Established by Govt. of Arunachal Pradesh vide Act 9 of 2012, the Arunachal University of Studies Act, 2012 Recognized as per u/s 2(f) of University Grants Commission Act, 1956
NH-52, Namsai, Arunachal Pradesh -792103

MASTER OF SCIENCE (CHEMISTRY) – THIRD SEMESTER

Third Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Inorganic Chemistry – III	4	100
2	Organic Chemistry – III	4	100
3	Physical Chemistry – III	4	100
4	Special paper – I (any one) 1. Organometallic Chemistry of Transition Metals 2. Stereochemistry and Photochemistry 3. Electrochemistry	4	100
5	Elective paper (any two) 1. Chemistry Application of Group Theory 2. Medicinal Chemistry 3. Material Chemistry 4. Photoinorganic Chemistry 5. Fuel and Combustion Technology 6. Environmental Chemistry	2 2	100 100
6	Lab - (Special Paper)	2	100
	Total	**22**	

Subject Name: INORGANIC CHEMISTRY - III

Course A: Inorganic Reaction Mechanisms

Mechanisms of substitution reactions of tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral complexes. Potential energy diagrams, transition states and intermediates, isotope effects, Berry's pseudo rotation mechanism, factors affecting the reactivity of square planar complexes, Swain-Scott equation, Trans effect and its application to synthesis of complexes.

Molecular rearrangement processes: Electron transfer reactions (outer and inner sphere) HOMO and LUMO of oxidant and reluctant, chemical activation. Precursor complex formation and rearrangement, nature of bridge ligands , fission of successor complexes, Two-electron transfers, Synthesis of coordination compounds using electron transfer reactions, mixed valence complexes and internal electron transfer.

Course B: Catalysis and Bio-inorganic Chemistry

Transition metal ion catalysts for organic transformations and their application in hydrogenation (using symmetric and chiral organometallic catalysts), isomerization, olefin oxidation, carbonylation and polymerization reactions. Role of metal ions in biological systems. Toxic metal ions and their detoxification, chelation therapy/chelating agents in medicine. Recent advances in cancer chemotherapy using chelates. Biological nitrogen fixation. Natural and synthetic oxygen carriers. Na-K, ATPase or sodium pump. Futuristic aspects of organo transition metal complexes as catalysts and in bio-inorganic chemistry.

Recommended Texts:

1. Katakis, D. & Gordon, G. Mechanism of Inorganic Reactions John Wiley & sons: N.Y.(1987).

2. Langford, H. &.Gray, H. B. Ligand Substitution Processes W. A. Benjamin: N. Y. (1966).

3. Tobe, M & Wadington, F.C.Ed., Inorganic Reaction Mechanisms Thomas Nelson: London (1973).

4. Hughes, M. N. The Inorganic Chemistry of Biological Processes, 2nd Ed., Wiley (1981).

5. Masters, C. Homogeneous Transition Metal Catalysis Chapman & Hall (1981).

Subject Name: ORGANIC CHEMISTRY - III

Course A: Photochemistry & Pericyclic Reactions

Photophysical processes: Jablonskii diagram, energy pooling, exciplexes, excimers, photosensitization, quantum yield, solvent effects. Stern-Volmer plot, delayed fluorescence, etc.

Photochemistry of alkenes: cis-trans isomerizatlon, non-vertical energy transfer; photochemical additions; reactions of 1, 3- , 1, 4- and 1, 5-dienes; dimerizations.

Photochemistry of carbonyl compounds: Norrish type I & II reactions (cyclic and acyclic); α, β-unsaturated ketones; β, γ -unsaturated ketones; cyclohexanones (conjugated); cyclohexadienones (cross-conjugated & conjugated); Paterno-Buchi reactions, photoreductions.

Photochemistry of aromatic compounds: Isomerizations, skeletal isomerizations, Dewar and prismanes in isomerization. Singlet oxygen reactions: Photo Fries rearrangement of ethers and anilides; Barton reaction, Hoffman-Loefller-Freytag reaction.

Pericyclic reactions: Electrocyclic, cycloaddition, sigmatropic and chelotropic reactions: General Orbital Symmetry rules, Frontier Orbital approach, PMO approach, Correlation diagrams for different svstems, Hückel-Mobius approach, General pericyclic selection rule and its applications, 1,3-dipolar additions, Ene reaction.

