Ph.D. Course work

Pre-Ph.D. Examination Syllabus

w.e.f: A.Y:: 2021-2022

DEPARTMENT OF CHEMISTRY,

K L Deemed to be UNIVERSITY,

Koneru Lakshmaiah EducationFoundation

VADDESWARAM - 522502, ANDHRA PRADESH, INDIA.

List of Pre-Ph.D. Courses

DEPARTMENT OF CHEMISTRY

List of Pre-Ph.D. Courses Proposed

LTPS: 4-0-0-0 (For all Courses)

S.No	Paper 1	Subject Code
1	RESEARCH METHODOLOGY	21RES102

S. No	**Paper-2**		**Paper-3**	
1	Introduction to Organic Chemistry	21CHE201	Modern Organic Synthesis	21CHE301
2	Analytical Separation Techniques	21CHE202	Modern Instrumental Methods of Analysis	21CHE302
3	Fundamentals of Inorganic Chemistry	21CHE203	Applications in Inorganic Chemistry	21CHE303
4	Chemistry of Nanomaterials	21CHE204	Applied Electrochemistry	21CHE304
5	Principles of Environmental Science	21CHE205	Water Management Techniques	21CHE305
6	Basics of Physical Chemistry	21CHE206		

Paper-2 Syllabus

Introduction to Organic Chemistry

LTPS: 4-0-0-0

UNIT- I: Purification and drying of organic solvents Benzene, toluene, xylene, Tetrahydrofuran, chloroform, dichloromethane, methanol, dimethyl formamide, dimethylsulfoxide,

Preparation of Reagents: Sodium methoxide, TMEDA-ZnCl2 Complex, Lithium diisopropylamide, Butyl Lithium, organomagnesiumhalide, wittig reagent, sodamide, dialkyllithiumcuprate. Oxidising agents, Reducing agents.

UNIT- II: Named reactions and rearrangements Benzoin condensation, Perkin reaction, Cannizaro reaction, Diels Alder reaction, Hetero diel's alder reaction, Peterson olefination, Wolf Kishner reduction, Claisen rearrangement, Cope rearrangement, Oxycope rearrangements, Benzidine rearrangement, Beckman rearrangement.

UNIT-III: Transition metal complexes in organic synthesis – Applications of Organo Palladium compounds, Rhodium complexes, Metal carbonyl complexes of Fe, Co and Ni.

UNIT-IV: Emerging greener methodologies: Sonochemistry and green aspects; Microwave in chemical synthesis: Basic principles, advantages, and examples; Electrochemical synthesis: concepts and examples.

UNIT- V: Chromatographic techniques: Principles & applications with respect to Thin-Layer chromatography, Paper chromatography, Column chromatography, Gas Chromatography and HPLC with suitable examples & Chromatograms

Reference books:

1. Mike Lancaster, 2002, Green Chemistry: An Introductory Text, Royal Society of Chemistry.
2. Nina Hall (Editor-in-chief), 2000, The New Chemistry, Cambridge university Press.
3. M.B. Smith & Jerry March 2001, March's Advanced Organic Chemistry, 5th Edition, John Wiley & Sons, New York.
4. J. Clayden, N. Greeves, S. Warren, and P. Wothers, 2001, Organic Chemistry, Oxford University press INC, New York.

Analytical Separation Techniques

LTPS: 4-0-0-0

Unit- I: Basic Separation Techniques: Theory and Techniques of distillation, fractional distillation, steam distillation, vacuum distillation, Molecular distillation, and sublimation. Theory of action of drying agents, Fractionation by evaporation-working of Rotary film

evaporator. Extraction-Distribution law and derivation, solvents and their choice. Techniques-batch and continuous, multiple extractions. Complexation-Theory and application of complexing agents and choice. Dialysis–Theory, membranes, and their choice, techniques, and applications. Ultrafiltration and zone filtration – principles and techniques. Centrifugation-Principle, Techniques, Ultra centrifuge-description of apparatus, theory, sedimentation velocity, and molecular weight determination.

