PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To provide a specialization in pre-doctoral degree with advanced understanding in the concepts of organic, inorganic and physical chemistry.
- To impart the necessity of literature survey for research and a broad understanding of atomic and molecular spectroscopy and familiarize with crystal chemistry, stereochemistry, catalysis and photophysical processes.
- To provide comprehensive knowledge on chemical kinetics, polymeric materials, specialty polymers, thermal and chromatographic techniques.
- To gain knowledge on electro-analytical methods, water pollution, sludge handling and disposal and applications of nano-materials.

PROGRAMME OUTCOMES (POs):

- Candidates completing the Master of Philosophy in Chemistry will be acquired knowledge, general competence and analytical skills at an advanced level targeting future employment in research, industry, teaching or public administration.
- In-depth chemical knowledge and research experience within a specialized field of chemistry through a supervised master project.
- Knowledge on relevant methods applied for solving analytical and chemical problems within topical research fields.
- Students get motivated to handle sophisticated instruments and their take up highlighted jobs in industry.

SEMESTER I

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**TOTAL NUMBER OF CREDITS TO BE EARNED FOR THE AWARD OF DEGREE – 32**

### PROFESSIONAL ELECTIVES (PE)

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**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

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3

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Centre For Academic Courses
Anna University, Chennai-600 025.
OBJECTIVES

- To train students in kinetics of homogeneous reactions and electro analytical methods and its applications.
- To impart knowledge on organometallic compounds and reactive intermediates.
- To know the students about reagents in organic synthesis.

UNIT I  KINETICS


UNIT II  ELECTRO ANALYTICAL METHODS


UNIT III  ORGANOMETALLIC COMPOUNDS

Organometallic compounds: Nomenclature, structure, reactivity, basicity - synthesis and applications of organolithium, organoboron, organoaluminium, organoberyllium, organomagnesium,organotin and organosilicon compounds, bioorganic metallic compounds, fluxional organometallic compound.

UNIT IV  REACTIVE INTERMEDIATES


UNIT V  REAGENTS IN ORGANIC SYNTHESIS

Reagents in organic synthesis: Uses of NBS, lithium diisopropylamide, aluminium isopropoxide, lithium aluminium hydride, potassium tertiary butoxide and trimethylsilyl iodide. Reagents containing P,S, B, Si - protecting groups – hydroxyl, amino, carbonyl and carboxylic acid.synthetic analysis and planning – control of stereochemistry.

TOTAL: 60 PERIODS

OUTCOMES

- Will have an understanding of the various methods available in all branches of chemistry.
- Will be able to use organometallic compounds appropriately
- Will capable of running an organic synthesis process

TEXT BOOKS

REFERENCES

CX7102 RESEARCH METHODOLOGY AND ANALYTICAL TECHNIQUES

OBJECTIVES
- To make the student conversant with the literature for research and atomic spectroscopy for qualitative and quantitative analysis.
- To enable students know about the molecular spectroscopy for qualitative and quantitative analysis and also advanced spectroscopy.
- To acquire knowledge of thermal and chromatographic techniques.

UNIT I LITERATURE FOR RESEARCH

UNIT II ATOMIC SPECTROSCOPY FOR QUALITATIVE AND QUANTITATIVE ANALYSIS
Atomic energy levels-flame emission spectrophotometry – Theory, Instrumentation(Source, Types of burners, types of fuels, etc.), Interferences (Chemical, radiation and excitation interferences), qualitative, quantitative analysis (Standard addition method, internal standard method) and applications. Atomic absorption Spectroscopy – Theory(Different processes in flame), Instrumentation, (Hollow cathode lamp, chopper etc.), background correction qualitative, quantitative and applications.