Course B: Chemistry of Life Processes

Introduction to metabolic processes: Catabolism and anabolism, ATP- currency of biological energy, energy rich and energy poor phosphates, role of NADH, NADPH, $FADH_2$, TPP, coenzyme A, lipoic acid and biotin.

Carbohydrate metabolism: Glycolysis, fate of pyruvate under anaerobic conditions, citric acid cycle, oxidative phosphorylation (electron transport system), gluconeogenesis, C4 pathway, pentose phosphate pathway and photosynthesis.

Fatty acid metabolism: Even chain and odd chain (saturated and unsaturated) fatty acids, ketone bodies, fatty acid anabolism, calorific values of food.

Protein metabolism and disorders: Degradation of amino acids (C3, C4, C5 family), urea cycle, uric acid and ammonia formation.

Proteins (structure and functions): Primary, secondary, tertiary and quaternary structures. Enzymes, active sites, allosteric sites and mechanisms of their actions, e.g. chymotrypsin, carboxypeptidase, lipases, etc.

Nucleic acids: Chemical and enzymatic hydrolysis, structure and functions of DNA, RNA (m-RNA, t-RNA, r-RNA), an overview of gene expression (replication, transcription and translation), genetic code (origin, Wobble hypothesis and other important features), genetic errors, carcinogenesis and recombinant DNA technology.

Recommended Texts:

1. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).

2. Horspool, W. M. Aspects of Organic Photochemistry Academic Press (1976).

3. Lowry, T. H. & Richardson, K. S. Mechanism and Theory in Organic Chemistry Addison-Wesley Educational Publishers, Inc. (1981).

4. March, J. Advanced Organic Chemistry John Wiley & Sons (1 992).

5. Marchand, A. P. & Lehr, R. E. Pericyclic Reactions Academic Press (1977).

6. Stryer, L. Biochemistry 4th Ed., W. H. Freeman & Co. (1995).

7. Sykes. P. A Guidebook to Mechanism in Organic Chemistry 6th Ed., Prentice-Hall (1996)

8. Zubay. S. Biochemistry Addison-Wesley (1983).

Subject Name: PHYSICAL CHEMISTRY - III

Spectroscopic methods: Characterization of electromagnetic radiation. Born-Oppenheimer approximation. Heisenberg's Uncertainty Principle. Basic elements of spectroscopy. Time dependent perturbation. Einstein coefficients. Lambert-Beer's law. Integrated absorption coefficients. Transition dipole moments and general selection rules based on symmetry ideas.

Atomic spectra: Characterization of atomic states. Microstate and spin factoring methods. Hund,s rules. Derivation of spin and orbital selection rules (based on recursion relations of Legendre polynomials). Spectra of complex atoms. Zeeman and Stark effects. Atomic photoelectron spectroscopy.

Introduction to molecular spectroscopy: Rotational spectroscopy of diatomic molecules based on rigid rotator approximation. Determination of bond lengths and/ or atomic masses from microwave data. Effect of isotopic substitution. Non-rigid rotator. Classification of polyatomic molecules. Energy levels and spectra of symmetric top molecules and asymmetric top molecules. First order Stark effect.

Vibrational spectroscopy: Normal coordinate analysis of homonuclear and heteronuclear diatomic molecules. Extension to polyatomic linear molecules. Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constants and amplitudes. Anharmonic oscillator. Overtones and combination bands.

Dissociation energies from vibrational data. Vibration-rotation spectra, P, Q and R branches. Breakdown of the Born-Oppenheimer approximation. Nuclear spin effect.

Symmetry of normal coordinates. Use of Group Theory in assignment of spectra and selection rules for simple molecules.

Raman spectroscopy: Stokes and anti-Stokes lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy. Selection rules. Polarization of Raman lines.

Electronic spectroscopy: Diatomic molecules. Selection rules. Breakdown of selection rules. Franck-Condon factors. Dissociation energies. Photoelectron spectroscopy of diatomic (N_2) and simple polyatomic molecules (H_2O, formaldehyde). Adiabatic and vertical ionization energies. Koopmans' theorem.