Unit-II: Fundamentals of Chromatography: Classification of different chromatographic methods, methods of development-Elution development, Gradient elution development, displacement development, and frontal analysis. Principles of chromatography, different migration, adsorption phenomena, partition, adsorption coefficient, retardation factor, retention time and volume, column capacity, temperature effects, partition isotherm. Dynamics of chromatography-efficiency of the chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP), Van Deempter equation, resolution, choice of the column, length, and flow velocity. Column chromatography (adsorption chromatography): principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase).

Unit-III: Basic Chromatographic Techniques: Column chromatography-Construction and operation of the column, choice of adsorbents and eluents, techniques of elution, methods of detection, analytical and industrial applications. Paper chromatography-principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods-ascending, descending, horizontal, circular spreading, multiple development, two-dimensional development, reverse phase paper chromatographic technique-visualization and evaluation of chromatograms, applications. Thin Layer chromatography- principle, Ion Exchange: principles of ion-exchange systems, ion-exchange mechanism. Ion exchange chromatography: Principle, Equipment, Application. Ion chromatography: principles of separation, instrumentation, detectors, separation of cations and anions.

Unit-IV: Modern Separation Techniques: I Exclusion (Gel) Chromatography: Instrumentation, sources of errors, GPC calibration, Column packing, Theory of size of exclusion chromatography, Application of size exclusion chromatography (GPC). Supercritical Fluid Chromatography: Properties of Supercritical Fluid (SFC) –Instrumentation and operating variables, Comparison with other types of chromatography (HPLC and GLC), Applications. Capillary Electrophoresis and Electrochromatography: Over view of Electrophoresis, Capillary Electrophoresis, Applications of Capillary Electrophoresis and Capillary electrochromatography.

Unit-V: Modern Separation Techniques: II Gas Chromatography: Principles of gas chromatography, plate theory of gas chromatography, Instrumentation for gas chromatography, working gas chromatography, Evaluation of gas chromatogram, Identification of gas chromatogram, programmed temperature chromatography, flow programming chromatography (FPC), gas-solid chromatography, application of gas chromatography. High-Performance Liquid Chromatography: Introduction, Instrumentation, Refractive index detector, luminescence detector, ultraviolet detector, and electrochemical detector, Quantitative analysis, and data display, Derivatisation technique in HPLC, Chiral columns, C8 and C18 columns, Applications. HPTLC-principle, technique, applications. Plasma

chromatography, supercritical fluid chromatography.

TEXT BOOKS:

1. Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York
2. Separation methods by M.N. Sastri, Himalaya Publishing Company, Mumbai

REFERENCE BOOKS:

1. Chromatography by E. Helfman, Van Nostrand and Reinhold, New York
2. Chromatography by E. Lederer and M. Lederer, Elsevier, Amsterdam.
3. Chemical separation methods by John A Dean, Von Nostrand Reinhold, New York
4. Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York
5. Basic Gas Chromatography by H.M Mc Nair and J. M. Miller, John Wiley, New York
6. Analytical Gas Chromatography by W. Jeumings, Academic Press, New York
7. Practice of HPLC by H. Eugelhardt (ed), Springer Verrag, Berrin

Fundamentals of Inorganic Chemistry
LTPS: 4-0-0-0

UNIT I: Chemistry of main group elements: Recent advances and general trends in properties – Chemical periodicity, Boron hydrides, carboranes, metallacarboranes, intercalation compounds, nitrogen – phosphorous compounds, boron-nitrogen compounds, sulphur – nitrogen cyclic compounds, interhalogen and pseudohalogens.

UNIT II: Chemistry of Transition elements: Relationship of structure, reactivity, electronic and magnetic properties of 3d,4d, 5d elements. Chemistry of lanthanides and actinides, magnetic and optical properties. Difference in properties compared to d-block elements, Metal cluster compounds (structure, bonding and reactivity). Applications of transition metals.

UNIT III: Coordination compounds: Crystal field theory (CFT) – Crystal field splitting patterns in Octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries. Factors affecting crystal field splitting energies, Spectrochemical series, Jahn – Teller effect, nephelauxetic effect, ligand field theory, Term symbols and Spectroscopic states.

UNIT IV: Metal clusters and organo-transition metals – Metal-metal bond, carbonyl clusters -low dimensional solids, Transition metal to carbon bonds, Complexes with -acceptor, and -donor ligands -18e and 16e rule complexes – Examples, Isolobal analogy, Application of Wades rule.