UNIT III MOLECULAR SPECTROSCOPY FOR QUALITATIVE AND QUANTITATIVE ANALYSIS
Molecular energy levels - electronic transitions UV- Vis spectroscopy – Beer-Lambert’s law (applications and limitations), quantitative analysis of Fe, Ni and nitrite, electronic transitions in organic and inorganic molecules– Woodward Fieser rules for dienes and carbonyl compounds- Spectrophotometric titrations – Multicomponent analysis.IR Spectroscopy – principles, instrumentation and qualitative analysis by IR, FTIR spectrophotometer

UNIT IV MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROSCOPY
UNIT V THERMAL METHODS AND CHROMATOGRAPHIC TECHNIQUES

Thermal methods – TGA, DTA and DSC techniques – principles, instrumentation and applications -chromatographic techniques – CC, TLC, GC, PC and HPLC.

OUTCOMES

- Will become adept in mining information from literature source available
- Will gain a broad idea about spectroscopy for qualitative and quantitative analysis of material
- Will be conversant with thermal and chromatographic techniques.

TEXTBOOKS


REFERENCES


CX7001 ADVANCED ORGANIC CHEMISTRY L T P C
4 0 0 4

OBJECTIVES

- To familiarize the students with the stereochemistry and reactive intermediates.
- To provide the importance of industrial applications of oxidation and reduction reactions
- To provide exposure to the students in understanding organometallic and organic synthesis and applications of spectral techniques.

UNIT I STEREOCHEMISTRY

Introduction to molecular symmetry and point groups. Topicity and prostereoisomerism, nomenclature of stereotopic ligands and faces, stereoheterotopic ligands – centre of chirality, assignment of absolute stereochemistry, axial chirality, planar chirality and helicity. Conformational analysis – acyclic systems, cyclic systems, cyclohexane and decalins. Conformation and reactivity with examples. Stereoselectivity – classification, terminology, principle of stereoselectivity, examples of diastereoselectivity and enantioselectivity including few examples from pericyclic reactions.

UNIT II REACTIVE INTERMEDIATES

UNIT III OXIDATION AND REDUCTION REACTIONS 12
Oxidation with Cr and Mn reagents – oxidation with LTA, DDQ and SeO₂ – oxidation using DMSO either with DCC or Ac₂O or oxalyl chloride, oxidation using Dess – Martin reagent – vicinal hydroxylation of olefinic double bonds – Woodward and Prevost procedures – epoxidation using peracids including Sharpless procedure, ozonolysis. Reduction using various reagents – hydrogenation, hydration of carbon – carbon double and triple bonds – asymmetric reduction of carbonyl functions

UNIT IV ORGANOMETALLIC CHEMISTRY FOR ORGANIC SYNTHESIS 12
Fundamental concepts in transition metal chemistry for organic synthetic transformations – metal carbenes, synthesis, reactivity, cycloaddition reactions of metal carbenes, synthesis of fused ring systems, Dotz reaction, mechanism of ring formation, application of cobalt carbynyls in organic synthesis, PausonKhand reaction, Volhardt reaction, Pearson reaction, use of Organoiron complexes for stereo specific synthesis of substituted cyclic compounds

UNIT V APPLICATIONS OF SPECTRAL TECHNIQUES 12
Principles and applications of UV – Visible, IR, NMR, EPR, XRD and Mass spectrometry in the determination of structure of organic molecules. Optical rotatory dispersion and its applications.

TOTAL: 60 PERIODS

OUTCOMES
- Will be capable of applying stereochemistry and reactive intermediates.
- Will be able to appreciate the significance of oxidation and reduction reactions.
- Will get a general idea about organometallic and organic synthesis and applications of spectral techniques.

TEXTBOOKS

REFERENCES

CX7002 ADVANCED PHYSICAL CHEMISTRY L T P C
4 0 0 4

OBJECTIVES
- To familiarize the students with the catalysis and photochemistry.
- To provide the importance of industrial applications of photochemistry and bio-physical chemistry.
- To provide exposure to the students in understanding macromolecular dynamics.

UNIT I CATALYSIS 12
UNIT II PHOTOCHEMISTRY

UNIT III INDUSTRIAL APPLICATIONS OF ELECTROCHEMISTRY

UNIT IV BIO-PHYSICAL CHEMISTRY

UNIT V MACROMOLECULAR DYNAMICS

OUTCOMES
• Will be capable of applying catalyst and photochemistry in an industry.
• Will be able to appreciate the significance of photochemistry and bio-physical chemistry in an industry.
• Will get a general idea about macromolecular dynamics.

