-27

SYLLABUS OF COURSES UNDER

AUDIT COURSES

PROFESSIONAL COMMUNICATION SKILLS (PCS)

Course Code	25UC5201	Mode	General	LTPS	0-0-4-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To develop and demonstrate principles of listening, speaking, reading, and writing in various functional contexts	3	5, 6
CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.	3	5, 6
CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic, Algebra & Geometry to improve problem solving ability.	3	5, 6
CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3	5, 6

Syllabus

Module 1	A) Vocabulary: Synonyms, Antonyms and One-word substitutes, (B)Reading comprehension, Critical reading, (C) Writing skills: Email writing, report writing and paragraph writing (D) Listening/Speaking Skills: listen & speak, Functional grammar
Module 2	(A)Personal Skills: Intra & Interpersonal skills (B) Assertiveness (C) Group Discussion (D) Resume writing (E) Video resumes (F) Interview skills
Module 3	Simple Equations, Ratio & Partnership, Averages, Percentages, Profit & Loss, Simple & Compound Interest, Numbers, Quadratic Equations & Inequalities, Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability, Mensuration, Data Interpretation.
Module 4	Syllogism, Logical Venn Diagrams, Cubes & Dice, Number& letter series, Number, letter & word Analogy, Odd Man Out, Coding & Decoding, Blood Relations, Directions, clocks, calendars, Number, ranking & Time sequence test, Seating Arrangements, Data Sufficiency.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	The Business Student's Handbook: Skills for Study and Employment	Fisher, Julie and Bailey, Peter	Cengage Learning	2017
2	The Complete Guide to mastering soft skills for workplace success	Adams, John	Adams media	2019
3	Writing Tools: 55 Essential Strategies for Every Writer	Roy Peter Clark	Little, Brown, and Company	2006
4	Quantitative Aptitude	R. S. Agarwal	SCHAND	2017
5	A Modern Approach to Verbal Reasoning	R. S. Agarwal	SCHAND	2018

SYLLABUS OF COURSES UNDER

PROFESSIONAL CORE

SYMMETRY AND MOLECULAR SPECTROSCOPY (SMS)

Course Code	25CY5101	Mode	General	LTPS	2-1-0-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the principles of symmetry operations and group theory to determine point groups, construct character tables, and analyze molecular vibrations relevant to IR and Raman spectroscopy.	3	1, 2
CO2	Apply the fundamental principles of spectroscopic techniques to interpret spectral data and determine structural information of molecules using UV, IR, NMR, and MS.	3	1, 4
CO3	Apply the principles of microwave, photoelectron, and ESR spectroscopy to analyze molecular structure, electronic configurations, and magnetic properties of simple molecules.	3	1, 5
CO4	Apply the principles of Raman, Mössbauer, X-ray diffraction, and laser spectroscopy to interpret spectral data and investigate structural, electronic, and magnetic properties of materials.	3	1, 5

Syllabus

Module 1	Symmetry and Group Theory in Chemistry*:* Symmetry and Group theory in Chemistry: Symmetry elements & operations, group, subgroup, Understanding Character Tables of Symmetry Groups, relation between order of a finite group and its subgroup. Point group of symmetry. Schon files symbols, representation of groups by Matrices (representation for Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitly). **Sub-group, classes and similarity transformation and conjugates. Abelian and non-abelian groups, Representation of groups: Reducible and non-reducible groups,** The great orthogonality theorem (without proof) and **construction of character table for C2v and C3v.** Character tables and their use, Application of group theory in IR and Raman spectroscopy
Module 2	Spectroscopic methods: Introduction to spectroscopic methods (UV, IR, NMR, MS) -Electromagnetic spectrum, Classification based on absorption-Emission-Importance- Characterization of electromagnetic radiation -Beer-Lambert's law-deviations from Beers Law, Franck-Condon principle. Dispersive spectrometers, Fourier Transform spectrometers, Signal to Noise Ratio, how spectra are obtained.
Module 3	Microwave spectroscopy, Photoelectron Spectroscopy: The motion of molecules-Degrees of freedom -Energy associated with the degrees of freedom Type of spectra-Microwave spectroscopy. –Principle-Classification molecules, rigid rotator model, -Microwave spectra of diatomic molecules and polyatomic molecules. Photoelectron Spectroscopy: Basic principles, Koopman’s theorem. Photoelectron spectra of simple molecules, Electron spin chemical analysis (ESCA), Auger electron spectroscopy.

	Electron Spin Resonance (ESR)-Spectroscopy- Theory-ESR lines and intensity-g-values -factors affecting the ESR lines- Zero field splitting and Kramer's degeneracy. Applications of ESR
Module 4	Raman spectroscopy: Principle-Classical and quantum theories of Anharmonic perturbation, Raman effects, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS)-Application. Mossbauer Spectroscopy: Principle- Isomer Shifts – Quadrupole splitting and Magnetic hyperfine splitting – Selection Rules. Applications- X-ray Diffraction-Introduction-principle-Braggs law-Scherrer Formula-Applications. Laser spectroscopy- General principles of laser spectroscopy, features of lasers and population inversion. Examples of some common lasers –solid state, gas and dye lasers.

Textbooks:

S. No	Title	Author(s)	Publisher	Year
1	Organic Spectroscopy	W. Kemp	MacMillan	1994
2	Modern Spectroscopy	J. Michael Hollas	Wiley	2013
3	Atomic and molecular Spectroscopy	S. Svanberg	Springer	2003
4	Basic atomic and molecular Spectroscopy	J. Micheal Hollas	Royal Society of Chemistry	2002
5	Introduction to Molecular Spectroscopy	G.M. Barrow	McGraw Hill, New York	1964
6	Fundamentals of Molecular spectroscopy	C. N. Banwell	McGraw Hill, New York	2000
7	Spectroscopy	B.P. Straughan and S. Walker	Chapman Hall, London	1976
8	Introduction to Photoelectron Spectroscopy	P.K.Ghosh	John Wiley New York	1989

CHEMICAL BONDING AND COORDINATION CHEMISTRY (CBCC)

Course Code	25CY5102	Mode	General	LTPS	3-0-4-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply bonding models to determine molecular shapes and geometries of simple molecules.	3	1, 2, 5
CO2	Use chemical concepts to explain the structure, bonding, and reactivity of boron cluster compounds.	3	1, 2
CO3	Apply bonding theories to describe the structure, reactivity, and uses of coordination complexes.	3	1, 2, 3
CO4	Use spectral and magnetic data to explain the color and analytical properties of transition metal complexes.	3	1, 2
CO5	Analyze synthesis and characterization data to interpret the properties of inorganic compounds and evaluate results using scientific guidelines.	4	1, 2, 3