UNIT V: Metal Ligand Equilibria in solution: Stepwise and overall formation constants, factors affecting formation constant – chelate effect – Determination of formation constants by Spectrophotometric method (Job's) and pH metric method (Bjerrum's). Stability correlations - Irwing – William's series, Theory of Acids and Bases, Bronsted and Lewis acids and bases, hardness and softness (HSAB principle), Macrocyclic effect - Crown ethers and Cryptates.

Text Books

1. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkinson, IV Edition, John Wiley and Sons, New York, 1980.
2. Inorganic Chemistry by J.E. Huheey, III Edition, Harper International Edition,1983.
3. Inorganic Chemistry by Shriver and Atkins, Oxford University Press, 5th edition. 5.
4. Concise Inorganic Chemistry by J.D.Lee, Oxford University Press; Fifth edition, Wiley India edition.

Reference Books

1. Inorganic chemistry by Sharpe and Housecroft, Fourth edition, Pearson.
2. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox, Fourth edition, W H Freeman & Co; Pck edition.

Chemistry of Nanomaterials
LTPS: 4-0-0-0

Unit-I Fundamentals of nanomaterials: Introduction, Definitions, Historical development of nanomaterials, Classification of nanomaterials, Size & Scale Units Scaling Atoms, Molecules, Clusters and Supramolecules, Structure and Bonding in Nanomaterials Chemical Bonds (types and strength) Intermolecular Forces Molecular and Crystalline Structures Hierarchical Structures Bulk to Surface transition, surface reconstruction, Self-assembly and thermodynamics, Properties and Size dependence of properties: Chemical, Optical, vibrational, thermal, Electrical, Magnetic, Mechanical, Theoretical Aspects-e.g. density functional theory.

Unit-II Nanomaterial Synthesis: Chemical routes, Electrochemical methods, Vapor growth, Thin films methods: chemical vapor deposition, physical vapor deposition, (sputtering, laser ablation), Langmuir-Blodgett growth, Mechanical methods: ball milling, mechanical attrition, Sol-gel methods, Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon, Bio-inspired synthesis, Nanocomposite fabrication, Nanolithography.

Unit-III Nanoporous materials and quantum dots: Micro, Meso, and Macroporous materials, methods of synthesis, different additions in nanoporous materials. The surface area of porous materials and its determination. Thermogravimetric studies of nanoporous materials. Quantum dots, mechanism based on bandgap, excitons, quantum confinement effect, Bohr's radius in quantum dots.

Unit-IV Nanoparticles characterization techniques: Scanning and Transmission Electron Microscopy, Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy, Diffraction and scattering techniques, Vibrational spectroscopy, Surface techniques.

Unit-V Applications: Nano-electronics, Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries, and energy-related applications, High strength nanocomposites, Nanoenergetic materials

Textbook

1. The Physics and Chemistry of NanoSolids by Frank J. Owens and Charles P.
2. Poole Jr, Wiley-Interscience, 2008.

Reference Books

1. Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition)
2. Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005
3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005)

Basics of Physical Chemistry
LTPS: 4-0-0-0

Unit-1: Chemical Kinetics: Fast reactions; Rate constants of fast reactions; Their determination by Stopped flow method, Relaxation method, Flash photolysis and Nuclear Magnetic Resonance methods. Ionic reactions; Influence of solvent on the rate of reactions (single & double sphere A.C. model); Primary salt effect; Secondary salt effect; Influence of frequency factor; Influence of ionic strength.

Unit-2: Catalysis: Types of Catalytic Reagents; Types of Catalysis (Homogeneous and Heterogeneous catalysis); Catalytic activity; Acidity Functions; Theory of Homogeneous catalysis; Theory of Heterogeneous catalysis (Chemical theory & Adsorption theory); Kinetics of heterogeneous reactions.