Polyatomic molecules. Oscillator strengths. Use of Free Electron Model, HMO theory and Group theory for polyenes and carbonyl compounds (formaldehyde). Qualitative ideas of solvent effects- viscosity, polarity, hydrogen bonding.

Excited states: Deactivation. Jablonskii diagram. Fluorescence and phosphorescence and factors affecting these. Calculation of excited state life-times from absorption data. Quenching of fluorescence, Stern-Volmer equation.

NMR spectroscopy: Larmor precession. Mechanisms of spin-spin and spin-lattice relaxations and quantitative treatment of relaxation. Quantum mechanical treatment of the AB system. Selection rules and relative intensities of lines.

Principles of Mossbauer spectroscopy: Isomer shifts. Quadrupole and Nuclear Zeeman splittings. Applications in structure determination.

Diffraction Methods: Atomic scattering factors. Scattering by a small crystal. Direct and reciprocal lattice. Miller indices. Bragg's law and Laue's equations. Structure factors. Systematic absences for different types of unit cells (primitive, face-centred, body - centred, side-centred) and application to some common metal and metal salt structures (rock salt, zinc blende). Space groups. Glide planes and screw axes. Structure determination for organic crystals like naphthalene. Fourier series.

Patterson's functions. Heavy atom method. Comparison of X-ray method with electron and neutron diffraction methods.

Recommended Texts:

1. Hollas. J. M. Modern Spectroscopy 4th Ed., John Wiley & Sons (2004).

2. Barrow. G. M. Introduction to Molecular Spectroscopy McGraw-Hill (1962).

3. Brand. J. C. D. & Speakman. J. C. Molecular Structure: The Physical Approach 2nd Ed., Edward Arnold: London (1975).

4. Chang. R. Basic Principles of Spectroscopy McGraw-Hill, New York, N.Y. (1970).

5. Moore, W. J. Physical Chemistry 4th Ed., Prentice-Hall (1972)

6. Warren, B. E. X-Ray Diffraction Dover Publications (1990)

7. Bacon, G. E. Fifty Years of Neutron Diffraction Hilger (1987)

Subject Name: ORGANOMETALLIC CHEMISTRY OF TRANSITION METALS

Inorganic π Acid Ligands: Dioxygen and dinitrogen, nitrosyl, tertiary phosphines and arsines as ligands.

Complexes of π donor ligands: Transition metal alkenyls, alkynyls, carbenes and carbines

Complexes of unsaturated molecules: Preparation, bonding and structure of alkene, alkyne, allyl, dienyl and trienyl complexes; reactions with special reference to organic synthesis

Transition metal compounds in catalysis: Hydrogenation, hydroformylation and polymerization; Wacker Process

Transition metal Compounds with M-H bonds: Metal hydrides (classical and nonclassical). Agostic interaction. Application of NMR in studying hydrido complexes

Recommended Texts:

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed. (1999) John Wiley & Sons, NY.

2. J.E. Huheey, Keiter and Keiter, Inorganic Chemistry,

3. R. H. Crabtree, the Organometallic Chemistry of Transition Metals, John Wiley.

4. Ch. Elschenbroich and A. Salzer, Organometallics, VCH.

5. J.P. Collman, L.S. Hegedus, J.R. Norton and R.G. Finke, Principles and Applications of Organotransition metal Chemistry, Univ. Sci. Books, Mill Valley. California.

Subject Name: STEREOCHEMISTRY AND PHOTOCHEMISTRY

Stereochemistry:

Enantioselcetive synthesis with chiral non racemic reagents and catalysts: Hydroboration with chiral boranes (IPCBH2), (IPC)2BH, Carbonyl group reduction with chiral complex hydride (BINAL-H, Chiral oxazaborolidines), Chiral organometal complex –(-)DAIB; 3-exo-dimethylamino isoborneol. Enantioselective epoxidation of alkene: Sharpless epoxidation, enantioselective hydrogenation with [Rh(DIPAMP)]+. Diastereoselective synthesis:Aldol reactions (Chiral enolate & Achiral Aldehyde and Achiral enolate and chiral aldehyde).

Optical Activity in absence of chiral carbon: Biphenyls and Allenes and Atropisomerism.

Conformation: Conformational analysis of decalines and cyclohexene.