Syllabus

Module 1	**Structure & Bonding**: Shapes of molecules (VSEPR Theory, Bent's rule), Valence Bond Theory, Molecular Orbital Theory in explaining the structures of simple molecules [homonuclear diatomic (H_2, H_2^+, He_2, He_2^{2+}, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2), heteronuclear diatomic (HF, CO).
Module 2	**Structure and bonding in boron clusters**: Preparation, structure and reactions of boranes, carboranes, metallocarbene's, boron–nitrogen ($H_3B_3N_3H_3$), Electron counting in boranes–Wades rules (Polyhedral skeletal electron pair theory).
Module 3	**Chemistry of transition metal compounds**: Limitations of VBT, Crystal field theory - crystal field splitting patterns in octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies, Spectrochemical series, Jahn – Teller effect.
Module 4	**Electronic spectra of transition metal complexes**: Term symbols – Russell – Sander's coupling – derivation of term symbols for various configurations. Spectroscopic ground states. Selection rules, break-down of selection rules. Orgel and Tanabe-Sugano diagrams for d1 – d9 octahedral and tetrahedral transition metal complexes of 3d series – Calculation of Dq, B and β parameters.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	IV Edition, John Wiley and Sons, New York,	1980
2	Inorganic Chemistry	J.E. Huheey	III Edition, Harper International Edition,	1983
3	Theoretical Inorganic Chemistry	M.C. Day and J. Selbin	Affiliated East-West press Pvt. Ltd., New Delhi.	1997
4	Inorganic Chemistry	Shriver and Atkins	Oxford University Press,	2010
5	Concise Inorganic Chemistry	J. D. Lee	Oxford University Press; Fifth edition, Wiley India edition.	2008

STRUCTURAL ORGANIC & STEREO CHEMISTRY (SOSC)

Course Code	25CY5103	Mode	General	LTPS	3-0-4-0	Pre-Requisite	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply principles of aromaticity and reaction mechanisms to predict products and explain the selectivity and orientation in aromatic substitution reactions.	3	1, 2
CO2	Use knowledge of reactive intermediates and retrosynthetic analysis to design organic synthesis pathways and apply functional group transformations.	3	1, 2
CO3	Apply mechanistic and kinetic principles to interpret reaction outcomes and control factors like thermodynamic and kinetic stability.	3	1, 2
CO4	Use stereochemical concepts and conformational analysis to analyze chiral molecules and predict their behaviour in supramolecular and nano systems.	3	1, 2, 3
CO5	Analyze the composition of a binary mixture and select appropriate synthetic routes for preparation of organic molecules.	4	1, 2, 3

Syllabus

Module 1	**Aromaticity and Aromatic electrophilic substitution** Basic definition of aromaticity, Huckels rule, intermediates and orientation, electrophiles, reactivity and selectivity, kinetic isotopic effects, Nitration, halogenation, sulfonation, Friedel Crafts reaction, protonation, Nucleophilic aromatic substitution.
Module 2	**Reactive Intermediates:** Carbenes, Nitrenes, Radicals, Carbo-cations, ylides, benzyne; Substitution and Elimination reactions; Acid and base concept of organic compounds; Ideal synthesis; fundamentals of retrosynthesis; Functional **group transformations, umpolung and protecting groups.**
Module 3	**Reaction mechanisms:** Definition of reaction mechanism, transition state theory, Substituent effects, linear free energy relationships, Hammett equation and related modifications. Basic mechanistic concepts like kinetic vs thermodynamic control, Hammond postulate, Curtin-Hammett principle, isotope effects; Oxidation and Reduction reactions, Chemistry of cyclic and acyclic compounds.
Module 4	**Stereochemistry:** Introduction, optical isomerism and chirality, resolution, conformational analysis, stereo electronic effect, and stereochemical aspects. **Organic molecules in supramolecular and nano systems.**

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Organic chemistry	Clayden J, Greeves N, Warren S. T. Pradeep,	Oxford university press	2012
2	advanced organic chemistry: reactions, mechanisms, and structure	Smith MB. March's Wang, X.; Bashir, S.; Liu, J.	John Wiley & Sons	2020
3	Advanced organic chemistry: part A: structure and mechanisms	Carey FA, Sundberg RJ	Springer Science & Business Media	2007
4	Organic reactions stereochemistry and mechanism	Kalsi PS.	New Age International	2007
5	Structure and Mechanism in Organic Chemistry	C. K. Inglod,	Cornell University Press.	1953

MOLECULAR THERMODYNAMICS & CHEMICAL KINETICS (MTCK)

Course Code	25CY5104	Mode	General	LTPS	3-0-4-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the laws and concepts of classical thermodynamics to solve problems in chemical systems.	3	1, 2
CO2	Use the properties of surfactants and macromolecules to explain their applications in chemical and biological systems.	3	1, 3
CO3	Apply rate laws and kinetic principles to interpret chemical reaction rates and mechanisms.	3	1, 5
CO4	Use concepts of photochemistry and luminescence to explain excited-state processes in chemical systems.	3	1,3
CO5	Analyze experimental data and processes to develop practical skills for solving problems in industrial applications.	4	1, 2, 5

Syllabus

Module 1	**Thermodynamics:** Chemical equilibrium- effect of temperature on equilibrium constant-Van't Hoff equation. Partial molar quantity- different methods of determination of partial molar quantity. Chemical potential- Phase rule and its derivation, Gibbs-Duhem equation, Duhem- Margules equation, Classius-Clapeyron equation. Third law of thermodynamics- Determination of the absolute entropy- Apparent exceptions to Third law of thermodynamics.
Module 2	**Micelles and Macromolecules**: Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization- micro emulsion, reverse micelles. ***Polymers***-Definition, types of polymers, electrically conducting, kinetics of polymerization. Molecular mass- Number and mass average molecular mass, molecular mass determination- Osmometry, viscometry, calculation of average dimensions of various structures.
Module 3	**Chemical Kinetics**: Theories of reaction rates- Collision theory- Limitations, Transition state theory. Effect of ionic strength-Primary and secondary salt effects. Effect of dielectric constant, effect of substituent, Hamett equation -limitations- Taft equation. Consecutive reactions, parallel reactions, opposing reactions (Uni molecular steps only, no derivation). Specific and general acid-base catalysis. Fast reactions- different methods of studying fast reactions- flow methods, relaxation methods- temperature jump and pressure jump methods.

Module 4	**Photochemistry:** Electronic transitions in molecules, Franck-Condon principle. Electronically, excited molecules- singlet and triplet states, spin-orbit interaction. Quantum yield and its determination. Actinometry. Derivation of fluorescence and phosphorescence quantum yields. Quenching effect- Stern Volmer equation. Photochemical equilibrium and delayed fluorescence- E type and P type. Photochemical primary processes, types of photochemical reactions-photo dissociation, addition, and isomerization reactions with examples.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Thermodynamics For Chemists	Samuel Glasstone	Ewp	2008
2	Chemical Kinetics	K J Laidler	Pearson Education India	2003
3	Photochemistry	R.P. Kundall And A. Gilbert	McGraw Hill.	2014
4	Physical Chemistry.	Ira N. Levine	McGraw Hill.	2008
5	Advanced Physical Chemistry	Gurdeep Raj	Krishna Prakashan Media P. Ltd	2016

REACTION MECHANISM AND ORGANOMETALLIC CHEMISTRY (ROMC)

Course Code	25CY5205	Mode	General	LTPS	3-0-4-0	Pre-Requisite	CBCC

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply coordination chemistry principles to explain reaction mechanisms of coordination complexes.	3	1, 2
CO2	Apply thermodynamic concepts to explain complex formation and acid- base behaviour in aqueous solutions.	3	1, 2, 4
CO3	Apply bonding models to describe the structure and bonding in d-block organometallic complexes.	3	1, 2
CO4	Use bonding concepts to illustrate metal cluster structures and categorize reaction types of d-block organometallic complexes.	3	1, 2, 3
CO5	Analyze experimental data from the preparation and quantitative analysis to interpret and evaluate the properties of inorganic complexes.	4	1, 4

Syllabus

Module 1	Reactivity of coordination complexes – inert and labile complexes –ligand substitution reactions in octahedral and square planar complexes –Trans effect– electron transfer reactions – inner and outer sphere electron transfer mechanisms.
Module 2	Thermodynamics of complex formation in aqueous medium – stepwise and overall formation constants –factors affecting formation constant – determination of formation constant-HSAB principle to explain the stability of coordination compounds.
Module 3	Organometallic complexes of d-block element – 16 and 18 electron rules – Synthesis, structure and spectral properties of metal carbonyl and metal nitrosyl complexes-Fischer and Schrock carbene complexes.
Module 4	metal clusters – metal-metal bonds – carbonyl and non-carbonyl clusters – isolobal analogy and application of Wade's rule – Zintle ions – Chevrel phases. Catalysis: Homogeneous (Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation) and heterogenous (Fischer-Tropsch reaction, Ziegler Natta Polymerization, Haber process).