Unit-3: Enzyme Catalysis and Surface Chemistry: Specificity in Enzyme Catalyzed reactions; Michaelis-Menten mechanism; Influence of Concentration on Enzyme-Catalyzed reactions; Influence of Temperature on Enzyme Catalyzed reactions; Acid-base catalysis. Adsorption; Factors influencing adsorption; Surface area and its measurements; Adsorption isotherm curves; Langmuir's adsorption isotherm-its limitations; B.E.T. Adsorption isotherm-its applications; Negative adsorption; Positive adsorption; Chemisorption; Physisorption and Determination of surface area.

Unit-4: Quantum Mechanics: Introduction to Quantum Mechanics: Postulates of Quantum Mechanics; Schrödinger wave equation; Physical significance of wave function; Eigen values and Eigen functions; Particle in a box (one dimensional) behavior; Normalization; Orthogonality; Degeneracy.

Unit-5: Photochemistry: Types of Photochemical reactions; Laws of Absorption (Grothuss-Draper law & Einstein's law); Quantum yield; Primary & Secondary Photochemical processes; Joblonski Diagram: Fluorescence, Phosphorescence, Inter-System Crossing; Internal

Conversion-Vibrational Cascade and Chemiluminescence. Kinetics of Photochemical reactions; Dissociation of HI; Reaction between Hydrogen and Chlorine; Reaction between Hydrogen and Bromine; Reaction between Hydrogen and Oxygen; Explosion limits.

Text Books & Reference Books

1) Chemical Kinetics By K.J. Laidler, Pearson Education India; 3 Edition (2003)
2) An Introduction To Chemical Kinetics, Michel Soustelle, Wiley , First Edition (2011)
3) Atkins' Physical Chemistry: Peter Atkins , Julio De Paula , James Keeler, Oxford University, Press, 11th Edition (2018).
4) Advanced Physical Chemistry, Gurudeep Raj, Krishna Prakashan Media P. Ltd., 4th Edition (2016).

Principles of Environmental Science

LTPS: 4-0-0-0

UNIT I Ecology, Environment and Energy Resources: Principles of ecology; ecosystem-structure and functions; biomes and biodiversity; biogeochemical cycles; environment-management and pollution; sustainable development; inter and intra-species relationship, Major ecosystems of world-arctic, tundra, northern coniferous forests, temperate forests, grassland deserts, tropical rain forests, fresh water, and marine ecosystems. Ecology of population community, succession and fluctuation dynamics of ecosystem. Environment-definition and concepts. Components of environment-atmosphere, hydrosphere, biosphere, pedosphere and their interaction. Ecological successions: Energy resources- renewable and non-renewable.

UNIT II Environmental Chemistry, Environmental Health and Toxicology: Environmental segments- atmosphere, hydrosphere, lithosphere; Chemical interactions; Toxic chemicals in environment; environmental health hazards; Biochemical effects- arsenic, lead, mercury, carbon monoxide, nitrogen oxides, sulfur dioxide, ozone and PAN, cyanide, pesticides; Measuring toxicity and Risk assessment. Environmental monitoring: Introduction concepts and Importance. Monitoring systems - physical, chemical and biological, monitoring tools –

UNIT III Air Pollution & Control Technologies: Air pollution- types and sources; Air pollutants- classification and properties; Meteorological aspects of air pollution; Air pollution-sampling and measurement; Control methods- particulate and gaseous emissions; Automobile

pollution.Role of different gases, particulates, heavy metals and pesticides in environmental pollution. Sampling and analysis techniques of monitoring pollution

UNIT IV EIA, Environmental Law and Policy Concept of EIA; EIA methodologies; Impact prediction and assessment-air, water, biological, socio-economic; Concepts of Environmental Audit; Environmental education; Environmental Policy; Environmental Law and regulations; Citizen participation.

UNIT V Solid and Hazardous Waste Management: Waste-definition and types; Generation; Collection; Segregation; transport; Treatment; Disposal Methods; Waste Processing and management; Creation of TSDF; Impacts of waste; legal and administrative regulations: problems associated with waste disposal; Impact on air, water and soil. Waste processing; physical, chemical, and biological methods; landfilling operations and its impact on water and agriculture. Hazardous wastes and their disposal.