Photochemistry:

(a) Introduction and Basic Principles of Photochemistry: Absorption of light by organic molecules, properties of excited states, mechanism of excited state processes and methods of preparative photochemistry.

(b) Photochemistry of alkenes and related compounds: Isomerization, Di-β-methane rearrangement and cycloadditions.

(c) Photochemistry of aromatic compounds: Ring isomerization and cyclization reactions.

(d) Photochemistry of carbonyl compounds: Norrish type-I cleavage of acyclic, cyclic and α, β unsaturated carbonyl compounds, Norrish type-II cleavage. Hydrogen abstraction: Intramolecular and intermolecular hydrogen abstraction, photoenolization. Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, photodimerisation of α, β unsaturated ketones, rearrangement of enones and dienones, Photo-Fries rearrangement

Rearrangements: Sommelet-Hauser, Favorskii, rearrangements. Hofmann-Loffler-Freytag reaction, Barton reaction and Shapiro reaction.

Recommended Texts:

1. M.B. Smith and J. March, March's Advanced Organic Chemistry-Reactions, Mechanisms and Structure, 5th Edition (2001), John Wiley & Sons, New York.

2. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.

3. J. Aube and R. E. Gawley, Principles of Asymmetric Synthesis.

4. E.L. Eliel, S.H. Wilen and L.N. Mander, Stereochemistry of Organic Compounds, Wiley Interscience, New York (2004).

5. Paul de Mayo, Molecular Rearrangements, Vol.I & II, Interscience Publishers, New York (1963).

6. John D. Coyle, Introduction to Organic Photochemistry, John Wiley and Sons, New York (1986).

7. C.H. Depuy and O.L. Chapman, Molecular Reactions and Photochemistry, 2nd Edition (1988), Prentice-Hall of India (P) Ltd., New Delhi.

8. F.A. Carey and R.J. Sundberg, Photochemistry in Advanced Organic Chemistry, Chapter 13, Part A, 3rd Edition (1990), Plenum Press, New York.

9. N. J. Turro, Modern Molecular Photochemistry, University Science Books, Sausalito (1991).

Subject Name: ELECTROCHEMISTRY

Activity coefficient and ionic migration in electrolyte solutions: Quantitative treatment of Debye- Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ionsolvent interaction on activity coefficient. Debye-Hückel-Onsagar (D-H-O) theory of conductance of electrolyte solution, its applicability and limitations. Pair-wise association of ions (Bjerrum and Fuoss treatment), modification of D-H-O theory to account for ion-pair formation, determination of association constant (KA) from conductance data.

Electrical double layer at metal/electrolyte interface: Thermodynamics of double layer, electrocapillary equation, determination of surface excess and other electrical parameter selectrocapillarity, excess charge capacitance, and relative surface excesses. Metal/ water interaction-contact adsorption, its influence on capacity of interface, complete capacitypotential curve, constant capacity region hump. Specific adsorption.

Electrode kinetics: Multistep reactions- a near equilibrium relation between current density and over potential, Concept of rate determining step. Determination of reaction order. Stoichiometric number, and transfer coefficient. Electrocatalysis-comparison of electrocatalytic activity. Importance of hydrogen evolution reaction and its mechanism.

Electrochemical techniques: Impedance technique-its application for studying electrode kinetics and corrosion. Rotating disc electrode (RDE): Application of measurement of electrochemical rate constant.

Recommended Texts:

1. Modern Electrochemistry, Vol. 1 & 2A and 2 B, J.O'M. Bockris and A.K.N. Reddy,Plenum Press, New York (1998).

2. Electrochemical Methods: Fundamentals and Applications; A.J. Bard and L.R. Faulkner, 2nd edition (2001), John Wiley & Sons, New York.

Subject Name: CHEMICAL APPLICATIONS OF GROUP THEORY

Group Theory in Chemistry: Classification of Groups; Matrix representation of symmetry elements and point groups, matrices of C3v and C4v point groups, transformation matrices; Structure of character tables, determination of symmetry species for translations and rotations.

Chemical Applications of Group theory:

IR and Raman Spectroscopy: Brief introduction to molecular vibrations; selection rules for fundamental vibrational transitions, symmetry of normal modes of molecules, Infrared and Raman activity of some typical molecules (molecules of C2v, C3v, C4v, D2h, D3h, D4h, Td and Oh point groups

Crystal Field Theory: Splitting of levels and terms in chemical environment, construction of energy level diagrams, selection rules and polarizations.