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	IV Edition, John Wiley and Sons, New York,	1980
2	Inorganic Chemistry	J.E. Huheey	III Edition, Harper International Edition,	1983
3	Theoretical Inorganic Chemistry	M.C. Day and J. Selbin	Affiliated East-West press Pvt. Ltd., New Delhi.	1997
4	Inorganic Chemistry	Shriver and Atkins	Oxford University Press,	2010
5	Concise Inorganic Chemistry	J. D. Lee	Oxford University Press; Fifth edition, Wiley India edition.	2008
6	Vogel's textbook of quantitative inorganic analysis	Jeffery, Bassett, Mendham and Denney	Fifth edition, Longman.	2003
7	Organometallic and Bioinorganic chemistry	Ajai Kumar	7^{th} edition	2021
8	Basic Organometallic Chemistry	B D Gupta	Second edition	2013

QUANTUM, SURFACE & ELECTROCHEMISTRY (QSEC)

Course Code	25CY5206	Mode	General	LTPS	3-0-4-0	Pre-Requisite	MTCK

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply quantum chemistry tools to study the structure and dynamics of molecules.	3	1, 2
CO2	Use adsorption principles to explain surface processes and their mechanisms.	3	1, 3
CO3	Apply electrochemical theories and models to solve problems related to redox systems and conductivity.	3	1, 5
CO4	Use statistical mechanics principles to calculate thermodynamic probabilities and predict particle distributions in chemical systems.	3	1,3
CO5	Analyze experimental procedures and data to develop skills for solving industry-relevant chemical problems and improving process outcomes.	4	1, 2, 5

Syllabus

Module 1	**Quantum Mechanics:** Introduction to quantum mechanics. Schrödinger wave equation. Time-independent and time dependent Schrödinger wave equations and the relation between their solutions. Eigenfunctions and Eigenvalues. Physical Interpretation of wave function. Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Normalization, orthogonality and orthonormality of wave functions. Average (expectation) values. Postulates of quantum mechanics. Solutions of Schrödinger wave equation for a free particle, particle in a ring, particle in a three-dimensional box. Quantum mechanical degeneracy, tunnelling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator.
Module 2	**Surface phenomena:** Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena),
Module 3	E**lectrochemistry**: Activity coefficients and ion-ion interactions. Physical significance of activity coefficients, mean activity coefficient of an electrolyte and its determination. Derivation of the Debye-Hückel theory of activity coefficients the electrode-electrolyte interface. The electrical double layer. The Helmholtz-Perrin parallel-plate model, the Goey-Chapman diffuse-charge model and the Stern model. Electrodics: Charge transfer reactions at the

	electrode-electrolyte interface. Derivation of Butler-Volmer equation. Tafel equation, Low field equilibrium, Nernst equation.
Module 4	**Statistical Thermodynamics:** Fundamentals: Idea of microstates and macro states. Concept of distributions- Binomial & multi-nominal distributions for non-degenerate and degenerate systems, Thermodynamic probability, and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in chemistry. Types of statistics: Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. 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.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Advanced Physical Chemistry	Gurdeep Raj	Krishna Prakashan Media P. Ltd	2016
2	Physical Chemistry	Peter Atkins and Julio de Paula,	Oxford University Press	2018
3	Quantum Chemistry	Lowe, J. P. & Peterson, K.	Quantum Chemistry Academic Press	2005
4	Physical Chemistry	Gilbert Castellon	Narosa Publishing House	2004
5	Introductory Statistical Mechanics.	*Bowley, Roger and Sanchez, Mariana*	Oxford University Press	2000

BIOMOLECULES (BM)

Course Code	25CY5207	Mode	General	LTPS	3-0-4-0	Pre-Requisite	SOSC

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the classification and chemical properties of carbohydrates to predict their reactions and functions in biological and industrial processes.	3	1, 2
CO2	Use knowledge of amino acids and peptides to synthesize peptides and analyze protein purification and enzyme inhibition methods.	3	1, 3
CO3	Apply structural and chemical properties of nucleic acids to explain their functions and analyze their biological significance.	3	1, 3
CO4	Use the classification and reactions of lipids to analyze lipid metabolism and apply lipid profiling and drug delivery methods.	3	1, 4
CO5	Apply the principles of chromatography, and qualitative analysis to isolate, separate and identify various biomolecules.	4	1, 2, 5

Syllabus

Module 1	**Carbohydrates:** Classification, Physicochemical properties- stereochemistry- Chemistry, Structure and functions of monosaccharides, disaccharides, polysaccharides- Mucopolysaccharides- Deoxy sugars, amino sugars, reactions of carbohydrates- Proteoglycans, Glycoproteins and Glycolipids- separation of carbohydrates. **Industrial and biomedical applications.**
Module 2	**Amino acids and Proteins:** Alpha-Amino acids: Classification, Structure Physicochemical properties, and biological significance-synthesis and reactivity, Peptides: bond, Peptides of biological importance, Chemical synthesis of peptides, Solid phase peptide synthesis, Proteins Classification, Isolation, Purification and Characterization of proteins, structure, functions, properties, and significance, Enzymes, Characteristics and functionality. **inhibition, and drug design principles. Protein misfolding diseases: Alzheimer's, prion diseases.**
Module 3	**Nucleic Acids:** Basic Structure, Biological significance, Reactions of Nucleic acid bases, Physicochemical properties of Nucleic Acids, DNA- structure, denaturation, RNA, Functions of Nucleotides, Structure, and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thiamine, Uracil) bases. Structural features of nucleic acids (DNA & RNA) and their biological functions.