TEXTBOOKS

REFERENCES

CX7003 ADVANCES IN NANO CHEMISTRY AND NANOTECHNOLOGY L T P C
4 0 0 4

OBJECTIVES
• To introduce the students about nanochemistry and nanomaterials synthesis.
• To teach the importance of characterization of nanomaterials
• To teach the students importance of applications of nanomaterials.

UNIT I INTRODUCTION TO NANO CHEMISTRY
Importance of surface – particle shape and surface – surface and volume – atomic structure and particle orientation – energy at nanoscale – the material continuum (zero, one and two dimensional materials) – nanothermodynamics – chemical interactions at the nanoscale – supramolecular chemistry.
UNIT II  NANOMATERIALS SYNTHESIS  12

UNIT III  NANOMATERIALS CHARACTERIZATIONS  12
Structural characterization (XRD, SAXS, SEM, TEM, SPM) – chemical characterization (optical spectroscopy, electron spectroscopy, ionic spectrometry) – surface characterization (XPS, AES, SIMS).

UNIT IV  ADVANCED NANOMATERIALS AND PROPERTIES  12

UNIT V  APPLICATIONS OF NANOMATERIALS  12
Nanocatalysis (transition metal nanoparticles in catalysis, aerogel supported nanoparticle in catalysis, multi metallic nanoparticles in catalysis) – organic/polymeric field–effect–transistors (FET) – polymer based nanocomposites – nano biosensors and energy materials.

TOTAL:60 PERIODS

OUTCOMES
• Will be aware of the synthesis of nanomaterials.
• Will have clear understanding of nano tube, nano wires and nano composites.
• Will have an idea of the various fields where nanotechnology can be applied.

TEXTBOOKS

REFERENCES
OBJECTIVES

- To impart knowledge on metal ions in biological systems and metalloenzymes.
- The students must know about oxygen transport and proteins in electron transport.
- To make the student conversant with the chemotherapy.

UNIT I  METAL IONS IN BIOLOGICAL SYSTEMS  12
Survey of metal ions, metal ion transport – passive and active transport – sodium and potassium ion pumps; transport proteins – ionophores; storage proteins – iron, copper and calcium.

UNIT II  METALLOENZYMES  12
Structure, active site and general mechanism of catalytic activity – kinetic aspects – ATP hydrolysis, acid catalysis – carboxypeptidases, oxaloacetate decarboxylase.

UNIT III  OXYGEN TRANSPORT  12
Hemoglobin, myoglobin, iron coordination chemistry – Perutz mechanism; hemocyanin, hemeerythrin.Ferredoxin and Rubredoxin

UNIT IV  PROTEINS IN ELECTRON TRANSPORT  12

UNIT V  CHEMOTHERAPY  12
Toxicity and carcinogenicity of metal ions – deficiency, defects and therapy – role of metal ions in diagnosis and treatment – metal complexes and chelating agents in medicine.

TOTAL: 60 PERIODS

OUTCOMES

- Will gain in-depth understanding of the role of metal ions in biological systems.
- Understands the function of oxygen transport and proteins in electron transport.
- Will have a wide knowledge about chemotherapy.

TEXTBOOKS


REFERENCES

OBJECTIVES

- Students should be conversant with the overview of bio separations and enzyme isolation.
- Students must know about the enzyme purification and also about electro kinetic methods.
- To teach finishing operations.

UNIT I  OVERVIEW OF BIO SEPARATIONS  12


UNIT II  ENZYME ISOLATION  12

Isolation of products – membrane process – dialysis, ultra filtration, reverse osmosis and electro dialysis; adsorption – adsorption isotherms, batch and fixed bed adsorption, extraction and aqueous two phase extractions, precipitation – salting out, organic solvent mediated precipitation, selective denaturation and large scale precipitations.

UNIT III  ENZYME PURIFICATION  12

Product purification – Chromatography – principles of chromatographic separation – gel filtration, reversed phase, hydrophobic interaction, ion exchange IMAC and bio affinity chromatographic techniques.