Molecular Orbital Theory: Introduction, transformation properties of atomic orbitals; hybridization schemes for bonding, hybrid orbitals as LCAOs; Molecular Orbital Theory for some typical ABn types (n = 2, 3, 4, 6) of molecules (H_2O, NH_3 and BH_3)

Electronic Spectra: General considerations, typical examples from tetrahedral and octahedral systems, Orgel energy level diagrams.

Recommended Texts:

1. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edn. (1999), John Wiley & Sons, New York.

2. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 2nd Edn. (1999), Prentice Hall International Inc., London.

3. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi (1999).

Subject Name: MEDICINAL CHEMISTRY

UNIT- I

Introduction to Medicinal Chemistry

Definition, History and development of medicinal chemistry.

Physico-Chemical factors and Biological activity: Introduction; Physicochemical properties in relation to biological action - Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Optical and Geometrical isomerism; factors governing ability of drugs to reach active site; dissociation constants; isosterism and bio-isosterism.

Drug metabolism principles, Factors affecting drug metabolism including stereo chemical aspects.

Drug Design: Introduction, procedures followed in development of new drugs design, concepts of lead compound and lead modification, concepts of analogues & prodrugs , structure-activity relationship (SAR).

Combinatorial Chemistry:

Concept and applications of combinatorial chemistry: solid phase and solution phase synthesis.

Brief introduction; classification - chemical and pharmacological; synthesis of selected members; mode of action; relevant SAR of following classes of compounds (Unit II to Unit VI):-

UNIT-II

Non-Steroidal Anti-Inflammatory Drugs (NSAID): Salicylates, Indomethacin, Diclofenac Sodium, Ibuprofen.

UNIT-III

Antibiotics and Anti-infective Drugs:

Antibiotics: Penicillin: penicillin G, Penicillin V, Amoxycillin, Chloramphenicol, Cephalosporin, Tetracycline and Streptomycin.

Local anti-infective drugs: Introduction and general mode of action of Nalidixic Acid derivatives, Quinoloine derivatives.

UNIT-IV

Central Nervous System Depressant:

General anesthetics: Inhalation anesthetics; Intravenous anaesthetics; Basal anesthetics.

Local anesthetics: Esters, amides, Quinoline & Iso-quinoline analogues.

Central Nervous System Stimulants: Xanthine derivatives; Analeptics and miscellaneous CNS stimulants.

UNIT-V

Antineoplastic agents: Alkylating agents; Antimetabolites, Antibiotics

UNIT-VI

Diuretics:

Mercurial Diuretic & Non-mercurial diuretics (Thiazides, Carbonic-anhydrase inhibitors, miscellaneous sulphonamides diuretics).

Books Recommended:

1. An Introduction to Medicinal Chemistry, Graham L. Patrick.
2. Medicinal Chemistry: Principles and Practice Edited by F.D. King.
3. Textbook of Organic Medicinal and Pharmaceutical Chemistry, Edited by Charles O. Wilson, Ole Gisvold, Robert F. Doerge.
4. Introduction to Medicinal Chemistry, Alex Gringuage.
5. Principles of Medicinal Chemistry, William O. Foye, Thomas L. Lemice and David A. Williams.
6. Introduction to Drug Design, S.S. Pandeya and J. R. Dimmock, New Age International.
7. Burger's Medicinal Chemistry and Drug Discovery, Vol-1to VI, Ed. M.E. Wolff, John Wiley.
8. Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw-Hill.
9. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
10. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.

bject Name: MATERIALS CHEMISTRY

Introduction: Materials and their classification, inorganic and organic materials.

Inorganic materials: Design and synthesis of inorganic materials, requirements and constraints, combination properties of composites, functional materials, active materials; solid state reactions for synthesis of inorganic materials: ceramic methods, precursor method and sol-gel synthesis, physical and chemical vapour depositions; carbides, nitrides, structural and functional ceramics, intermetallics; intrinsic and extrinsic properties: electrical, optical and magnetic properties; ceramic superconductors, magnetic ceramics.