Module 4	**Lipids:** Classification, role of lipids, fatty acids and glycerol derived from oils and fats; Physical properties - polymorphism, reactions of fats, rancidity, reversion, polymerization, saponification, addition, hydrogenation, phospholipids, lipid metabolism; intermediary metabolism of fatty acids, synthesis of fatty acids. **Lipids in nanomedicine: Lipid nanoparticles for drug delivery. Lipid profiling by TLC.**

LAB COMPONENT:

1. Qualitative analysis of carbohydrates
2. General colour reactions of proteins
3. Identification of fats
4. Qualitative analysis of Amino acids
5. Separation of plant pigments by column chromatography
6. Separation of amino acids by thin layer chromatography
7. Estimation of carbohydrates by Anthrone method
8. Estimation of Amino acids
9. Isolation of polysaccharide (starch or glycogen) from the biological material.
10. Isolation of casein from milk.
11. Extraction of lipid/oil from plant material and determination of its saponification value and iodine number.
12. Demonstration of GC and HPLC

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Organic Chemistry, Volume 2	I.L. Finar	Pearson	1975
2	Medicinal Chemistry	Graham L. Patrick	Oxford University Press	2005
3	Chemistry of Natural products	S V Bhat, B.A. Nagasampagi	Narosa	2006
4	Chemistry of Natural Products	V. K. Ahluwalia	Springer & Ane books Pvt. Ltd.	2022
5	The Biosynthesis of Secondary Metabolites	Richard B Herbert	Chapman &Hall	2011

SYLLABUS OF COURSES UNDER

PROFESSIONAL ELECTIVES

CONCEPTS OF ORGANIC SYNTHESIS (COS)

Course Code	25CY5221	Mode	General	LTPS	3-0-0-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply modern synthetic methods and green chemistry principles to design and analyze environmentally friendly synthesis routes for pharmaceuticals and fine chemicals.	3	1, 2
CO2	Use reagents like enolates and protecting groups to plan and perform key reactions in organic synthesis with chemo- and stereoselectivity.	3	1, 2, 5
CO3	Apply rearrangement and coupling reactions to develop synthetic strategies for building complex organic molecules.	3	1, 2, 5
CO4	Use principles of pericyclic and photochemical reactions to predict products and design stereoselective synthetic pathways.	3	1, 5

Syllabus

Module 1	**Modern methods of synthesis**: Modern methods of synthesis and reactions of Carbonyl compounds, addition of N, O, and S nucleophiles, Reduction using hydride reagents, chemo and stereoselectivity, formation of enols and enamines, kinetic and thermodynamic enolates. **Emerging Trends and Green Chemistry in Organic Synthesis (Green chemistry principles, Organo catalysis and phase-transfer catalysis, Designing environmentally benign synthesis routes for pharmaceuticals and fine chemicals)**
Module 2	**Reagents:** lithium and boron enolates in aldol and Michael reactions, stereoselective aldol condensations, alkylation, and acylation of enolates, condensation reactions, Claisen, Dieckman, Knoevenagel, Stobbe and Darzen glycidic ester, acyloin, emphasis on synthetic utility of these reactions. **Protecting groups in synthesis: alcohol, carbonyl, and amine protection.**
Module 3	**Rearrangements:** Rearrangement reactions involving electron deficient carbon, nitrogen, oxygen centres and the synthetic utility of these rearrangements. Coupling reactions: Heck, Suzuki, Negishi, Stille, Sonogashira coupling **and their applications. Introduction to CH activation and functionalization.**
Module 4	**Pericyclic reactions:** Classification, electrocyclic, sigmatropic, cycloaddition, cheletropic and ene reactions, Woodward-Hoffmann rules, frontier orbital and orbital symmetry correlation approaches, examples highlighting pericyclic reactions in organic synthesis, stereochemical aspects. **Introduction to photochemical reactions in organic synthesis.**

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Advanced Organic Chemistry-Reactions, Mechanism and Structure	Jerry March	John Wiley.	2006
2	Advanced Organic. Chemistry.	Francis A. Carey and Richard J. Sundberg.	Springer	2007
3	Structure and Mechanism in Organic Chemistry	C.K.Ingold, Cornell	University Press.	2018
4	Principles of Organic Synthesis,	R.O.C Norman and J. M. Coxon.	Springer	1993
5	Stereochemistry of carbon compounds	E.Eliel	McGraw Hill Education	2001

FOOD ANALYSIS AND QUALITY ASSESSMENT (FAQA)

Course Code	25CY5222	Mode	General	LTPS	3-0-0-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply knowledge of food regulations, standards, and analytical methods to prepare samples and perform compositional analysis of foods.	3	1, 2, 4
CO2	Use standard analytical techniques to determine the moisture, ash, fat, protein, and vitamin content in food samples.	3	1, 2, 5
CO3	Apply chemical and biochemical methods to analyze food properties such as pH, fat characteristics, protein content, and contaminants.	3	1, 2, 4
CO4	Use physical analysis methods like rheology, thermal analysis, and color measurement to evaluate the physical properties of food materials.	3	1, 2, 5

Syllabus

Module 1	Introduction to Food Analysis, Indian Government Regulations and International Standards Related to Food Analysis, Nutrition Labelling, Evaluation of Analytical Data, Sampling and Sample Preparation.
Module 2	Compositional Analysis of Foods, Moisture and Total Solids Analysis, Ash Analysis, Fat Analysis, Protein Analysis, Vitamin Analysis, Traditional Methods for Mineral Analysis.
Module 3	Chemical Properties and Characteristics of Foods, pH and Titratable Acidity, Fat Characterization, Protein Separation and Characterization Procedures, Application of Enzymes in Food Analysis, Immunoassays, Analysis of Food Contaminants, Residues, and Chemical Constituents of Concern, Analysis for Extraneous Matter, Determination of Oxygen Demand.
Module 4	Physical Properties of Foods, Rheological Principles for Food Analysis, Thermal Analysis, Colour Analysis.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Food Analysis	Suzanne Nielsen (Ed.)	Springer	2017
2	Food Analysis Theory and Practice	Y. Pomeranz & Clifton E. Meloan	CBS Publishers	2004
3	Principles of Food Chemistry	John M. deMan	Springer	2018
4	Food Chemistry	H.-D. Belitz, W. Grosch, P. Schieberle	Springer	2009
5	Manual of Methods of Analysis of Foods (Food Safety and Standards Authority of India)	FSSAI	Government of India Publications	Latest
6	Introduction to Food Chemistry	Richard Owusu-Apenten	CRC Press	2005
7	Food Proteins and Their Applications	Srinivasan Damodaran, Alain Paraf	CRC Press	1997
8	Food Analysis Laboratory Manual	Suzanne Nielsen	Springer	2010
9	Methods for Food Analysis and Quality Assurance	S. S. Nielsen (Ed.)	Springer	2003
10	Food Analysis and Instrumentation: Theory and Practice	Yeshajahu Pomeranz	Springer	1994

BIOSENSORS AND DIAGNOSTIC DEVICES (BDD)

Course Code	25CY61E1	Mode	General	LTPS	2-1-0-0	Pre-Requisite	ST

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the principles, components, fabrication techniques, and performance parameters of biosensors to design and evaluate effective sensor systems.	3	1,3
CO2	Use the characterization techniques and transduction principles in biosensor-based detection.	3	1,2
CO3	Demonstrate the fabrication and applications of key biosensors in clinical and environmental fields.	3	1,3
CO4	Use the concepts of point-of-care devices, microfluidic platforms, and immunoassays in rapid and on-site diagnostics.	3	1,3