UNIT IV  ELECTRO KINETIC METHODS  12

Electrophoretic separation – gel electrophoresis – analytical and preparative scale, capillary electrophoresis, isoelectronic focusing.

UNIT V  FINISHING OPERATIONS  12

Final product purification and formulation – crystallization; drying and lyophilisation; formulation strategies.

TOTAL: 60 PERIODS

OUTCOMES

- Will be capable of employing bio separations and enzyme isolation practices available.
- Will gain in depth knowledge about enzyme and its action.
- Will be capable of planning final product purification and formulation processes.

TEXTBOOKS


REFERENCES

OBJECTIVES
- To make the students conversant with the fundamentals of catalysis and also catalysts synthesis.
- To make the students knowledgeable in catalysts characterization and catalytic reactors.
- To familiarize the students with the catalytic reactions.

UNIT I  FUNDAMENTALS OF CATALYSIS

UNIT II  SYNTHETIC METHODS

UNIT III  CATALYSTS CHARACTERIZATION
BET – surface area and pore size distribution - XRD, XPS, Auger electron spectroscopy, X-ray absorption spectroscopy EXAFS, X-ray fluorescence, Electron probe micro analysis - Electron microscopy, Mossbauer spectroscopy, Temperature programmed techniques – TPD, TPR, TPS, TPO - MAS NMR - $^{29}$Si, $^{31}$P, $^{27}$Al, LEED, EELS scanning probe microscopy, STM, AFM, SEM, TEM, DRS UV-Vis and DRIFT spectroscopy.

UNIT IV  CATALYTIC REACTORS
Integral and fixed bed reactors – Two-Phase Reactors, Three-Phase Reactors, Suspension Reactors – Reactors for Homogeneously Catalyzed Reactions. Stirred flow reactors – micro catalytic reactors of pulse type - static reactors - Reaction monitoring by GC.

UNIT V  CATALYTIC REACTIONS

TOTAL: 60 PERIODS

OUTCOMES
- Will have in depth knowledge about the catalyst available and their application.
- Will know the characterization techniques.
- Will be able to define conditions of catalytic activity in the industrial environment.

TEXTBOOKS
REFERENCES

CX7007 ENVIRONMENTAL CHEMISTRY

OBJECTIVES
- The students should be conversant with the Chemistry of environmental toxicology
- To impart knowledge on water pollution and wastewater treatment.
- To know the students about Sludge handling and disposal.

UNIT I ENVIRONMENTAL SEGMENTS

UNIT II CHEMICAL TOXICOLOGY

UNIT III WATER POLLUTION
Water quality parameters and standards – turbidity, color, pH, acidity, solids, hardness, chlorides, residual chlorine, sulphates, fluorides, phosphates, iron and manganese, nitrogen, DO, BOD, COD, grease, volatile acids – analytical techniques in water analysis – soil pollution.

UNIT IV WASTEWATER TREATMENT

UNIT V SLUDGE HANDLING AND DISPOSAL

TOTAL: 60 PERIODS

TEXTBOOKS
OUTCOMES

- Will have a clear understanding of environmental pollution.
- Will be able to discuss pollution abatement methods.
- Will be capable of developing skills and technology towards green chemistry.

REFERENCES


CX7008 ENZYME TECHNOLOGY

OBJECTIVES

- To impart knowledge on enzyme isolation and enzyme immobilization.
- To make the student conversant with enzyme catalysis and industrial enzymes.
- To acquaint the student with enzyme reactors.

UNIT I ENZYME ISOLATION

Sources of enzymes; enzyme extraction; principles of enzyme assays and kinetics studies; effects of enzyme concentration; expression of enzyme activity; effect of substrate concentration.

UNIT II ENZYME IMMOBILIZATION

Immobilization techniques; Adsorption; entrapment; covalent cross-linking with bifunctional reagents; covalent coupling to polymeric supports.