Organic materials: Molecular electronics: molecular materials for electronics and molecular scale electronics: Molecular properties, molecular arrangement and molecular interactions, piezoelectric and pyroelectric organic materials; molecular magnets based on transition metal complexes and organic ferromagnets, organic non-linear optical materials: photochromic organic materials and their classes; conducting polymers: polyacetylene, polypyrrole, polyaniline and polythiophene; conductive change transfer materials: TTFTCNQ, metal–dithiolate systems, fullerenes. Langmuir-Blodgett films, molecular electronic logic and architectures.

Nanomaterials:

Recommended Texts:

1. P.J. Vander Put, Inorganic Chemistry of Materials, Plenum Press, New York, 1998.

2. M.C. Petty, M.R. Bryce and D. Bloor, Editors An Introduction to Molecular Electronics, Edward Arnold, London 1995

Subject Name: PHOTOINORGANIC CHEMISTRY

Photochemistry of Transition Metal Complexes: Photoreactions of complexes of Cr(III) and Co(III), photo-aquation, photo-substitution and photo-racemization Photochemistry of Ru(bpy)32+ and its application as photocatalyst for photo-splitting of water, photooxidation of 2-propanol and photo-reduction of carbon dioxide, cyanide bridged triruthenium(II) bipy complexes as antenna. Photochemistry of diisocyanide bridged diimers of Rh(I). Applications of quenching and sensitization techniques in the identification of reactive state in coordination complexes. Photochemistry of Transition Metal Carbonyls and Europium complexes.

Recommended Texts:

1. D. M. Roundhill, Photochemistry and Photophysics of Metal Complexes, Plenum Press, New York and London (1994).

2. G. J. Ferraudi, Elements of Inorganic Photochemistry, John Wiley & Sons (1988).

3. V. Balzani and V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, London (1970).

4. O. Horvath and K.L. Stevenson, Charge Transfer Photochemistry of Coordination Complexes, VCH Publishers Inc. (1993)

Subject Name: FUEL AND COMBUSTION TECHNOLOGY

Introduction: History of solid, liquid and gaseous fuels, Production, present scenario and consumption pattern of fuels, Fundamental definitions, properties and various measurements techniques.

Solid Fossil Fuel (Coal): Coal classification, composition and basis, Coal mining, Coal preparation and washing, Combustion of coal and coke making, Coal liquefaction, Coal gasification

Liquid Fossil Fuel (Petroleum): Exploration of crude petroleum, Evaluation of crude, Distillation: Atmospheric distillation and Vacuum distillation, Secondary processing: (a) Cracking, Thermal cracking, Visbreaking, Coking, Catalytic cracking (b) Reforming of naphtha (c) Hydrotreatment, dewaxing and deasphalting, Refinery equipments, Petroleum refining techniques, Desulfurization of petroleum fuels.

Gaseous Fuels: Natural gas and LPG, Producer gas, Water gas, Hydrogen, Acetylene, Other fuel gases

Combustion Technology: Fundamentals of thermochemistry, Combustion air calculation, Calculation of calorific value of fuels, Adiabatic flame temperature calculation, Mechanism and kinetics of combustion, Flame properties, Combustion burners, Combustion furnaces, Internal combustion engines

Recommended Texts:

1. Fuels and Combustion, Samir Sarkar, 3rd. ed Universities Press.

2. Modern Petroleum Refining Processes, B.K. Bhaskar Rao, 4th ed., Oxford & IBH Publishing Co. Pvt. Ltd.

3. Modern Petroleum Technology, Vol 1, Upstream, Ed. by Richard A. Dave, IP, 6th ed., John Wiley & Sons. Ltd.

4. Modern Petroleum Technology, Vol 2, Downstream, Ed. by Alan G. Lucas, IP, 6th ed., John Wiley & Sons. Ltd.

5. Combustion, Irvin Glassman, 2nd ed., Academic Press.

6. Fuels Combustion and Furnaces, John Griswold, Mc-Graw Hill Book Company Inc.

7. Petroleum Refinery Engineering, W.L. Nelson, 4th ed. Mc-Graw Hill Book Company.

Subject Name: ENVIRONMENTAL CHEMISTRY

Introduction to Environmental Chemistry: Concept and scope of environmental chemistry, Environmental terminology and nomenclatures, Environmental segments, The natural cycles of environment (Hydrological, Oxygen, Nitrogen)

Atmosphere: Regions of the atmosphere, Reactions in atmospheric chemistry, Earth's radiation balance, Particles, ion and radicals in atmosphere; Chemistry of ozone layer.