Syllabus

Module 1	**Introduction to Biosensors:** Definition and historical perspective, Various components of biosensors, working mechanism, Probes: antibodies, nucleic acids, enzymes, receptors etc. Methods for probe attachment to surfaces Adsorption; chemisorption, physisorption, polymer trapping, covalent attachment, film deposition techniques; molecularly imprinted polymers and biomimicry. Biosensor construction and modification, Electrodes: carbon (graphene, carbon nanotubes, fullerene, corannulene) metal nanoparticles, polymer, nanocomposites, Thin-Film Electrodes and Screen-Printed electrodes etc. based electrodes. Sensor characteristics: calibration, dynamic range, signal-to-noise ratio, sensitivity, selectivity, interference etc.
Module 2	**Surface characterization and Transducers:** Techniques used to characterize biosensors (UV-Vis, FT-IR, SEM, AFM, XPS, XRD etc.), Various types of transducers and detection methods; principles of Calorimetric, Optical, Electrochemical, Impedimetric, and Chemiluminescence-based Biosensors.
Module 3	**Design and Applications of Biosensors:** Fabrication and applications of colorimetric, fluorescence, voltametric, amperometry, and optical biosensors. Working principles of some commercialized biosensors- Glucose biosensor, Urea/Uric Acid biosensor, Pregnancy test biosensor etc. Immunosensors and clinical applications, Biosensors for drug resistance and environmental pollution.
Module 4	**Diagnostic Devices:** Point of care device, necessity and applications, Lab-on-Chip platform, Microfluidic device, Introduction-antigen-antibody binding and assays; Immunoassays –types (RIA, ELISA, Chemiluminescent IA, FIA), working mechanism of few commercial point of care devices.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Biosensors an Introduction	Brian R Eggins	John Wiley & Sons	1996, 1st Edition
2	Biosensors Principles and Applications	Loic J Blum, Pierre R Coulet	Marcel Dekker,Inc	1991, 1st Edition
3	Biosensors Theory and Applications	Donald G. Buerk	Technomic Publishing	1993, 1st Edition

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS (IMCA)

Course Code	25CY61E2	Mode	General	LTPS	3-0-6-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Demonstrate the working mechanism and applications of voltametric techniques towards pharmaceutical drug analysis and environmental monitoring	3	1,2
CO2	Illustrate the principle of fluorescence spectroscopy and apply it for clinical quantitative analysis	3	1,2
CO3	Apply the basic principles of IR and Mass spectroscopy for the interpretation of organic molecules	3	1,2
CO4	Apply the basic principles of thermal and radiochemical methods of analysis for the determination of stability of compounds and quantitative estimations of radioactive elements.	3	1,2
CO5	Apply the key concepts of instrumentation techniques to set a procedure for the analysis of target species of interest and analyse the obtained results	4	1,2

Syllabus

Module 1	**Electro analytical Methods of Analysis:** Polarographic principles, polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppressors, interference due to dissolved oxygen, Applications, numerical problems. Differential pulse polarography, square wave polarography, **Anode stripping voltammetry:** principle, instrumentation, hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltammetry. **Principle of cyclic Voltammetry**, cyclic voltammogram of $K_3[Fe(CN)_6]$, and parathion, criteria of reversibility of electrochemical reactions, quash irreversible and irreversible processes. **Coulometric analysis:** principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I^- and S^{2-} by using I_2 liberations and Ce^{4+} liberation in solutions
Module 2	**UV-Visible Spectroscopy**: Single and double beam spectrophotometers-instrumentation, sources of radiation, detectors, determination of certain metal ions by using ligands, simultaneous determinations of dichromate and permanganate in a mixture, spectrophotometric titrations. **Spetcrofluorimetry:** Theory of fluorescence, phosphorescence, factors affecting the above, quenching, the relation

	between the intensity of fluorescence and concentration, Chemiluminescence, Electroluminescence and Bioluminescence (Principle and Applications).
Module 3	**Infrared spectroscopy:** Principle, instrumentation, molecular vibrations, factors influencing vibrational frequencies, sampling techniques, characteristic frequencies of organic molecules, principle of Fourier transform IR. **Mass Spectroscopy:** Principle, basic instrumentation, ionization techniques, fragmentation rules, interpretation of mass spectra. **Spectro-Analytical Methods of Analysis: Flame photometry:** theory, instrumentation, applications **Atomic Absorption Spectrometer:** theory, instrumentation, radiation source, applications. Inductively coupled plasma, principle of ICP-OES and ICP-MS.
Module 4	**Thermal methods of Analysis:** Thermo gravimetry-theory, instrumentation, applications with examples, Differential thermal analysis-principle, instrumentation, Differential scanning calorimetry-principle, instrumentation, applications. **Radio chemical methods of analysis:** detection and measurement of radioactivity, introduction to radioactive tracers, applications of tracer technique, isotope dilution analysis-applications, activation analysis-application, advantages and disadvantages, radiocarbon dating technique and applications, Radiochemical Immunoassay, and clinical applications.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Instrumental methods of analysis	H.H Willard, Meritt Jr. and J.A Dean	CBS Publishers & Distributors	1988, 7th Edition
2	Instrumental Methods of Analysis	Chatwal and Anand	Himalya Publishing House	2011, 5th Edition
3	Instrumental methods of analysis	B.K Sarma	Goel Publishing House	2014, 17th Edition
4	Principles of instrumental analysis	Douglas Skoog, F. Holler, Stanley Crouch	Brooks/Cole	2017, 7th Edition
5	Vogel's Textbook of Quantitative Chemical Analysis	Mendham, Denney, Barnes, Thomas	Pearson Education	2008, 6th Edition

ADVANCED SEPARATION AND CHROMATOGRAPHIC TECHNIQUES (ASCT)

Course Code	25CY61E3	Mode	General	LTPS	2-1-0-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the fundamental principles and theories of classical and modern separation techniques in analytical scenarios.	3	1, 5
CO2	Demonstrate the use of instrumentation and operational procedures in gas and liquid chromatography, including advanced techniques such as GC-MS and LC-MS.	3	1, 5
CO3	Implement solid and liquid phase separation methods such as electrophoresis, ion exchange, gel filtration, and solvent extraction for effective chemical analysis.	3	1, 5
CO4	Apply appropriate procedures to develop and validate analytical methods suited for industrial, environmental, and pharmaceutical applications.	3	1, 5

Syllabus

Module 1	**Fundamentals of separation techniques:** Basic principles underlying chemical separations and the classification of various techniques based on the physical processes involved. Key concepts include adsorption, partition, migration rates, retention time, and retardation factor. Theoretical aspects such as partition isotherms, Van Deempter equation, height equivalent to a theoretical plate (HETP), and resolution.
Module 2	**Chromatographic instrumentation and hyphenated techniques:** Advanced chromatographic methods and their instrumentation. Theory and operational details of gas chromatography (GC) including column types, temperature programming, and detectors such as thermal conductivity (TCD), flame ionization (FID), electron capture (ECD), nitrogen-phosphorus (NPD), and photoionization (PID) detectors. Principles and applications of GC-MS with emphasis on interface technology, total ion chromatograms, selected ion monitoring, and spectral library searching. Liquid chromatography, the design and operation of high-performance liquid chromatography (HPLC) with detectors such as UV, refractive index (RI), fluorescence, and diode array (DAD). Integration of mass spectrometry with liquid chromatography (LC-MS) and its utility in trace analysis and pharmaceutical applications.
Module 3	**Classical and specialized separation methods:** Physical and chemical separation techniques beyond mainstream chromatography. Methods such as paper chromatography, thin-layer chromatography (TLC), and high-performance TLC (HPTLC) in terms of principles, operational techniques, and applications. Ion exchange chromatography, ion exclusion, and ion chromatography are covered along with their industrial relevance. Gel filtration and molecular sieving using

	zeolites are introduced for the separation of macromolecules and gases. Electrophoretic techniques, particularly capillary electrophoresis, for high-resolution separation of ionic species. Solvent extraction methods, including batch, continuous, counter-current, and special cases involving crown ethers, surfactants, and supercritical fluids. Affinity chromatography and counter-current distribution as advanced bio separation techniques.
Module 4	**Analytical method development and validation:** Systematic development and validation of analytical methods. Validation parameters including linearity, accuracy, precision, specificity, robustness, limit of detection (LOD), and limit of quantification (LOQ). Regulatory importance of method validation in pharmaceuticals and industrial quality control. Dissolution testing using USP Apparatus I and II along with sampling strategies for solids, liquids, and gases. Statistical evaluation of analytical data, covering standard deviation, confidence intervals, and the comparison of analytical results using significance tests.