UNIT III ENZYME CATALYSIS

Immobilized enzyme catalytic reactor design, enzyme catalysis in aqueous and non-aqueous solvents, polymerization esterification, ester hydrolysis; peptide synthesis.

UNIT IV INDUSTRIAL ENZYMES

Production, applications in various industries, food processing; bakery products, dairy products, brewing; leather industry detergents, enzyme in medicine diagnostics, enzyme sensors, Biosensors; Use of enzymes in analysis – types of sensing – gadgetry and method, Use of unnatural substrates – artificial enzymes – enzyme mimicking.

UNIT V ENZYME REACTORS

Design and operation of ideal reactors – CSTR and PER; design and packed bed and fluidized – bed immobilized enzyme reactors: membrane reactors for immobilized enzyme systems.

TOTAL: 60 PERIODS

OUTCOMES

- Will gain in depth knowledge about enzyme and its action.
- Will gain the knowledge of enzymes, their kinetics and action in general.
- Will be in a position to use enzymes in the industry.

TEXTBOOKS

REFERENCES

CX7009 PHYSICAL ORGANIC CHEMISTRY

OBJECTIVES
- Impart knowledge on chemical kinetics and isotopic effects on kinetics.
- The students must know about structure and reactivity relationship.
- To make the student conversant with organic reaction mechanisms and photochemical reactions.

UNIT I CHEMICAL KINETICS

UNIT II KINETIC ISOTOPE EFFECTS

UNIT III STRUCTURE AND REACTIVITY RELATIONSHIP

UNIT IV ORGANIC REACTION MECHANISMS

UNIT V PHOTOCHEMICAL REACTIONS

TOTAL: 60 PERIODS

15
OUTCOMES
- Will be able to apply kinetics to study organic reaction mechanisms.
- Will be capable of correlating structure and reactivity of a compound.
- Will get a general idea about photochemical processes.

TEXT BOOKS

REFERENCES

CX7010 POLYMER CHEMISTRY AND TECHNOLOGY L T P C
4 0 0 4

OBJECTIVES
- To make the students conversant with the basic concepts of polymer science and Copolymerization.
- To familiarize the students with the crystalline and amorphous polymers and also processing of polymers.
- To acquaint the students with the specialty polymers.

UNIT I BASIC CONCEPTS OF POLYMER SCIENCE
Classification of polymers – chain polymerization – mechanism of free radical, cationic, anionic and co-ordination polymerization – Living polymers- atom transfer radical polymerization (ATRP)– chain transfer reaction and constant – Alfin catalysts – Initiator – Step-growth polymerization-kinetics of esterification in presence and absence of external catalyst.

UNIT II COPOLYMERIZATION

UNIT III CRYSTALLINE AND AMORPHOUS POLYMERS
Crystalline and amorphous polymers-factors affecting crystallinity and crystallizability -effect on polymer properties. Glass transition temperature- thermal transitions-Determination of Tg and Tm – factors affecting Tg Polymer characterization by IR, NMR, TGA, DTA and DSC – Molecular weight of polymers and its distribution – molecular weight determination by GPC and Viscosity measurement- Mark – Houwink equation.
UNIT IV  SPECIALTY POLYMERS  12
Interpenetrating polymer networks (IPN) - Heat resistant polymers – Ladder polymers-
conducting polymers – photocrosslinking polymers - liquid crystalline polymers - Bio-compatible
polymers – polymer composites- polymers for optical storage devices.

UNIT V  PROCESSING OF POLYMERS  12
Compounding of polymers, moulding techniques – compression, injection, extrusion, blow
moulding, rotational moulding, thermoforming, vacuum forming, calendaring, casting, reaction
injection moulding, injection blow moulding and lamination.

TOTAL: 60 PERIODS

OUTCOMES
• Will be aware of preparation and properties of polymers at length.
• Will be able to methodically discuss moulding techniques.
• Will develop capacity to characterize polymers and draw a parallel to their properties

TEXTBOOKS
1. V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, “Polymer Science” New Age

REFERENCES
   (2003).
5. M.S.Bhatnagar, “ A Textbook of Polymers, Volume 1: Chemistry and Technology of
   Polymers (Basic Concepts),S. Chand & Company Ltd. (2010).