Hydrosphere: Complexation in natural water and waste-water, Micro-organisms in aquatic chemical reactions, Eutrophication, Microbiology mediated redox reactions.

Lithosphere: Inorganic and organic components in soil, acid-base and ion-exchange reactions in soil, micro and macro nutrients, nitrogen pathways and NPK in soil.

Chemical Toxicology: Toxic chemicals in the environments, Impact of toxic chemicals on enzymes, Biochemical effects of arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur oxides.

Air Pollution: Particulates, Aerosols, SOx, NOx, COx and hydrocarbon, Photochemical smog, Air-quality standards

Water Pollution: Water-quality parameters and standards: physical and chemical parameters, Dissolved oxygen, BOD, COD, Total organic carbon, Total nitrogen, Total sulfur, Total phosphorus and Chlorine, Chemical speciation (Pb, As, Hg)

Recommended Texts:

1. G.W. Vanloon, S.J. Duffer, Environmental Chemistry - A Global Perspective, Oxford University Press (2000).

2. F.W. Fifield and W.P.J. Hairens, Environmental Analytical Chemistry, 2nd Edition (2000), Black Well Science Ltd.

3. Colin Baird, Environmental Chemistry, W.H. Freeman and Company, New York (1995).

4. A.K. De, Environmental Chemistry, 4th Edition (2000), New Age International Private Ltd.,New Delhi.

5. Peter O. Warner, Analysis of Air Pollutants, 1st Edition (1996), John Wiley, New York.

6. S.M. Khopkar, Environmental Pollution Analysis, 1st Edition (1993), Wiley Estern Ltd., New Delhi.

7. S.K. Banerji, Environmental Chemistry, 1st Edition (1993), Prentice-Hall of India, New Delhi.

Subject Name: PRACTICAL CHEMISTRY SPECIAL PAPER

INORGANIC CHEMISTRY

1. (a) Synthesis and structural characterization (IR, electronic spectra and magnetic susceptibility) of $[Ni(py)_4(NCS)_2]$.

(b) Synthesis of a series of Ni(II) complexes (with ligands of varying ligand field strength), electronic spectral interpretation and calculation of various ligand-field parameters.

2. Synthesis and structural characterization (IR, Electronic spectra) of the cis- and transisomers of $[Co(en)_2Cl_2]$

3. Synthesis and characterization (IR and PMR & CMR) of $[Al(acac)_3]$

4. Synthesis, purification by sublimation and structural characterization (IR and electronic spectra) of ferrocene.

5. Acetylation of ferrocene and separation of the acetyl derivative by column chromatography.

ORGANIC CHEMISTRY

1. Separation and identification of organic mixtures containing up to three components.

2. Preparation of organic compounds involving several stages, characterization of intermediates and final products by IR and NMR spectroscopy.

3. Techniques of organic chemistry: Special practical's involving steam distillation, photo-isomerization and thin layer chromatography etc.

4. Quantitative analysis of (i) sulphur and (ii) nitrogen.

PHYSICAL CHEMISTRY

1. Kinetics of decomposition of benzene diazonium chloride.

2. Conductometric study of the kinetics of saponification of ethyl acetate.

3. Determination of transport numbers of Cu^{2+} and SO_4^{2-} by Hittorf's method.

4. Conductometric titration of triple mixture ($HCl+NH_4Cl+KCl$) with (i) NaOH and (ii) $AgNO_3$.

5. Analysis of halide mixture by differential potentiometry.

6. Conductometric titration of a polybasic acid.

7. Verification of the Nernst law of electrode potential.

8. Determination of band-gap of a semiconductor.

9. Ternary phase diagram of water, benzene, and acetic acid.

10. Determination of molecular weight of a macromolecule by viscometry.

11. Half-life periods of a source containing two radionuclides.

12. Electrochemical Impedance study of metal/solution interface.

13. Cyclic Voltammetry of the $[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}$ system.

Subject Name: SUMMER TRAINING

Summer training at any Industry/ National Laboratory/ University/ Institution