Textbooks:

S. No	Title	Author(s)	Publisher	Year
1	Chemical Applications of Group Theory	F.A. Cotton	Wiley	3rd Edition
2	Organic Spectroscopy	W. Kemp	MacMillan	1994
3	Modern Spectroscopy	J. Michael Hollas	Wiley	2013
4	Atomic and molecular Spectroscopy	S. Svanberg	Springer	2003
5	Basic atomic and molecular Spectroscopy	J. Micheal Hollas	Royal Society of Chemistry	2002

APPLIED CHEMICAL ANALYSIS (ACA)

Course Code	25CY61E4	Mode	General	LTPS	3-0-6-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the principles, methodologies, and procedures to analyze ores such as Iron, Manganese, Chromite, Phosphate, and Aluminium.	3	1, 2
CO2	Demonstrate the application of general analytical methods for evaluating finished products including Steel, Dolomite, Fire Clay, Fluorspar, and Magnesite.	3	1, 3
CO3	Implement general methods of analysis to determine the composition of Cement, Soaps, Oils, and Paints.	3	1, 2, 4
CO4	Apply relevant chemical and physicochemical principles to the analysis of Organic Functional Groups.	3	1, 4, 5
CO5	Utilize appropriate instrumental techniques to conduct chemical analysis.	3	1, 2

Syllabus

Module 1	Analysis of raw materials: Analysis of non-ferrous alloys: Brass – Analysis of the constituents – Cu, Zn, Sn, Pb and Fe. Bronze -Analysis of the constituents -Cu, Sn, Zn, Pb and Fe. Solder - Analysis of the constituents – Sn, Pb and Sb. Analysis of Ferro alloys : Ferro silicon - Analysis of the constituents – Si, C, P,S Ferro vanadium- Analysis of the constituents – V, C, P, S. Si, Al. Ferro manganese - Analysis of the constituents – Mn, S, C, P, Si Silico manganese -Analysis of the constituents –Mn, S, C, P, Si Ferro chromium - Analysis of the constituents – Cr, C, Si.
Module 2	Analysis of Soil, Fertilizer and Fuel: Analysis of soils: sampling, determination of moisture, total N, P, Si, lime, humus nitrogen, alkali salts, soil absorption ratio. Analysis of fertilizers: ammoniacal fertilizers, Phosphate fertilizers, Nitrate fertilizers. Analysis of fuels: solid fuels-coal, proximate analysis, ultimate analysis, heating value, grading of coal based on Ultimate Heat Value (UHV).

Module 3	Assessment of Air Quality: Composition of Pure Air, Classification of Air Pollutants, Toxic Elements Present in Dust, and their Sources – Collection of Air Samples. Sources, Effects, Control of Pollution and Chemical Analysis for the following. Primary Pollutants: Carbon compounds - Carbon monoxide (CO) and Carbon dioxide (CO2). Sulphur compounds- sulphur dioxide (SO2), Sulphur trioxide (SO3) and Hydrogen Sulphide (H2S). Nitrogen compounds - nitric oxide (NO), and nitrogen dioxide (NO2), Hydrocarbons - Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH). Particulate matter - Repairable and Suspended particulate matter, Inorganic and Organic particulates. Secondary pollutants - ozone (O3), peroxy acetyl nitrate (PAN), peroxy benzyl nitrate (PBN), Standards for ambient air quality.
Module 4	Kinetic Methods of Analysis & Non aqueous Titrimetry: Kinetic methods of analysis: introduction, slow reactions, catalysed reactions, methods of determination of catalyst concentration, extrapolation method for the determination of catalyst, variable time method, fixed time method, examples for the determination of toxic metals and anions using some typical kinetic reactions. Non aqueous titrimetry: Classification of solvents and titrations for non-aqueous titrimetry- Types of reactions – Indicators. Determination of acids Determination of bases Karl-Fisher reagent for the determination of moisture content in drugs and other samples.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Handbook of Analytical Control of Iron and Steel Production	Harrison John,	Wiley	2016
2	Standard methods of Chemical Analysis	Welcher	CRC	2018
3	Technical Methods of Analysis,	Griffin	Mc Graw Hil	2005
4	Commercial Methods of Analysis	Foster Dee Sneel and Frank M. Griffin,	Mc Graw Hill Book Co.	2004
5	Water Pollution	Lalude	Mc Graw Hill	2000

NANO CHEMISTRY (NC)

Course Code	25CY61E5	Mode	General	LTPS	2-1-0-0	Pre-Requisite	COS

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the fundamental concepts of nanostructures, particle size, and confinement to analyze and explain size-dependent properties and biological interactions of nanomaterials.	3	1, 3
CO2	Use various top-down and bottom-up synthesis methods and characterization techniques to prepare and analyze nanomaterials for specific applications.	3	1, 3
CO3	Apply metal nanoparticles in catalytic reactions to design and evaluate catalytic processes for industrial and environmental applications.	3	1, 3, 5
CO4	Use nanomaterials to solve problems related to energy storage, environmental remediation, and biomedical applications such as drug delivery and biosensing.	3	1, 3, 5

Syllabus

Module 1	Introduction: Scope and importance of nano chemistry. Types of nanostructures, Properties of nanomaterials: Chemical, and Physical. Role of particle size, Concept of confinement, strong and weak confinement with suitable examples, Size and shape dependent optical, electronic, photonic, magnetic, properties. **Bio-nano chemistry: Nano in biological systems and nanotoxicity**
Module 2	Nanoparticles synthesis: Bottom-up synthesis of nanomaterials: Chemical precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Hydrothermal routes, Microwave heating synthesis; Top-down synthesis of nanomaterials: ball milling, photolithography, laser ablation, CVD. Green pathways to synthesize nanomaterials. Characterization methods: X-ray absorption spectroscopy, BET method for surface area analysis. Dynamic light scattering for particle size determination.
Module 3	Metal nanoparticles in catalysis: Catalysis by nanoparticles in Gas-Phase Reactions: CO Oxidation, Propylene Epoxidation, Catalysis by nanoparticles in Liquid-Phase Reactions: Hydrogenations, Coupling Reactions (Sonogashira, Hiyama–Denmark, Heck-Mizoroki, Suzuki-Miyaura Cross-Coupling), Oxidation of Alcohols (Alcohols to Aldehydes, Aldehydes to Carboxylic Acids, Esterification of Alcohols and Aldehydes). **Electrochemical catalysis using nanomaterials, Nanozymes and biomimetic catalysis.**

Module 4	Applications of nano chemistry in energy, environment, and health. Hydrogen energy and development. Hydrogen storage. Carbon capture, Transformation of CO_2 to fine chemicals. Environmental remediation by chemical degradation/removal of contaminants. Nanomaterials as sorbents. **Nanomaterials for photovoltaics, supercapacitors, and batteries- Nanomedicine: Drug delivery systems, biosensors, and bioimaging.**

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	NANO: The Essentials	T. Pradeep,	McGraw-Hill	2012
2	From Theory to Application for In-Depth Understanding of Nanomaterials	Wang, X.; Bashir, S.; Liu, J.	Walter de Gruyter GmbH & Co KG	2023
3	Textbook of Nanoscience and Nanotechnology	S Murty, P Shankar, Baldev Rai, B. Rath, and James Murday	Springer	2013
4	Nanomaterials handbook	Gogotsi, Y.	New York: CRC Press	2006
5	Nano chemistry for Chemistry Educators	R. A. Much, K. Winkelmann & M. Hugerat	RSC publishers	2022