Reference books:

1. Ecology- E.P. Odum, 1983, Holt-Saunders International Edition
2. Environmental Chemistry- A.K. De, New Age Intt. Pub. Co., New Delhi, 1990 A Text Book of environmental – C.S. Rao, Wiley Eastern Limited., 1993

Paper-3 Syllabus

Modern Organic Synthesis

LTPS: 4-0-0-0

1. Synthetic strategies and Asymmetric synthesis. Design of Organic synthesis: Terminology, Retrosynthesis, FGI, disconnection, synthon synthetic equivalent, protecting groups, chemoselectivity, regioselectivity and stereoselectivity. Linear and convergent strategies, Use of disconnection approach in the synthesis of multistriatin, Warfarin and α-bisabolene.

2. IR Spectroscopy: Introduction, Principles, Characteristic vibrational frequencencies of functional groups, Fermi resonance, Effect of hydrogen bonding on vibrational frequencies. ii) Electronic spectroscopy: Introduction, Principles and Wood -Ward Fisher rules. iii) NMR Spectroscopy (^{1}H NMR): Introduction, Principles, factors effecting the chemical shifts, spinspin coupling, first order spectra. iv) Mass Spectrometry: Introduction, Principles, use of isotopic peaks, salient feature of fragmentation of organic compounds, McLafferty rearrangements, retro Diels-Alder fragmentation and ortho effects. Simple problems on structure determination based on the above spectral methods.

3. Modern Concepts of Organic Chemistry and Green Chemistry: a) New Techniques and concepts in organic synthesis. i) Combinatorial synthesis ii) Tandem synthesis iii)

Mosher's method for configuration determination iv) Baldwin rules v) Kahne's glycosidation vi) Methods of oligonucleotide synthesis. b) Green Chemistry: Introduction, principles of green chemistry, Different approaches to green synthesis: Microwave and Ultrasound assisted organic synthesis, Solid phase and aqueous phase organic synthesis.

4. Transition metal complexes in organic synthesis – Applications of Organo Palladium compounds, Rhodium complexes, Metal carbonyl complexes of Fe, Co and Ni.
   Phase transfer catalysts – Application of phase transfer catalysts in organic synthesis with reference to Tetraalkylammonium, Tetraalkylphosphonium, Trialkylsulphonium salts and Crown ethers.

Text books:

1. Spectroscopic identification of organic compounds by RM Silverstein, G C Bassler andT B Morrill
2. Organic Spectroscopy by William Kemp
3. Spectroscopic methods in Organic chemistry by DH Williams and I Fleming
4. Modern NMR techniques for chemistry research by Andrew B Derome
5. Advanced organic chemistry part A and Part B by F.A. Carey and R.J. Sundberg, Springer, 2007
6. 6. Some modern methods of organic synthesis by W. Carruthers, Cambridge University press 4 th edition, 2012

Modern Instrumental Methods of Analysis

LTPS: 4-0-0-0

Unit-I UV-Vis spectroscopy and Atomic Absorption spectroscopy: Brief review of the electromagnetic spectrum, UV-Visible range, energy-wavelength-color relationships, Interaction of electromagnetic radiation (UV-Vis) with matter and its effects, Chromophores, oxochromes, bathochromic, hypocromic, hipsochromic, hyperchromic shifts. Calculation of λmax.Woodward-Hofmann rules for conjugated dienes and α,β-Unsaturated carbonyl compounds, Electronic Spectra of diatomic molecules, the vibrational structure of an electronic transition, classification of bands, rotational fine structure of electronic vibrational transition. Electronic Spectra of Polyatomic Molecules- Instrumentation-Applications. Chiroptical spectroscopy-CD, ORD curves, applications to organic molecules. Problems related to UV and ORD curves. **Atomic Absorption spectroscopy:** Introduction and importance; Principles and instrumentation; Interferences - Chemical & Spectral and evaluation methods; Applications of Atomic Absorption Spectroscopy for qualitative and quantitative analysis.

Unit-II Infrared and Raman Spectroscopy: Introduction; basic principles; Instrumentation; Detectors, Qualitative, Quantitative analysis and Applications. Raman spectroscopy: Classical and quantum theories of Raman effects, pure rotational, vibrational and Vibrational – rotational Raman spectra, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, coherent antistrakes Raman Spectroscopy (CARS)-Application. Raman spectroscopy – identification of some organic functional groups. Solving some problems related to IR and Raman spectroscopy.