CX7011  PRINCIPLES OF BIOCHEMISTRY  L  T  P  C
4  0  0  4

OBJECTIVES
• To provide exposure to the students to understand concepts of carbohydrates and lipids
  and also proteins..
• To make the students conversant with enzymes and also nucleic acids.
• To impart knowledge on metabolism and energetics

UNIT I  CARBOHYDRATES AND LIPIDS  12
Basic concepts of biochemistry – Biomolecules and their interactions with water and other
biological substances, carbohydrates – Mono, di,oligo and polysaccharides, complex
carbohydrates, Lipids – properties and structure of glycerolipids, phospholipids, sphingolipids,
glycolipids, steroids and prostaglandin.
UNIT II PROTEINS 12
Properties and structure of amino acid, peptides, proteins and conjugated proteins. Protein conformation: Native conformation of protein molecules, the secondary structure of fibrous protein, the alpha helix, beta pleated sheet, collagen helix, tertiary structure of globular proteins, quaternary structure of oligomeric proteins.

UNIT III ENZYME KINETICS 12
Enzyme synthesis, isolation and purification, effect of charge and hydrophobicity, activity and turnover number. Enzyme kinetics: Michaelis–Menten equation, $K_m$, enzyme denaturation, enzyme regulation and activities; occurrence, structure, properties and functions of coenzymes and cofactors.

UNIT IV NUCLEIC ACIDS 12

UNIT V METABOLISM AND ENERGETICS 12
Carbohydrate, lipid, protein and nucleic acid metabolism inter-conversion of biological substance, glycolysis, TCA cycle, oxidation of fatty acids in animal tissues, urea cycle, respiratory chain, ATP cycle and other energy rich compounds.

TOTAL: 60 PERIODS

TEXTBOOKS

REFERENCES

CX7012 PROPERTIES OF POLYMERIC MATERIALS L T P C
4 0 0 4

OBJECTIVES
- To provide exposure to the students to understand the mechanical properties and also thermal and electrical properties.
- To make the students conversant with optical properties and polymeric materials characterizations.
- The students should be conversant with quality control and testing organizations.

UNIT I MECHANICAL PROPERTIES
12

UNIT II THERMAL AND ELECTRICAL PROPERTIES 12
UNIT III  OPTICAL PROPERTIES  12

UNIT IV  POLYMERIC MATERIALS CHARACTERIZATIONS  12

UNIT V  QUALITY CONTROL AND TESTING ORGANIZATIONS  12

TOTAL: 60 PERIODS

OUTCOMES
- Will be aware of preparation and properties of polymers at length.
- Will be able to methodically discuss moulding techniques.
- Will develop capacity to characterize polymers and draw a parallel to their properties

TEXTBOOKS

REFERENCES

CX7013  SOLID STATE CHEMISTRY  L T P C
4 0 0 4

OBJECTIVES
- The students should be conversant with the crystal chemistry and preparative methods.
- To impart knowledge on characterization of solids and electrical properties.
- To teach the students about magnetic, optical and thermal properties.

UNIT I  CRYSTAL CHEMISTRY  12
Structures of complex oxides and related compounds – defects in solids – origin and types of defects, non-stoichiometry – defects and physical properties – ionic conductivity and optical properties.

UNIT II  PREPARATIVE METHODS  12
Polycrystalline materials by solid state, precipitation, precursor, ion exchange, sol-gel, intercalation methods – high pressure synthesis, preparation of single crystals – different methods – preparation of thin films, amorphous and nano crystalline materials.
UNIT III CHARACTERIZATION OF SOLIDS

UNIT IV ELECTRICAL PROPERTIES

UNIT V MAGNETIC, OPTICAL AND THERMAL PROPERTIES

TOTAL: 60 PERIODS

OUTCOMES
- Gets a general understanding of the essentials of crystal chemistry and their applications
- Understands the structure of solids and methods to characterize them.
- Is conversant with basics of magnetic, optical and thermal properties.

TEXTBOOKS

REFERENCES