ORGANIC SYNTHESIS (OS)

Course Code	25CY61E6	Mode	General	LTPS	3-0-6-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply appropriate reagents and reaction conditions to achieve selective carbon- carbon bond formation.	3	1, 2
CO2	Use suitable reaction conditions, catalysts and reagents to carry out selective functionalization of organoboranes and silanes.	3	1, 2
CO3	Employ appropriate oxidizing and reducing agents and reaction conditions to achieve selective transformations.	3	1, 2
CO4	Apply synthetic strategies involving phase transfer catalysis and polymerization to carry out challenging organic reactions.	3	1, 2
CO5	Analyze reaction mechanisms and optimization strategies to execute multi-step synthetic routes for target molecule synthesis.	4	1, 2, 5

Syllabus

Module 1	Formation of Carbon-Carbon bonds-alkylation via enolate the enamine and related reactions, umpolung (dipole inversion) reactions-the aldol reaction-applications of organo palladium, organo nickel and organo copper reagents, applications of alpha-Thio carbanions, seleno carbanions and sulphur ylides, synthetic applications of carbenes and carbenoids. Elimination reactions Pyrolytic, syn-eliminations, sulphoxide-sulphonate rearrangement the witting reaction-alkenes from aryl sulphonyl hydrazones, Claisen rearrangement of allyl vinyl ethers.
Module 2	Organoboranes & Silanes: Preparation of Organo boranes viz hydroboration with BH_3-THF, di cyclohexyl borane, disiamyl borane, thexyl borane, 9-BBN and diisopino camphenyl borane, functional group transformations of Organo Boranes-Oxidation, protonolysis and rearrangements. Formation of carbon-carbon bonds viz organo boranes carbonylation, the cyano borate process and reaction of alkenyl boranes and Tri alkenyl borates. Organo silanes: Synthetic applications of trimethylsilyl chloride dimethyl-t-butyl silyl chloride, trimethyl silyl cyanide, trimethylsilyl iodide and trimethylsilyl triflate, synthetic applications of silyl carbanion and B-silyl carbonium ions.

Module 3	Oxidation and Reduction: Oxidations of hydrocarbons, alkenes, alcohols, aldehydes, and ketones. Oxidative coupling reactions using Pb $(OAC)_4$, NBs, CRO_3, SeO_2, $NinO_2$ Dc- alkoxyl euphonium yields, $KMnO_4$, OsO_4, peracids and Ti (III) nitrate. Catalytic hydrogenation (homogeneous and heterogeneous), reduction by dissolving metals. Reduction by hydride transfer-reagents, reduction with hydrazine and diamide, selectivity in reduction of nitroso and nitro compounds, reductive cleavage.
Module 4	Design of Organic Synthesis: Retrosynthesis the disconnection approach-basic principles convergent and linear synthesis. Phase transfer catalysis-Principle and applications. Methods of polymerization (a) addition polymerization (b) Condensation polymerization (c) Radical polymerizations (two examples of each method) Reactions of un activated carbon-hydrogen bonds: The Hoffmann Lieffier-Freytag reaction-the Barton Reaction-Photolysis of organic hypo phthalates.

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Advanced Organic Chemistry-Reactions, Mechanism and Structure	Jerry March	John Wiley	2015
2	Advanced Organic Chemistry: Part A Structure and Mechanisms.	F.A. Carey and R.J Sundberg	Springer	2008
3	Structure and Mechanism in Organic Chemistry.	C. K. Inglod	Cornell University Press	1969
4	Organic Chemistry	R.T Morrison and R.N. Boyd	Prentice - Hall.	1992
5	Principles of Organic Synthesis	R.O.C Norman and J. M. Coxon	Blackie Academic	1993

ORGANIC SPECTROSCOPY (OSP)

Course Code	25CY61E7	Mode	General	LTPS	2-1-0-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply UV-Visible spectroscopy to identify functional groups and predict molecular structure.	3	1, 2
CO2	Use IR spectroscopy to detect functional groups and analyze molecular structures.	3	1, 2
CO3	Interpret NMR spectra to deduce the structure of organic compounds.	3	1, 2
CO4	Analyze mass spectra and apply combined spectroscopic data to determine molecular structures.	3	1, 2

Syllabus

Module 1	UV-VISIBLE SPECTROSCOPY: Various electronic transitions - Effect of solvent on electronic transitions - Chromophores, Auxochromes, Bathochromic and hypsochromic shifts, Solvent effects Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, and conjugated polyenes. Woodward -Fieser rules for conjugated dienes and carbonyl compounds - Ultraviolet spectra of aromatic and heterocyclic compounds - Steric effect in biphenyls. Applications towards deduction of the structure of Molecule and instrumentation of recording of spectra.
Module 2	IR SPECTROSCOPY: Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, Nitrogen compounds and sulphur compounds-Detailed study of Bending vibrations and stretching vibrations-Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect steric effect on vibrational frequencies, overtones, combination bands and Fermi resonance, Factors affecting I.R. group frequency, Applications towards deduction of structure of Molecule.
Module 3	NMR SPECTROSCOPY: HNMR: Nuclear spin - nuclear resonance - Saturation, shielding of magnetic nuclei - Chemical shifts and its measurements - Factors influencing chemical shift FT-NMR - Advantages of FT-NMR. Shielding mechanism - Mechanism of measurement - Chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, and amides) Contact shift reagents - Nuclear Overhauser effect (NOE). 2D-NMR SPECTROSCOPY: The Coupling constants. Applications towards deduction of the structure of Molecule.

Module 4	MASS SPECTROMETRY: Introduction - Ion production - Types of ionization; EI, CI, FD, and FAB - Factors affecting fragmentation - Ion analysis - Ion abundance. Mass spectral fragmentation of organic compounds - Common functional groups - Molecular-ion peak - Metastable peak - Mc. Lafferty rearrangement. Nitrogen rule - Isotope labelling – High-resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination. NUMERICAL PROBLEMS- Spectroscopic Interpretation of different Compounds for structure elucidation problems using multiple spectroscopic data (NMR, MS, IR and UV-Vis).