Unit-III Nuclear magnetic resonance spectroscopy: Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factors influencing, coupling constant J. Classification (ABX, AMX, ABC, A2, B2 etc.). 13C NMR –Principle, rules, applications, and problems. 2D NMR – Principle, COSY (HETCOR, HOMCOR) DQFCOSY, DEPT, INEPT, NOESY, INADEQUATE, HMBC, HMQC, and problems.

Unit-IV Mass Spectrometry and Thermal methods: Introduction; Basic principles, ionizing sources, types of ions, detectors, and applications. Rules, modes of fragmentation of various organic molecules, and problems. Principle and applications of GC-MS, HPLC-MS, GC-FTIR. Principles, basic instrumentation, and applications of TG, DTA, and DSC.

Unit-V Fluorescence, radiochemical and electrochemical methods: Theory of fluorescence, phosphorescence, factors affecting the above, quenching, the relation between the intensity of fluorescence and concentration, instrumentation, application. Chemiluminescence, Electro-chemiluminescence. Principle, energy dispersive X-ray fluorescence, wavelength dispersive X-ray fluorescence, X-ray photoelectronic spectroscopy, chemical shift, application of XPES and XRF. Introduction to radioactive tracers, applications of tracer technique, isotope dilution analysis, activation analysis – application. Cyclic voltammetry and differential pulse voltammetry– Principle, instrumentation, and applications.

TEXT BOOKS:

1) Instrumental methods of analysis by H.H Willard, Meritt Jr. and J.A Dean
2) Principles of instrumental analysis by Skoog and West
3) Vogels Textbook of Quantitative Inorganic analysis by J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4) Instrumental methods of analysis by B.K Sarma, Goel Publishing House, Meerut
5) Instrumental methods of Analysis by Chatwal and Anand
6) Instrumental methods of Analysis by Ewing

REFERENCE BOOKS:

1) Introduction to instrumental analysis by R. D. Braun, Mc Graw Hill - International edition.
2) Analytical spectroscopy by Kamalesh Bansal, 1st edition.
3) Instrumental methods of chemical analysis by Willard, Dean and Merittee- 6th edition.
4) Analytical chemistry principles by John H. Kenedey- 2nd edition, Saunders college publishing.
5) Spectroscopic identification of organic compounds Fifth Edition by Silvestrine, Bassler, Morrill, John Wiley and sons.
6) Analytical Chemistry by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH

Applications in Inorganic Chemistry
LTPS: 4-0-0-0

UNIT I

Electronic Spectra of transition metal complexes – 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. Charge transfer spectra. Magnetic properties of transition metal and inner transition metal complexes – spin and orbital moments, quenching of orbital momentum by crystal fields in complexes. Interpretation of UV-Visible spectra of transition metal complexes.

UNIT II

Inorganic Reaction Mechanisms: Substitution, anation and hydrolysis reactions, Inert and labile complexes- associative, dissociative and interchange mechanisms-ligand substitution reactions in Square planar and octahedral complexes –Trans effect. Electron transfer reactions –outer-sphere and inner-sphere mechanisms. Correlation of rates with structure and electronic configuration. Molecular rearrangements –Berry pseudorotation– fluxional molecules. Applications.

UNIT III

Bioinorganic Chemistry: Na+-K+ Pump, ionophores, Biochemistry of iron -its storage, transport and function- Ferritin, Transferrin, Siderophores and metallothionein. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins. Oxygen transport and storage: Hemoglobin, myoglobin, hemerythrin, hemocyanin,

photosystems, enzymes, coenzymes and metalloenzymes, nitrogen fixation, metal complexes in biological/biomedical applications.

UNIT IV

Organometallics in catalysis: Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation, Fischer-Tropsch reaction, Ziegler Natta Polymerization, Organometallic catalysts in organic reactions – Coupling reactions: Suzuki, Stille, Negishi, Sonogashira reactions.

UNIT V

Solid State Chemistry: Bonds in Solids – chemical and physical bonds, influence of the bonds on properties, Braggs Law – Crystal structure, Crystal defects and their influence on materials properties, non-crystal matter – amorphous, valence and conduction bands, Band theory of solids, Synthesis and preparation of materials, material properties– chemical, thermal, mechanical, electrical, dielectric, optic, magnetic, basic methods for characterization of solid matter – electron microscopy and diffraction, x-ray diffraction, thermal analysis, spectroscopic methods. Applications of solid-state materials.

Text Books

1. Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkinson, IV Edition, John Wiley and Sons, New York, 1980.
2. Inorganic Chemistry by J.E. Huheey, III Edition, Harper International Edition,1983.
3. Inorganic Chemistry by Shriver and Atkins, Oxford University Press, 5th edition. 5.
4. Concise Inorganic Chemistry by J.D.Lee, Oxford University Press; Fifth edition, Wiley India edition.

Reference Books

1. Inorganic chemistry by Sharpe and Housecroft, Fourth edition, Pearson.
2. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox, Fourth edition, W H Freeman & Co; Pck edition.

Water Management Techniques

LTPS: 4-0-0-0

UNIT I: Water Pollutants and Water Treatment:

Water Pollution: Water Physical and chemical properties, Sources,Eutrophication and Water and quality standards. Types of Pollutants, Sampling, and preservation of water. Analysis of the following in the Drinking water; Hardness, Alkalinity, DO, BOD, COD, Chlorides ammonia, Nitrate and Nitrite, Sulphate; Phosphate, Metals like – Fe^{2+}, Mn^{2+} ,Pb^{2+} , Ni^{2+} and Cr(VI) and Organics – Phenol. Types and Sources, Heavy metals- metalloids- organic-inorganic- biological- radioactive pollutants, Methods of Water treatment- sedimentation-flotation, secondary (biological) treatment- design and principles in biological treatment facilities- activated sludge process- trickling filters – tertiary treatment

UNIT II

Industrial Waste Water Treatment: Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry- tannery industry-

textile mill waste industry- fertilizer plant- steel plant- oil refinery- pharmaceutical [plant- paper and pulp mill]

UNIT III

Advanced Wastewater Treatment: Introduction, removal of suspended solids- removal of dissolved solids- Ammonia removal- phosphorous removal- chemical oxidation- recovery of materials from process effluents. low-cost waste treatment systems and their design,

UNIT IV

Sewage Treatment and Disposal: Self-purification of streams- BOD and its importance- treatment methods- primary, secondary and tertiary levels- disinfections of treated sewage effluent- septic tank design- effluent disposal methods- disposal on land, sewage sickness- disposal by dilution- design of biological treatment units- sludge characteristics, unit operations in sludge disposal, conventional and high rate digesters- disposal of sludge- gas utilization.

UNIT V

Phytoremediation Treatment: Introduction, current trends in role of phytoremediation- examples of species potential in absorbing heavy metals and pollutants in waste water- root zone treatment technology- microbial remediation- role of bacteria and the microbes in cleaning of sewage waters- oil spilled waters- domestic waste waters- polluted agricultural runoff- bio medical waste retaining waters. Chemical Toxiology: Bio chemical effects of the following, Calcium, Lead, Mercury,
Arsenic, Cyanide, Pesticides, Carbon monoxide, Nitrogen oxide and Sulphur dioxide.

Text Books:

1. Water Supply and Sanitary Engineering, G.S. Birdie & J.S. Brides, Dhanpat Rai &sons 1993.
2. A treatise on Rural, Municipal, and industrial waste management KVSG Murali Krishna
3. Environmental Sanitation (Social and preventive medicine) Dr. P.V. Rama Raju & KVSG Murali Krishna
4. Waste water engineering, treatment and reuse by Metcalf and Eddy, fifth edition, Tata Mc Graw Hill.