Textbooks:

S. No	Title	Author(s)	Publisher	Year
1	Organic Spectroscopy	W. Kemp	MacMillan	1994
2	Spectroscopic Identification of Organic Compounds	P.M. Silverstein F. X. Wester	Wiley	1998
3	Elementary organic Spectroscopy	Y R Sharma	S. Chand	1980
4	Fundamentals of molecular Spectroscopy	P S Sindhu	TMH, New Delhi	1983
5	Spectroscopy by Vol.3	B.P. Straughan and S. Walker	Chapman Hall, London	1976
6	Introduction to Molecular Spectroscopy	G.M. Barrow	McGraw Hill, New York	1964
7	Applications of Absorption Spectroscopy of Organic Compounds	J.R. Dyer	Prentice Hall	1965
8	Instrumental Methods of Chemical Analysis	B.K Sharma	Krishna prakashan Media	1981
9	Introduction to Spectroscopy	Donald L. Pavia	Cengage Learning	2008
10	Spectroscopic Methods in Organic Chemistry	Ian Fleming, Dudley Williams	Springer	2019

NATURAL PRODUCTS & HETEROCYCLIC CHEMISTRY (NPHC)

Course Code	25CY61E8	Mode	General	LTPS	3-0-6-0	Pre-Requisite	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply extraction, biosynthesis, and spectroscopic methods to analyze and elucidate the structures and biological significance of alkaloids and steroids.	3	1, 2, 3
CO2	Use isolation, synthesis, and characterization techniques to interpret the structures and biological roles of terpenoids and vitamins.	3	1, 2, 3
CO3	Apply modern synthetic methods and catalytic strategies to synthesize aromatic heterocycles and analyze their biological significance.	3	1, 2, 5
CO4	Use synthesis and green chemistry approaches to prepare and analyze aliphatic heterocycles, betaines, and meso-ionic compounds for diverse applications.	3	1, 2, 5
CO5	Analyze isolation and synthetic methods to differentiate between natural and synthetic products and evaluate reaction outcomes for structural confirmation.	4	1, 2, 3

Syllabus

Module 1	Chemistry of Alkaloids & Steroids: Introduction- classification- General methods of extraction and isolation of natural products, importance of natural products, biosynthesis- acetate pathway, shikimate pathway, mevalonate pathway- Structure elucidation, synthesis, and biological significance of Alkaloids- Quinine, cinchonine, morphine, reserpine; Steroids- Cholesterol, Oesterone, Progesterone. **Modern spectroscopic methods in structure elucidation (NMR, MS, UV, IR).**
Module 2	Chemistry of Terpenoids & Vitamins: Terpenoids-Classification of terpenoids, isolation and biosynthesis, Isoprene rule, Structure determination and synthesis of Farnesol, Camphor and Abietic acid, biological significance, and mode of action of forskolin and Taxol; Vitamins: Introduction, chemical properties and structure elucidation of vitamin A, Vitamin B, Ascorbic Acid and Vitamin D. **Mechanistic pathways and biological role in enzymatic reactions.**
Module 3	Aromatic Heterocycles: General introduction to heterocyclics and their importance, classification, Nomenclature of ring systems (Hantzch-Widman System). Synthesis and reactions of indoles, Quinoline, iso quinoline, pyrazole, pyridine, furan, oxazole, thiophene- Role of heterocyclic compounds in biological systems. **Modern synthetic approaches- Catalysis (Pd-catalysis, organo catalysis), Multicomponent reactions. Biological importance and pharmacological activity of aromatic heterocycles.**

Module 4	Aliphatic Heterocycles and Betaines: Synthesis and reactions of oxetanes, piperidines, epoxides, aziridines, diazirines, thiiranes; Azirines, Oxiranes, Azetidines. Betaines: Formation, aromaticity, and reactivity of pyridine-N-oxides and pyridinium imides. Meso-ionic heterocycles: Synthesis and aromaticity of Sydnones and 1,3- dipolar addition reaction of meso-ionic heterocycles. **Application of green chemistry approaches and modern reagents in heterocycle synthesis.**

LAB COMPONENT:

1. Isolation of Caffeine from tea
2. Isolation of Lycopene from Tomatoes
3. Isolation of Lactose from Milk
4. Isolation of Citric Acid from Lemon
5. Isolation of Limonene from Orange peels
6. Isolation of Piperine from Black Peppercorns
7. Identification of secondary metabolites present in plant extract.
8. Synthesis of indigo
9. Synthesis of benzotriazole
10. Synthesis of 2- hydroxy- 4- methyl quinoline
11. Synthesis of benzofuran
12. Synthesis of acridone
13. Synthesis of coumarin

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Organic Chemistry, Volume 2	I.L. Finar	Pearson	1975
2	Medicinal Chemistry	Graham L. Patrick	Oxford University Press	2005
3	Chemistry of Natural products	S V Bhat, B.A. Nagasampagi	Narosa	2006
4	Heterocyclic Chemistry	T. Gilchrist	Pearson	2005
5	An introduction to the Chemistry of heterocyclic compounds.	R. M. Acheson	Wiley	2008
6	Heterocyclic Chemistry	J. A. Joule & K. Mills	Wiley	2010

SYLLABUS OF COURSES UNDER PROJECT RESEARCH & INTERNSHIP

ESSENTIALS OF RESEARCH DESIGN (ERD)

Course Code	25IE5201	Mode	R	LTPS	1-1-0-0	Pre-Requisite	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	1, 3, 6
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	4, 6
CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	4, 6
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	4, 6

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources.
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables - scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multidimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research

Reference Books:

S. No	Title	Author(s)	Publisher	Year
1	Research Methods for Engineers	C.R. Kothari	New Age International Publishers	2019
2	Engineering Research Methodology	Y Krishnan Nallaperumal	Wiley	2013
3	Engineering Research Methodology -A Practical Insight for Researchers	Dipankar Deb and Balas	Springer	2019

TERM PAPER (TP)

Course Code	25IE6103	Mode	R	LTPS	0-0-4-0	Pre-Requisite	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Exploring the Methodology of Retrieving Research Papers from Sci/Scopus Database.	3	4, 6
CO2	Gather information from journals, research database and deliver presentations.	3	4, 6

Syllabus

Module 1	Exploring the Methodology of Retrieving Research Papers from Sci/Scopus Database, Gathering Information, and Delivering Presentations.
Module 2	Gathering Information from journals and Delivering Presentations.
Module 3	Investigate and analyze scholarly articles, books, and reputable sources.
Module 4	Examine and evaluate various data collection methods and sources, including surveys, interviews, archival records, and experimental data.

Reference Books:

S. No	Title	Author(s)	Publisher	Edition
1	Research methodology- methods and techniques	C. R. Kothari	New Age International	4
2	Research Methodology	Panneerselvam R	Prentice Hall India Learning Private Limited	2
3	Fundamentals of Research Methodology & Statistics	Yogesh Kumar Singh	New Age International	4
4	Research Methodology A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications	5

DISSERTATION (MAP)

Course Code	25IE6205	Mode	R	LTPS	0-0-32-0	Pre-Requisite	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Develop and publish a comprehensive research dissertation demonstrating advanced application of learned concepts.	6	2, 6
CO2	Develop a clear and feasible research question and design a robust methodology.	6	2, 4, 6

Syllabus

Module 1	Research Design and Methodology: Formulating research questions and hypotheses Designing experiments and surveys Data analysis techniques Ethical issues in research.
Module 2	Literature Review and Synthesis: Strategies for searching academic databases Critical analysis of existing research Writing a coherent literature review Integrating sources and avoiding plagiarism.
Module 3	Writing and Structuring a Dissertation: Crafting a compelling introduction Writing a detailed methodology section Presenting and discussing results Developing a strong conclusion Adhering to formatting and citation guidelines.
Module 4	Publishing in Academic or Research Journals: Selecting appropriate journals for submission Preparing a manuscript for submission Understanding the peer review process Responding to reviewer comments and revising manuscripts Promoting published research.

Reference Books:

S. No	Title	Author(s)	Publisher	Edition
1	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.	John W. Creswell, J. David Creswell	Sage publications	5
2	Conducting Research Literature Reviews: From the Internet to Paper"	Arlene Fink	Sage publications	3
3	Writing the Winning Thesis or Dissertation: A Step-by-Step Guide"	Randy L. Joyner, William A. Rouse, and Allan A.Glatthorn	Corwin Publications	3
4	Writing for Publication: Road to Academic Advancement.	Kenneth T. Henson	Pearson	2004