Applied Electrochemistry

LTPS: 4-0-0-0

Unit-I Electrodics: Basics of electrodics, rates of simple electrode reactions, elementary electron electrode process, Butler-Volmer equation, exchange current density and symmetry factor, experimental determinations, electrode rectification, Nernst equation as a special case of the Butler - Volmer equation, reaction resistance, polarisable & non-polarisable electrodes, low and high field approximations, Tafel equations. Examples of multi-electron reactions, Butler-Volmer equation for a multi-step reaction, the concept of the rate-determining step of an electrode reaction, current potential laws for electrochemical systems.Types of overvoltages, chemical and electrochemical overpotentials, phase, activation and concentration overpotentials, diffusion, migration, and hydrodynamic modes of transports, the role of supporting electrolyte, theory of diffusion over potential, reactions at an electrode,three-electrode system, sign conventions, rates of electrochemical reactions, overpotential, electrocatalysis, electrogrowth of metals, hydrogen evolution reactions, electronation of oxygen.

Unit-II Electrodeposition and corrosion: Factors affecting electrodeposition of metals, Simultaneous discharge of cations, depolarisation of metal deposition, separation of metals by electrolysis. Electrochemical passivity, Passivity and current density, chemical passivity, theories of passivity, Electroplating. Corrosion: The corrosion of metals, hydrogen evaluation type, and differential oxygenation type corrosion. Corrosion inhibition. Electrochemical theory of Corrosion. Corrosion testing. Materials and specimens, Surface propagation, Gravimetric method, measuring and weighing, exposure techniques. Planned interval tests. Corrosion rate determination at short time intervals.

Unit-III Electrochemical Techniques: Linear sweep voltammetry, Differential pulse voltammetry, Stripping voltammetry: Anodic stripping, cathodic stripping, adsorptive stripping voltammetry, Principles, and applications. Cyclic voltammetry: Principles and Applications, Applications of impedance measurements, Potentiodynamic polarization studies, Tafel method, Rotating disk, and ring disk electrodes and Applications. Principles, Instrumentation, and Applications. Chronomethods: Principles, Chrono-potentiometric - amperometric and – coulometric measurements, Instrumentation, and Applications. Electrochemical scanning tunneling microscopy. Spectro-electrochemistry principle and applications.

Unit-IV Electrochemical Sensors (Chemically Modified Electrodes): Biosensors, catalytic sensors, and gas sensors. Enzyme electrodes, preparation & properties of modified electrodes eg, Nafion modified electrode, PVP modified electrode. Applications such as Electrocatalysis, ion-selective electrodes. Introduction, formation of monolayers of organic molecules on electrodes. Bioelectrochemistry: bioelectrodics, membrane potentials, electrochemical communication in biological organisms Different electrodes of carbon as electrode material: Glassy corban electrode, carbon fibre electrode, carbon paste electrode, and carbon nano-tube paste based electrode and their applications.

Unit-V Battery Technology and Environmental Electrochemistry: basic concept, classification of batteries, primary, secondary, and reserve batteries, Construction, working, and application of Acid Storage batteries, Lithium -MnO_2 batteries, Nickel- Metal hydride batteries, Fuel Cells, Construction and working of H_2O_2 and methanol-O_2 Cell. Chemical-Hydrogen production and storage, Principle of direct energy conversion using fuel cells, thermodynamics of fuel cells, Types of fuel cells, AFC, PEMFC, MCFC, SOFC, Microbial fuel cell, Fuel cell performance.The solar-hydrogen solution. The CO_2 fixing, Photo-electrochemical reduction of CO_2, the photoelectrochemical splitting of water. Electrochemical removal of wastes: (i)Wastewater (ii) Sulphur dioxide (iii) Removal of metals (iv) Destruction of nitrates. Electrochemical treatment of low-level nuclear wastes.

Textbooks

1. J.O.M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Volumes 1 & 2, Plenum Press, New York. 1988.
2. S.Glasstone, Electrochemistry, Affiliated East-West Press, Pvt., Ltd., New Delhi, 1974.
3. A.J.Bard and L.R. Faulkner, Electrochemical methods –Fundamentals and Applications,,2nd Ed., John Wiley and Sons, 2001.
4. C.Hamann, A. Hamnett and W. Vielstich, Electrochemistry, Wiley, 2007

References

1. D.A.McQuarrie and J.D.Simon, Physical Chemistry-A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
2. J.Rajaram and J.C. Kuriakose, Kinetics and Mechanism of Electrochemical Transformations, Macmillan India Ltd., New Delhi, 1993.
3. R.J Gale, Spectroelectrochemistry, Wiley 2010.